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Influence of Drying on the Phytochemicals and Antioxidant Properties of *Bombax buonopozense* (Gold Coast Bombax) Sepals

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Abstract Dried sepals of red silk cotton plant (*Bombax buonopozense*) are incorporated into soups by some Ghanaian indigenes due to the antimicrobial and antioxidant properties. This study was aimed at determining the influence of drying (sun, solar, and oven drying) on phytochemicals and antioxidant properties of the sepals. DPPH radical scavenging activity method was used to determine the antioxidant activity, whereas total phenolics and tannin contents were determined by Folin-Ciocalteu's method, and total flavonoids by Aluminium trichloride method. The results revealed the presence of alkaloids, tannins, total flavonoids, and total phenols. There was no significant difference (P> 0.05) in alkaloids and tannins contents of the dried sepals regarding the drying methods used. The solar-dried sepals showed highest level of antioxidant activity with EC50 of 0.063 mg/mL. There was also no significant difference (P> 0.05) in antioxidant activity with EC50 of the dried sepals regarding the drying methods used. The solar drying method preserved most of the antioxidant properties and tolerable levels of phytochemicals in the sepals which makes it a potential source of natural antioxidants and can help reduce degenerative oxidative stress in consumers.

Keywords: *red silk cotton plant, phytochemicals, drying methods, DPPH, Aluminium trichloride*

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1. Introduction

Bombax buonopozense, commonly known as Gold coast Bombax or red silk cotton tree is a plant from the family *Bombacaceae*. It is mostly found in West Africa, specifically the rainforest of Northwest Sierra Leone, Eastern Gabon, Ghana and Nigeria [1]. The plant is locally known as *Akonkodeɛ* among the Akan tribe of Ghana. Red-flowered silk cotton is a tree with most of its parts known to serve medicinal and traditional purposes, besides other benefits [1]. The sepals are slimy in nature; therefore, they are dried and used as ingredient in soup preparation by some natives. The sepals are known to extend the shelf life of food due to their antimicrobial properties [2]. The leaves of the plant are also rich in phytochemicals and nutritional content; hence they are consumed as food by cooking alongside with other condiments [3]. Medicinal plants are those that contain one or more secondary metabolites in their organs and can be isolated for therapeutic purposes. Secondary metabolites are in the form of minerals, antioxidants, vitamins and phytochemicals such as the alkaloids, flavonoids, tannins, saponins, steroids, etc. [4]. Some phytochemicals provide useful aid to the body in various ways when they are in moderate amount. However, high amounts can be toxic to the body. Some of the phytochemicals in this plant parts act as antioxidants and synergistically help scavenge free radicals in the body system to prevent oxidative stress. The antioxidant properties of a certain plant help to reduce damage of DNA tissues, lipid cell and inhibits transformation of malignant cell etc. [5]. In the industry, the synthetic antioxidants such as butylated hydroxyl anisole and butylated hydroxytoluene are mostly used and have been found out to be carcinogenic [6]. Recently, much attention has been directed to the plants that are rich in antioxidants in order to replace the synthetic ones in the food industry. Natural antioxidants such as; polyphenols, vitamins (C, E) and carotenoids are capable of maintaining the stability and the quality of food. Some plants are highly perishable due to their high moisture content and presence of microorganisms which make them susceptible to deterioration and spoilage and for this reason, they are preserved by drying. Drying is a common and effective method of extending the shelf life of plant materials. It extends the shelf life of plants materials by preventing some biochemical processes that may alter the geometric, nutritional and organoleptic properties. The drying method

that is normally used for drying the sepals is sun-drying. Generally, this method of drying takes some weeks to dry plant materials and can affect the organoleptic and nutritional content of the drying materials. In general, some of the disadvantages of drying is that, some volatile compounds in the plant materials can be altered due to temperature intensity, esterification and oxidation reactions. Some of the drying techniques used include; microwave drying, oven drying, solar tent, direct sun and freeze drying etc. [7]. However, the drying method used has impact on the nutritional, phytochemicals, minerals and antioxidant property of the detached plant material. According to [1], "The various parts of the plant have medicinal benefits." This shows that the edible parts of this very plant serve as nutraceuticals to terminate degenerative free radicals in the biological system. In spite of this, the edible sepals are perceived to contain phytochemicals and antioxidants since the plant shares the same nutrients. The sepals are normally sun-dried and grounded to serve as ingredient in sauce by some natives. However, there is no documented information on the effect of drying on the phytochemicals and antioxidant properties of the sepals. Therefore, this study will provide baseline information on the quantity of phytochemicals and antioxidant levels present in the sepals and also help in the selection of effective drying methods that will provide better retention of the antioxidants and tolerable levels of the phytochemicals.

2. Materials and Methods

2.1. Sepals Collection and Pre-treatment

Fresh flowers of *Bombax buonopozense* (Gold coast Bombax) were obtained from the Faculty of Agriculture, KNUST, Kumasi - Ghana. The sepals of the flowers (Figure 1) were manually sorted out from the petals and carefully cleaned to remove dirt and defected parts. Completely randomized design (CRD) was used in the study. The samples were divided into 4 portions. One portion was analyzed as 'fresh' after sampling from the population, grounded with mortar and pestle, and stored in the refrigerator. The remaining three portions were dried using three different drying methods (oven, solar-tent and sun).

Figure 1. *Akonkodeɛ* sepals

2.2. Drying and preparation of Samples

Approximately 470.00 g each of the remaining three sample portions were dried using different drying methods. One portion was solar dried for 3 days. The sepals were spread on a tray and was placed in an enclosed glassy metallic case and drying was done continuously. The temperature range of the solar tent drier was recorded around 45°C to 55°C. Another portion was oven-dried at 40°C for 3 days. The samples were spread on a tray and were placed in a conventional laboratory oven (Binder GmbH Im Mittleren Osch 578532 Tuttlingen/ Germany) and dried continuously without power fluctuations. The last portion was sun-dried in an open air. The sepals were spread on a thin black polyethylene sheet and placed on a flat plate in direct sunlight (UV) rays in an open air for a calculated time of 112 hours 20 minutes. This calculated time ensured crispiness of the sepals as compared to the sepals dried using the solar tent drier and the oven method, however, they were removed from the dark each day. The sepals were turned occasionally to allow even contact of the sun rays. Temperature range of the sun was recorded as 25°C to 35°C. All samples were grounded and stored in zip-lock bags and were kept in the refrigerator at 4°C for the purpose of analysis. The moisture content of each dried sample was performed and the dry matter of each dried sample was used for the calculations.

Figure 2. Sun, Solar and Oven dried '*Akonkodeɛ*' sepals respectively

2.3. Methanolic Extraction of Samples

The methanolic extract process as described by the method of [8] with slight modification, was employed. The fresh and the powdered samples of the sepals (100.00 g each) were accordingly extracted with 600.0 ml of 80 % methanol (v/v). The mixture was placed in a flask and kept at room temperature for 48 hours. Filtration was done using Whatman No.1 filter paper to obtain a clear solution. The filtrate of the extract was dried for 24 hours in accordance to the drying methods. The average yield of each extract was approximately 6.00 g.

2.4. Qualitative Phytochemical Screening

Qualitative chemical tests were carried out on the methanolic extracts and on the powdered sepals using standard procedures for some selected phytochemical constituents such as alkaloids, flavonoids, tannins and phenols following the standard procedure as cited by [9] with slight modification.

2.4.1. Test for Alkaloids

Two milliliters of each extract were mixed with 2.0 ml of 1.0 % aqueous HCl, taken into separate test tubes and 3 drops of Wagner's reagents (potassium mercuric iodide) were added. The formation of a reddish-brown precipitate with Wagner's reagent indicated the presence of alkaloids.

2.4.2. Test for Phenols

Five milliliters of each extract were mixed with 1.0 ml of 5.0 % ferric chloride solution. Greenish black coloration indicated the presence of phenols.

2.4.3. Test for Tannins

One percent gelatin solution containing 10.0 % sodium chloride solution was added to each extract. The formation of white precipitate indicated the presence of tannins.

2.4.4. Test for Flavonoids

Two milliliters of each extract were shaken with 5.0 ml of NH_4Cl and 1.0 ml of concentrated hydrochloric acid was added. A yellow coloration that disappears on standing indicates the presences of flavonoid.

2.5. Quantitative Determination of Phytochemicals

2.5.1. Determination of Total Flavonoids

The total flavonoids in the sample was determined using the method cited in the work of [8] with slight modification. A volume of 0.5 ml of each of the sample extract (10 mg/ml) was mixed with 0.5 ml of 2.0 % $AlCl_3$. The mixture was incubated at 25°C for 1 hour for the yellow color. The absorbance of the mixture was read at 430 nm using microplate spectrophotometer (Synergy H1 hybrid reader BioTek Jos. Hansen & Soehne GmbH, Hamburg/ Germany.www.joshansen.com).

2.5.2. Determination of Total Phenolics

The total phenolics in the samples were determined by the method cited in the work of [8] with slight modification. Folin-Ciocalteu reagent was used to determine total phenolics content in aqueous extract of *Bombax buonopozense* sepals. A volume of 10.0 µl of each extract (10 mg/ml) was mixed with 50.0 µl Folin-Ciocalteu and 790.0 µl of distilled water and incubated for 8 minutes. After which 150.0 µl of 7.0 % Na_2CO_3 was added. The resulting mixture was vortexed for 30 seconds and incubated in room temperature for 2 hours for colour development. The absorbance of the mixture was read at 750 nm using microplate spectrophotometer (Synergy H1 hybrid reader BioTek Jos. Hansen & Soehne GmbH, Hamburg/ Germany. www.joshansen.com).

2.5.3. Determination of Tannins

Tannin determination was done according to the method described by [10] with slight modifications. A volume of 125.0 µl of each extract (10 mg/ml) was mixed with 62.5 µl of Folin-Denis reagent, followed by the addition of 125.0 µl of 35.0 % Na_2CO_3 solution and distilled water of 937.5 µl. The reaction mixture was allowed to stand for 30 minutes at room temperature. The absorbance of the mixture was recorded at 725 nm using microplate spectrophotometer (Synergy H1 hybrid reader BioTek Jos. Hansen & Soehne GmbH, Hamburg/Germany. www.joshansen.com).

2.5.4. Determination of Alkaloids

Alkaloids were quantitatively determined according to the method of Harbone cited in the work of [8,11] with slight modification. One hundred milliliters of 10.0 % acetic acid in methanol was added to 2.50 g of each dried and fresh plant samples. They were covered and allowed to stand for 4 h at room temperature. The filtrate was then concentrated on a water bath to 1/4 of its original volume. Drop wise of concentrated ammonium hydroxide was added to each extract until the precipitation was completed and the whole solution was allowed to settle. The precipitate for each extract were collected and washed with dilute ammonium hydroxide and then filtered. The residues were dried and weighed.

2.6. Determination of Antioxidant Property

2.6.1. DPPH Radical Scavenging Assay

1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity was determined using a method as described by [12] with slight modification. Hundred microliters of the various concentrations of the test sample was added to 100.0 µl of 0.5 mM 1, 1-diphenyl-1-picrylhydrazyl radical (DPPH) in a 96 well plate. The plates were covered with aluminum foil, shaken gently and kept in the dark for 20 minutes after which the absorbance was read on a Synergy H1 plate reader at the absorbance wavelength of 517 nm. DPPH free radical scavenging activity in percentage (%) was calculated using the following formula;

$$\textit{The antioxidant activity}\ (\textit{DPPH inhibition})\ (\%) = \frac{(\text{ACcontrol} - \text{ASsample})}{(\text{ACcontrol})} \text{x}100$$

Where AC is the absorbance at 517nm and AS is the absorbance of the sample at 517nm.

2.7. Statistical Analysis

Data obtained was analyzed using one-way analysis of variance (ANOVA). Means were separated by Turkey Honest Significant Difference (THSD) at $p<0.05$.

3. Results and Discussion

3.1. Moisture Content of Bombax buonopozense Sepals

Table 1 below shows the percentage moisture content for fresh and dried *Bombax buonopozense* sepals. The fresh sepals were found to be 81.14 ± 0.35 and the moisture content obtained from the various drying methods (oven, solar and sun) were 2.81 ± 0.28, 5.53 ± 0.02 and 9.18 ± 0.10, respectively.

Table 1. Moisture content of fresh and dried *Bombax buonopozense* Sepals (Calyx)

Samples	% Moisture content
Fresh	81.14 ± 0.35^{a}
Oven dried	2.81 ± 0.28^{b}
Solar dried	5.53 ± 0.02^{c}
Sun dried	9.18 ± 0.10^{d}

Values are means of two replicates ± standard deviation. Means in the same column with different superscripts are significantly different ($p < 0.05$).

Moisture is a universal solvent that has the capability of dissolving many substances. It has the ability to shuttle nutrients and other substances around the body thus, providing a better platform for various tissues and organs to perform their functions effectively [4].

The results above show that, the moisture content of both fresh and dried sepals was significantly different ($p < 0.05$) from each other with the fresh sepals having highest moisture content. The moisture content obtained for the fresh sepals was closer to the moisture content of fresh roselle sepals (88.09 ± 0.05), both of which happen to be in the in the same family *Malvacae* [12]. Furthermore, higher moisture content of a sample shows a better mass flow rate which is attributed to drive moisture from the interior tissues to the surface to enhance efficient evaporation of moisture due to its thin outer skin [13]. The moisture content obtained for the various drying method indicated that the oven dried sepals recorded the least moisture content (2.81 ± 0.28). This implies that oven drying method was able to expel most of the water from the sepal. The disparities of the moisture content values between the different drying methods of the sepals may be attributed to temperature differences, climatic conditions (humidity), and temperature consistency. Despite the temperature of the oven (40°C), it was able to dry the sepals better than the solar drier with temperature range of (45-55°C). This could be attributed to the fact that, the temperature in the oven was consistency without any power fluctuations. Moreover, the moisture content of the solar dried sepals was lower than the sun-dried sepals. Both the solar and the sun depend on the sun as their source of energy. However, the solar drier has transparent glass that receives the sun rays directly to dry the samples and also has a solar collector which is able to store energy received from the sun. The climatic conditions did not have much influence on the sepals in the solar drier as compared to the sepals in the direct sun. This accounted for the high moisture content of the sun-dried sepals. However, the moisture content obtained for the dried sepals were below moisture content of 20.0 % which implies extensive shelf life stability [7].

3.2. Some Selected Phytochemicals Screening

Table 2 below shows the presence of some selected phytochemical constituents in both the fresh and dried *Bombax buonopozense* sepals. The results revealed the presence of alkaloids, phenols, flavonoids and tannins in the sepals. Phytochemicals are chemicals produced by plant which are known to have many pharmacological benefits and medicinal properties. They are not essential nutrients, neither the body requires them but their presence in food in tolerable levels will help fight against some heart diseases [14].

3.3. Some Quantitative Phytochemical Constituents

Table 3 shows the results for the quantitative phytochemical components of fresh and dried *Bombax buonopozense* sepals. The results showed that the fresh *Akonkodeɛ* sepals recorded highest quantity of alkaloids (29.27 ± 0.40 g/100 g DM) followed by sun dried (0.80 ± 0.04 g/100 g DM), oven dried (0.65 ± 0.05 g/100 g DM) and solar dried (0.53 ± 0.07 g/100 g DM) *Akonkodeɛ* sepals. Total flavonoids of 27.68 ± 0.86 mgQE/g DM was recorded by fresh *Akonkodeɛ* sepals. However, there was decrease in the quantity of total flavonoids content for the dried *Akonkodeɛ* sepals with oven dried, sun and solar dried sepals having total flavonoids of 14.00 ± 0.09 mgQE/g DM, 10.77 ± 0.22 mgQE/g DM and 10.28 ± 0.40 mgQE/g DM respectively.

Table 2. Some selected qualitative phytochemical components of fresh and dried *Bombax buonopozense* sepals

Phytochemical component	Test	Observation	Inference			
			Fresh	Oven dried	Solar dried	Sun dried
Alkaloids	Wagner's	Reddish precipitate	+	+	+	+
Flavonoids	Aluminum chloride	Yellowish	+	+	+	+
Phenols	Ferric chloride	Greenish-black precipitate	+	+	+	+
Tannins	Ferric chloride	Black precipitate	+	+	+	+

Key: + = Present.

Table 3. Some Quantitative Phytochemical Components of Fresh and Dried *Bombax buonopozense* Sepals

Phytochemicals components	Fresh	Oven dried	Solar dried	Sun dried	Extract equivalents
Alkaloids (g/100g DM)	29.27±0.40[a]	0.65±0.05[b]	0.53±0.07[b]	0.80±0.04[b]	ND
TotalFlavonoids (mgQE/g DM)	27.68±0.86[a]	14.00±0.09[b]	10.28±0.40[c]	10.77±0.22[c]	Quercetin
TotalPhenolics (mgGAE/g DM)	32.25±0.42[a]	21.14±0.87[b]	20.11±0.38[bc]	19.37±0.48[c]	Gallic acid
Tannins (mgTAE/g DM)	116.62±3.01[a]	22.38±0.05[b]	20.19±0.66[b]	22.33±0.03[b]	Tannic acid

Values are means of three replicates ± standard deviation. Means in the same row with the same superscripts are not significantly different ($p > 0.05$).

The highest total phenolics content was recorded by the fresh *Akonkodeε* sepals (32.25 ± 0.42 mgGAE/g DM) followed by oven dried (21.14 ± 0.87 mgGAE/g DM), solar dried (20.11 ± 0.38 mgGAE/g DM) and sun dried (19.37 ± 0.48 mgGAE/g DM) *Akonkodeε* sepals. The fresh *Akonkodeε* sepals recorded highest quantity of tannins (116.62 ± 3.01 mgTAE/g DM) as compared to oven dried (22.38 ± 0.05 mgTAE/g DM), sun dried (22.33 ± 0.03 mgTAE/g DM) and solar dried (20.19 ± 0.66 mgTAE/g DM) *Akonkodeε* sepals. There was no significant difference *($p > 0.05$)* between the sun, solar and oven dried sepals for alkaloids and tannins. However, there were no significant differences *($p > 0.05$)* between the solar and sun dried *Akonkodeε* sepals in terms of total flavonoids and total phenolic content. The alkaloids and tannins contents of the dried sepals were below the values reported for alkaloids (5.77 g/100 g), and tannins (34.6 mg/g) present in the oven dried edible leaves of the same plant at 65°C for 24 hours (Chisom *et al.*, 2014). However, only the oven dried sepals had higher total flavonoids (14.00 ± 0.09 mgQE/g DM) than the edible leaves (13.5 mg/g). Notwithstanding, all the dried sepals recorded high amount of total phenolics as compared to the total phenolics (1.80 mg/g) in the edible leaves of *Bombax buonopozense* reported by [4]. Alkaloids are nitrogenous base compound that have many pharmacological benefits such as analgesic effect, anti-malarial, anti-hypertensive etc. The pure isolate of the plant can be used in the treatment of diseases. Their actions are manifested in the blood vessel and the promotion of diuresis, causes gastrointestinal tract diseases and nervous disorders when their quantity in the plant is high [1].

Flavonoids are water soluble and widely distributed polyphenolic compound. They have antioxidant potency of quenching free radicals that are associated with degenerative diseases due to their strong redox properties. They also have the ability to terminate the process of carcinogenesis. Their presence in the intestinal tract helps lower the risk of heart diseases. They act as cytoplasmic poison and inhibit enzymatic activities associated with deteriorative reactions [3]. Total phenolics are the largest group of phytochemicals that are well known for their antioxidant properties, thus they are capable of scavenging free radicals associated with oxidative diseases (Mbaebie *et al.*, 2012). They are also capable of inhibiting microbial growth by attacking their DNA thus reducing their activities and finally resulting in death. Tannins are a polymeric group of flavonoids that possess astringent effect which quickens the healing of wounds and inflamed mucus membranes [3]. They are reported to lower the digestibility of macro nutrients such as protein and carbohydrate by inhibiting the digestive enzymes. They prevent the bioavailability of minerals by forming complexes with them thus this can lead to anemia [4]. Notwithstanding, the pure extract of the tannins can be used to clarify wine, beer and fruit juices in the food industry. The fresh sepals cannot be consumed as fresh but rather in a dried form due to high amount of tannins present. The disparities of the quantities of the phytochemical constituents present in both the dried and fresh sample may be due to differences in temperature and geographical location of the plant, among other factors. [15] reported in the work, that decrease in phytochemical constituents is caused by thermal treatment which affects the integrity of the tissues, leading to the rupture of cell structure and the migration of the phytochemical constituents in to the atmosphere.

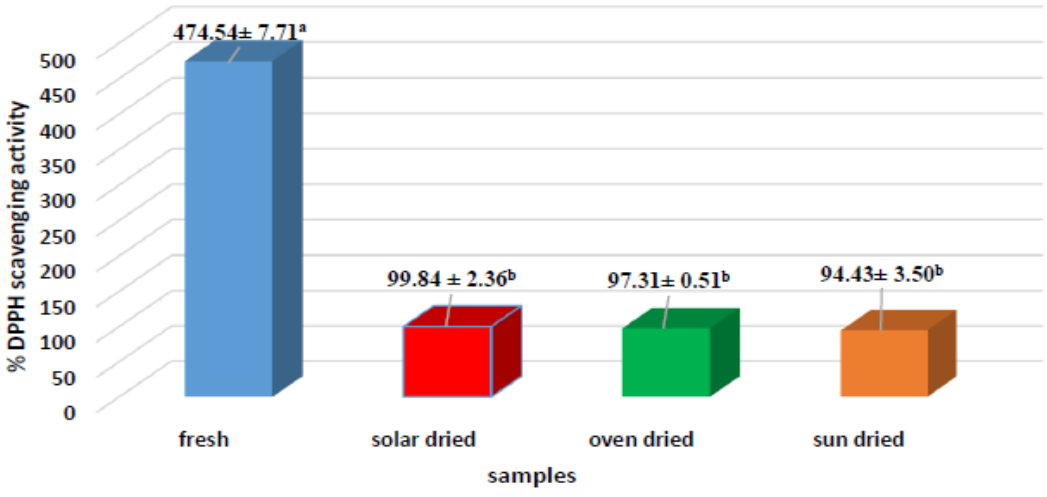

Figure 3. (%) DPPH Scavenging Activity by Bombax *buonopozense* Sepals Extract at 10 mg/ml

3.4. Antioxidant Activities of *Bombax buonopozense* Sepals Expressed in Dry Matter Basis

From Figure 3, the antioxidant activities of *Bombax buonopozense* sepals ranged from 94.43 % to 474.54 % in the order of fresh > solar> oven > sun. There was significant difference (P<0.05) between both fresh and dried *Akonkodeɛ* sepals, however, there was no significant difference (P>0.05) between the dried *Akonkodeɛ* sepals. The fresh *Akonkodeɛ* sepals recorded the highest antioxidant activity (474.54 ± 7.71 %) and amongst the dried *Akonkodeɛ* sepals, the solar dried sepals recorded the highest antioxidant activity (98.84 ± 2.36 %) followed by oven dried (97.32 ± 0.51 %) and the least antioxidant activity was recorded by sun dried 94.43 ± 3.50 % *Akonkodeɛ* sepals. The least antioxidant activity of the sun-dried sepals amongst the dried samples implies that most of the phytochemicals that contribute to the antioxidant potency were degraded. This shows that sun drying may not be efficient method for drying *Akonkodeɛ* sepals.

[16] reported that sun drying has consistently produced extracts of low antioxidants which has manifested in the results obtained for the sun-dried sepals in this study. The antioxidant activities exhibited by both the fresh and dried sepals could be explained by the presence of prominent phytochemicals such as tannins, phenols, flavonoids, alkaloids etc. which contributed synergistically to the antioxidant effect of the sepals [17]. There were disparities of the antioxidant activity between the fresh and dried *Akonkodeɛ* sepals. This could be due to thermal treatment (temperature) which can affect the phytochemicals by thermal breakdown thus, affect the integrity of the cell structure of the sepals which probably lead to loss of some of the phytochemical constituents. The loss of the phytochemical constituents can be caused by various chemical reactions such as enzymes, oxygen and light [18]. The highest antioxidant activity exhibited in the solar dried sepals could be attributed to few losses of the phytochemicals thus, retaining most of the phytochemicals that contribute to antioxidant potency. Moreover, antioxidant capacity of a plant sample depends on the position of the hydroxyl group on the aromatic core structure of the polyphenols, the specific composition, the total number of the phenolic hydroxyl group present (ortho or para), the higher the number of ortho or para-oriented phenolic hydroxyl group, the higher the antioxidant properties of the sample [19].

Table 4. Percentage DPPH radical scavenging assay in terms of EC_{50} of Bombax buonopozense (calyx) sepals

Sample	EC_{50} (mg/mL)
Ascorbic acid (Standard)	0.043 ± 0.002^{a}
Fresh sepals	0.052 ± 0.002^{a}
Solar dried sepals	0.063 ± 0.005^{ab}
Oven dried sepals	0.075 ± 0.006^{ab}
Sun dried sepals	0.0901 ± 0.001^{b}

Values are means of three replicates ± standard deviation. Means in the column with the same superscripts are not significantly different (p > 0.05).

The results indicated that there was no significant difference (p > 0.05) between the Ascorbic acid and the fresh, solar and oven dried sepals. Also, there was no significant difference (p > 0.05) between the dried sepals. Efficiency concentration at 50% (EC_{50}) simply means that, at 50% how active is the polyphenols present in the sample able to donate electrons to scavenge free stable radicals of DPPH in order to become a stable magnetic molecule. Hence the lower the concentration of the EC_{50}, the higher the antioxidant activity of the sample [19]. This implies that the antioxidant potency in the solar dried sepals was the greatest amongst oven and sun-dried sepals. The lower EC_{50} recorded by the sun-dried sepals can be attributed to the longest hours that was used to dry the sepals. Hence most of the phytochemicals that contribute to the antioxidant property were lost as compared to the fresh sepals which was not exposed to thermal treatment thus, the phytochemical constituents were intact.

4. Conclusion

Oven and solar drying techniques were the better drying methods because they retained most of the antioxidant properties and tolerable levels of phytochemical constituent in the sepals as compared to the sun drying method. However, the solar drying method has relatively better economic and hygienic advantage to dry *Bombax buonopozense* sepals. Consumer's health is not at risk due to the tolerable levels of phytochemical constituent and appreciable amount of antioxidant property in the sepal. Due to the high antioxidant potency in the sepals, they can be extracted and used in the food industry.

Statement of Competing Interest

The authors have no competing interests.

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