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Nutritional profiling of garden egg stalk *Solanum macrocarpum* L. (Solanales: Solanaceae)

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Abstract. This study was carried out to evaluate the nutritional properties of *Solanum macrocarpum* L. (Solanales: Solanaceae) (garden egg) stalk using standard methods. Sulphates and chloride were the most abundant anions while calcium and magnesium were the predominant mineral cations. Results for the proximate composition showed high carbohydrates (27.70%), fibre contents (22.94%), and ash (18.83%) while the phytochemical composition showed higher ribalinidine, catechin, and phenol contents. Vitamin B_6, C, A, and B_{12} were found in higher concentrations, while lysine (9.48 g/100 g), phenylalanine (6.86 g/100 g), leucine (6.59 g/100 g), and arginine (5.66 g/100 g) were the predominant essential amino acids. Results for the free radical scavenging potentials showed higher DPPH, nitric oxide, hydrogen peroxide, and ABTS radical scavenging potentials for the garden egg stalk, while their ferric reducing antioxidant power, superoxide and lipid peroxide scavenging were comparable to the standards used. This study has shown the high nutrient density of the garden egg stalk, thus encouraging its inclusion for dietary uses.

Keywords: Garden egg stalk; Phytochemicals; Micronutrients, Amino acids; Proteins.

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Introduction

Vegetables are useful components of the diet due to their contributions in forming a balanced diet. They are found among a vast amount of plant species that can serve as readily available proteinous sources and herbs.

The efficacies of various kinds of herbs have been widely explored, and because of their distribution in different localities have availed the opportunity for traditional herbalists to ensure affordable treatment of ailments. Notwithstanding, the explosion in population have necessitated an extensive research for undiscovered or underexploited herbs. *Solanum* is a widely dispersed genus of the Solanaceae Family with over a thousand species, a tenth of which are indigenous African species. The dominant species are *S. macrocarpon* and *S. aethiopicum* (Bonsu et al., 2002) and are commonly called garden eggs or locally known as Dauta in Hausa, Igbagba in Yoruba, and Afufa in Ibo.

Garden eggs *Solanum macrocarpum* L. (Solanales: Solanaceae) are highly regarded part of the regular daily diet and medicament in Nigeria. In other cases, egg plants are of cultural significance as they are used to show fruitfulness and blessings, and are frequently offered as kola to show goodwill during visits, ceremonies and other social gatherings. They can be consumed fresh, fried, and raw for soups, stew and sauce preparations. Bello et al. (2005) have reported their usage as medicament for weight loss, catarrh, rheumatism, skin diseases, digestive difficulties, and some allergies.

In addition, Igwe et al. (2013) and Odetola et al. (2004) observed that egg plants possess potent glucose lowering, anti-inflammatory, cholesterol lowering and asthma relieving properties. Obviously, both the fruit and leaves of egg plants have been extensive researched on, but no study is yet to be undertaken on the nutrient properties of the stalks attached to the fruit which are usually discarded.

This study was thus carried out to explore the nutrient density of the egg plant stalk.

Metodology

Sample collection and identification

Fresh garden egg *Solanum macrocarpum* fruits were bought from Choba Market, Port Harcourt, Rivers State. The stalk were collected and identified at the Department of Plant Science and Biotechnology, University of Port Harcourt, Choba, Rivers State.

Proximate composition and phytochemical analysis

Proximate content determination was carried out by the method of Ogunka-Nnoka et al. (2017). The method of Agomuo et al. (2018) and as modified by Agomuo and Amadi (2018) was adopted for the chromatographic isolation of the phytoconstituents. A bulk scientific chromatography machine, equipped with a Hp-88 capillary column of 100 m x 0.25 mm dimension was used under some of the following conditions; detector type was flame ionization detector, split injection (1 mL) mode at 220 °C, detector and oven temperature were 250 °C and 180 °C, respectively, and hydrogen as carrier gas. An internal standard was used for identification of the phytochemicals.

Determination of vitamins and minerals

For the vitamins determination, a 0.10 g homogenized samples was pressed and 1.0 mL of the extracts was transferred to a HP 6890N model of gas chromatography machine with a pulse flame photometric detector and a HP-5 30 m x 25 mm x 25 µm column. A split injection mode of 20:1 was used for nitrogen as the carrier gas with a 1.0mL/min flow rate. For the oven conditions, 50 °C was the initial temperature for 2 min, and maintained the detector a 320 °C. The mineral contents were estimated by the method of Amadi et al. (2018) by wet digestion of the samples in a mixture of concentrate nitric acid and $HClO_4$ (60% v/v) and afterwards estimated using an atomic mass absorption spectrophotometer. Sulphate was measured by turbidimetry, while chloride was by titrimetry.

Analysis of amino acids contents

Briefly, hydrolysates (150 µL) obtained following the method of Moore and Stein (2001) was injected into the separation column of a Sykam-S7130 model of HPLC analyzer as described by Amadi et al. (2017). The areas of the standards were used to determine the percentage amino acid composition of the sample. The amount of tryptophan was determined calorimetrically from alkaline hydrolysis of the sample according to Rama Rao et al. (1974).

Determination of the antioxidant properties

2,2-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid) (ABTS) radical scavenging assay was carried out as described by Agomuo and Amadi (2018) at a wavelength of 734 nm while 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay was carried out following the description of Shimada et al. (1992) at 517 nm. The determination of ferric reducing antioxidant power (FRAP) was at a wavelength of 700 nm following the procedure of Sutharsingh et al. (2011) while the method of Fontana et al. (2016) was adopted for the determination of superoxide radical scavenging assay. Nitric oxide scavenging activity was determined at a wavelength of 546 nm with Greiss Reagent as standard while the determination of lipid peroxidation inhibition potentials were in accordance with the method of Ruberto and Barrata (2000).

Results and discussion

The result for the proximate composition was presented in Table 1. The ash, moisture, and protein contents were 18.83%, 9.43%, and 15.41%, respectively, while the fat, fibre and carbohydrate contents were 5.68%, 22.94%, and 17.70%, respectively. The moisture content provides an indication as to its dry matter content, its susceptibility to microbial infestation, and the freshness of the food material. From the results of this study, the eggplant stalk contains poor moisture content, which was lower than the eggplant fruit itself (Nwodo et al., 2011).

The ash content directly relates to the amount of minerals in a food material, while the fibre content indicates the extent of gastric emptying and intestinal bulk, derivable from consuming the food material. Both the ash and fibre contents of the eggplant stalk in this study were greater than that of the fruit itself (Nwodo et al., 2011) as well as those for some other vegetables reported by Asaolu et al. (2012).

According to Ali (2009), food materials providing above 12% of proteins can be regarded as sufficient protein sources. This implies that the eggplant stalk is a sufficient protein source. The fat contents of the eggplant in this study compared with those of leafy vegetables (Udosen, 1995), while the result of this study further indicated that the eggplant is a better carbohydrate source when compared to those for its fruit varieties; *S. aethiopicum* and *S. macrocarpum* (Nwodo et al., 2011).

Table 1. Proximate composition of egg plant stalk.

Proximate composition	Contents (%)
Ash	18.83 ± 0.44
Moisture	9.43 ± 1.65
Protein	15.41 ± 1.99
Fat	5.68 ± 0.31
Fibre	22.94 ± 2.19
Carbohydrate	27.70 ± 2.61

Values represent means ± S.D. of duplicate determinations.

Table 2 shows the phytochemical composition of eggplant stalk. Ribalinidine, catechin, phenols and kaempferol (20.55, 13.46, 12.34, and 7.41 μg/g) were the predominant phytochemicals in the eggplant stalk, while anthocyanin, oxalates, and phytates were the least abundant phytochemicals. Ribalinidine and lunamarine are recognized alkaloids with antimalarial and analgesic effects (Agomuo et al., 2017), hence, the eggplant stalk could potentially possess effective antimalarial and analgesic properties.

In addition, the abundance of catechins and other phenols in the eggplant, as shown in Table 3, implies that this plant material could be useful in management of blood pressure and cardiovascular diseases (Khalesi et al., 2014). Also, coupled to the predominance of phenols, the kaempferol content of the eggplant stalk ensures its effectiveness in combating oxidative stress (Paolillo et al., 2011).

The low levels of the antinutrients; oxalates and phytates is an indication of higher mineral bioavailabilities.

Table 2. Phytochemical composition of egg plant stalk.

Parameters	Concentration (µg/g)
Anthocyanin	0.37
Oxalate	0.79
Sapogenin	4.41
Rutin	4.42
Phenol	12.34
Saponin	7.05
Lunamarin	1.49
Ribalinidine	20.55
Phytate	1.13
Kaempferol	7.41
Catechin	13.46

Table 3 reveals the vitamin compositions of the egg plant stalk. The fat soluble vitamins; A, D, E were 21.86, 9.63, and 7.82 µg/g, respectively, while vitamin B_6 (116.48 µg/g), C (46.26 µg/g), and B_{12} (13.41 µg/g) were the most abundant water soluble vitamins. The results imply that all the fat soluble vitamins were below their respective RDA's of 900, 10, and 15 µg (Ogunka-Nnoka et al., 2017).

Vitamin A and E are potent antioxidants while vitamin D is essential for the maintenance of bone health, hence, the eggplant requires supplementation with richer sources of these vitamins on account of dietary usage. Notwithstanding that the amounts of the water soluble vitamins found in the eggplant stalk were lower than their recommended daily allowance, their levels presented in this study, were greater when compared to some plants with notable health benefits (Ikewuchi and Ikewuchi, 2009).

The mineral contents of egg plant stalk were presented in Table 4. The minerals ranged from 5,073 mg/kg for the chloride content to 0.14 mg/kg for the copper level. The anions; chloride and sulphate were the most abundant minerals found in the egg plant stalk, followed by calcium and magnesium. The sodium and potassium contents of the eggplant stalk were greater than those reported for the eggplant fruit (Eze and Kanu, 2015). Also, the magnesium, zinc, and calcium contents of the eggplant stalk were lower than those found for commonly consumed vegetables like bitter leaf and *Amaranthus hybridus* (Asaolu et al., 2012), while the iron, copper and phosphorus levels found for the eggplant stalk, were below the recommended daily intake (Eze and Kanu, 2015). The deficiencies regarding the amounts found for these minerals contained in the eggplant stalk in this study, implies that it requires supplementation with richer nutrient sources, for dietary purposes.

Table 3. Vitamin composition of egg plant stalk.

Parameters	Concentration (µg/g)
Vitamin A	21.87 ± 1.26
Vitamin D	9.63 ± 0.27
Vitamin E	7.82 ± 0.04
Vitamin C	46.26 ± 1.32
Vitamin B_1	0.36 ± 0.04
Vitamin B_2	0.34 ± 0.04
Vitamin B_3	0.71 ± 0.05
Vitamin B_6	116.48 ± 5.62
Vitamin B_{12}	13.41 ± 0.65

Values represent means ± S.D of duplicate determinations.

Table 4. Mineral contents of egg plant stalk.

Minerals	Content (mg/kg)
Sodium	7.91 ± 0.02
Potassium	9.16 ± 0.10
Magnesium	22.13 ± 0.22
Zinc	4.85 ± 0.12
Calcium	41.41 ± 1.53
Iron	0.25 ± 0.02
Copper	0.14 ± 0.02
Phosphorus	8.61 ± 0.50
Sulphate	111.12 ± 6.43
Chloride	173.24 ± 53.9

Values represent means ± S.D. of duplicate determinations.

The amino acid composition of the eggplant stalk was shown in Table 5. Lysine (9.48 g/100 g), phenylalanine (6.86 g/100 g), leucine (6.59 g/ 100g), arginine (5.66 g/100 g), and histidine (5.35 g/100 g) were the predominant essential amino acids, while glutamate (14.69 g/100 g) and aspartate (12.21 g/100 g) were the most abundant of the non-essential amino acids. These amino acids were higher than those of the eggplant fruit, except for leucine and phenylalanine contents (Sodamade et al., 2015).

In addition, the threonine, isoleucine and tryptophan contents of the eggplant stalk in this study were higher than the WHO reference amino acid values (Sodamade et al., 2015). Similarly, the eggplant stalk produced higher individual non essential amino acids than popularly consumed vegetables such as *A. cruenthus*, *V. amygdalina*, and *T. triangulare* (Olubunmi et al., 2015). This implies that the eggplant is richly supplied with essential amino acids, and could serve as a dependable protein source.

Table 5. Amino acid content of egg plant stalk.

Components	Concentration (g/100g)
Essential amino acids	
Lysine	9.48
Histidine	5.35
Arginine	5.66
Methionine	1.54
Threonine	4.28
Isoleucine	4.49
Leucine	6.59
Valine	2.47
Typtophan	1.24
Phenyalanine	6.86
Non Essential amino acids	
Glycine	3.89
Alanine	4.06
Serine	3.84
Proline	3.91
Aspartate	12.21
Glutamate	14.69
Tyrosine	2.97
Cysteine	3.38
Total Amino Acids	96.91
Total Essential Amino Acids	47.96
Total Non-Essential Amino Acids	48.95

Figures 1-7 shows the *in vitro* antioxidant potentials of the eggplant stalk. The result indicated a concentration dependent free radical scavenging potentials of the eggplants at all the assay carried out.

The DPPH (Figure 1), nitric oxide (Figure 2), hydrogen peroxide (Figure 3), and ABTS (Figure 4) scavenging potentials of the garden egg stalk were higher than the standard ascorbic acid.

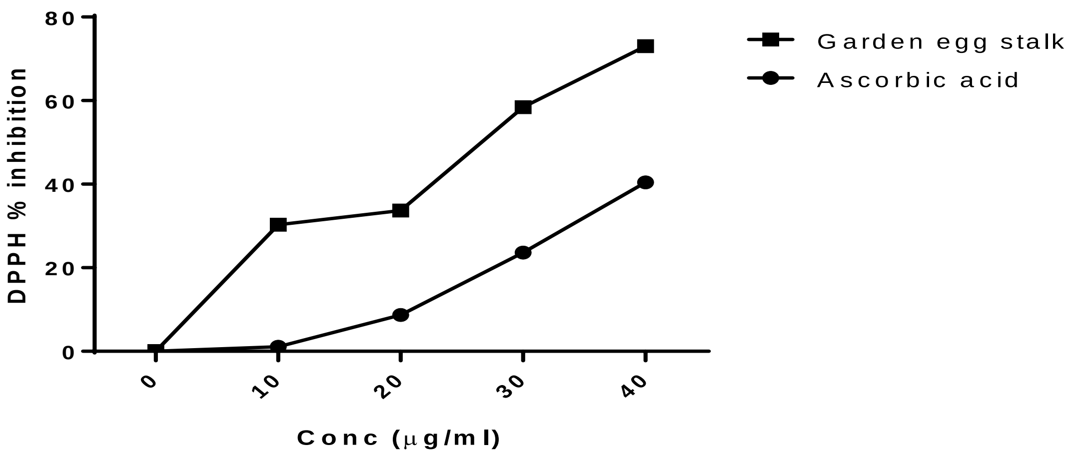

Figure 1. DPPH radical scavenging potentials of garden egg stalk.

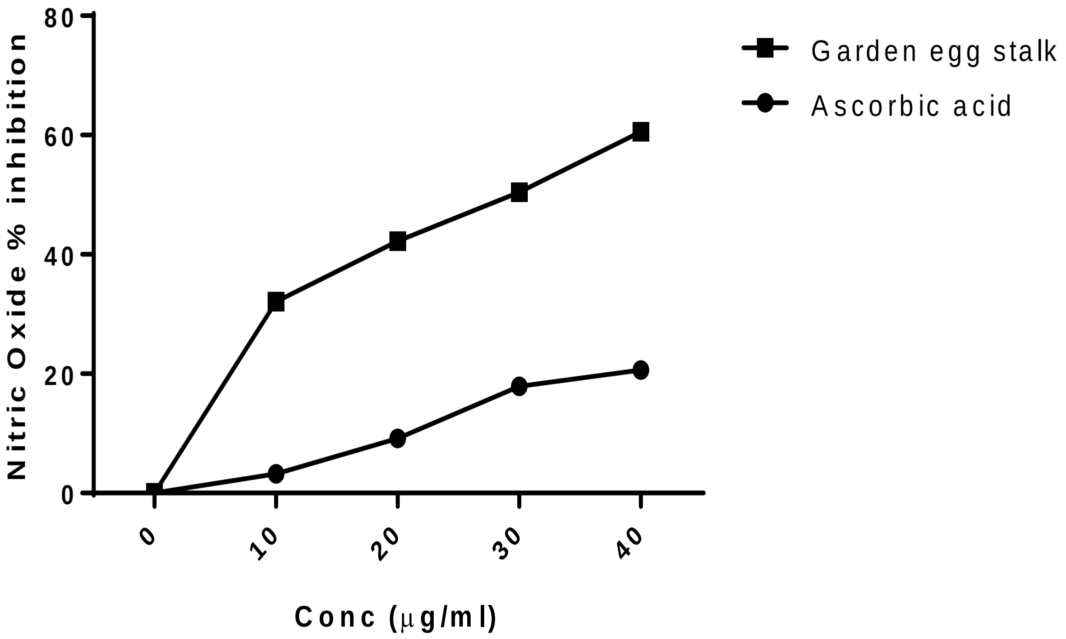

Figure 2. Nitric oxide scavenging potentials of garden egg stalk.

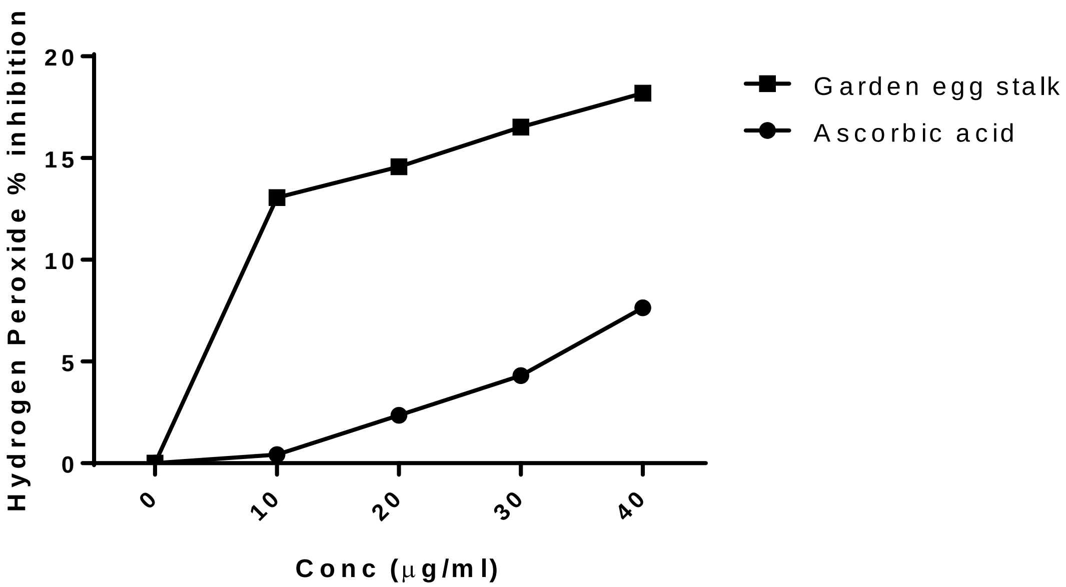

Figure 3. Hydrogen peroxide scavenging potentials of garden egg stalk.

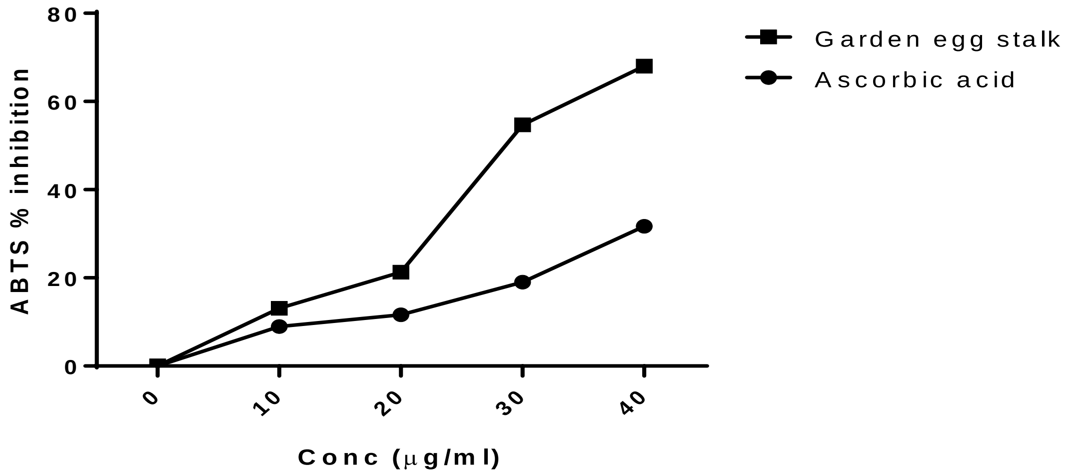

Figure 4. ABTS radical scavenging potentials of garden egg stalk.

While the Fe^{3+}, superoxide, and lipid peroxide scavenging potentials of the eggplant stalk as shown in Figures 5, 6, and 7, respectively, were equivalent to the standards used.

The significant DPPH and ABTS scavenging potentials of eggplant stalk shown in this study, testifies to the potent hydrogen donating capacities of their phytoconstituents, and in addition, their nitric acid and hydrogen peroxide scavenging potentials directly implicate rich supplies of phenolic acids in the eggplant stalk (Aluko et al., 2013).

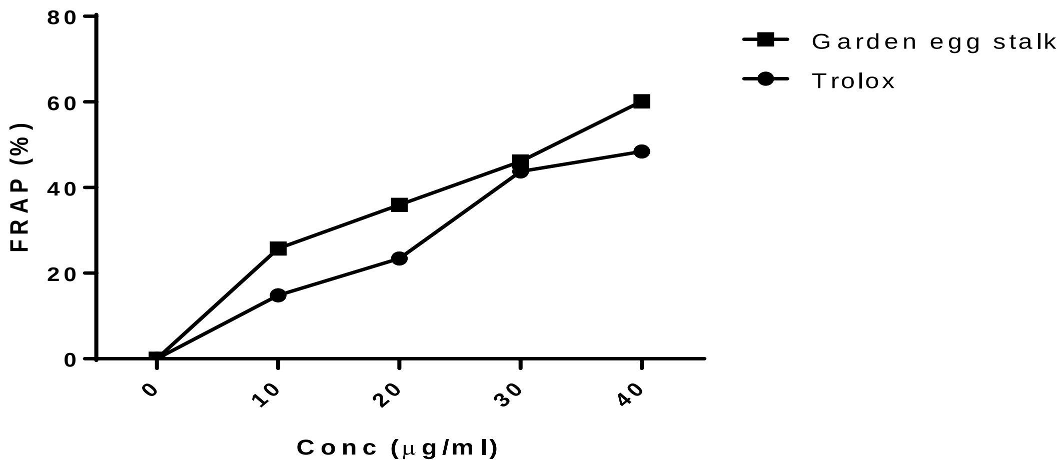

Figure 5. Ferric reducing antioxidant potentials of garden egg stalk.

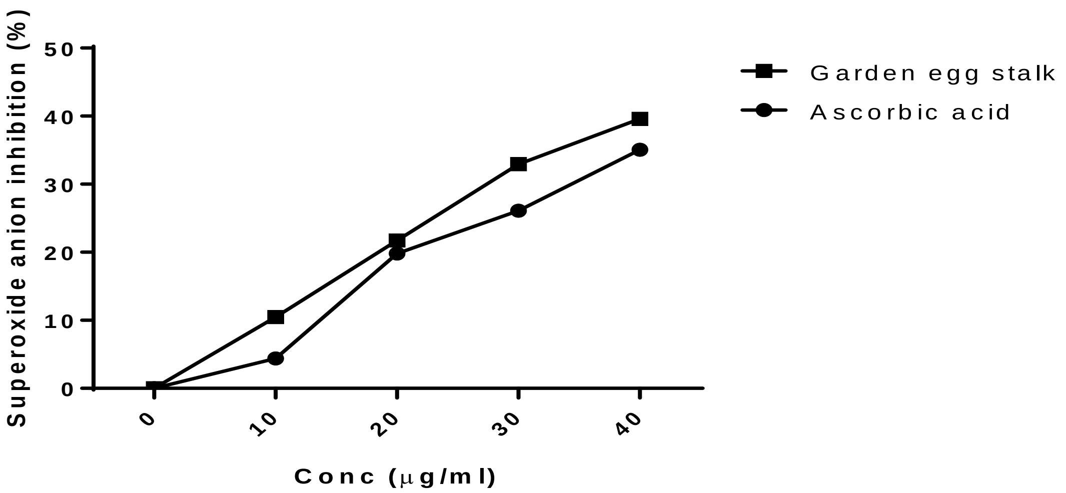

Figure 6. Superoxide anion scavenging potentials of garden egg stalk.

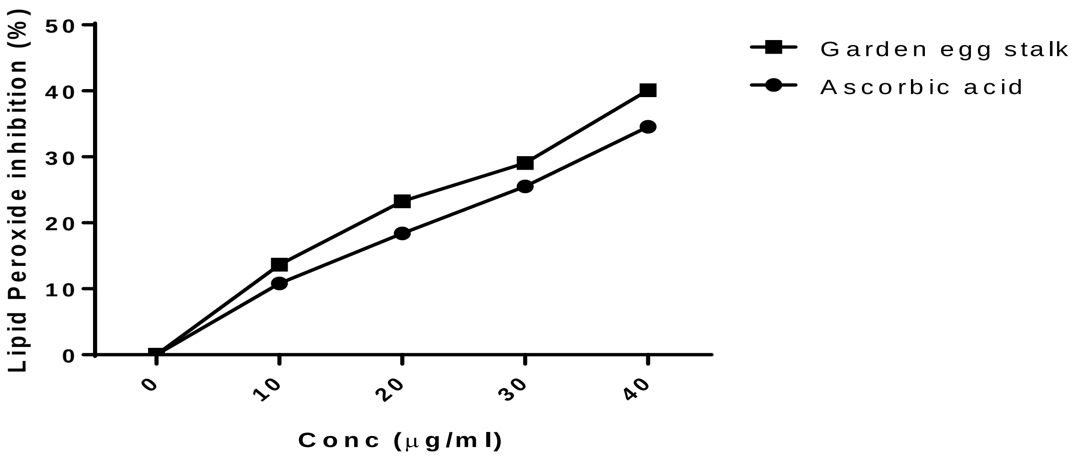

Figure 7. Fatty acid peroxyl radical scavenging potentials of garden egg stalk.

Conclusion

The nutritional evaluation of *S. macrocarpum* stalk in this study showed appreciable amount of proximate contents, micronutrients, and phytochemicals, while its free radical scavenging potentials further encourages its usage for relief of oxidative stress. Thus, this study has provided the needed scientific backing for the exploitation of garden egg stalk for dietary inclusion.

Conflict of interest

The authors declare that they have no conflict of interest in the publication.

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