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Research Article

Phytochemical composition and antioxidant properties of *Corchorus olitorius* leaves and *Azanza garckeana* seeds: Implications for phytocosmetic applications

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ABSTRACT

Skin aging, particularly photoaging, is largely driven by oxidative stress resulting from reactive oxygen species (ROS). Natural antioxidants from medicinal plants are of interest as potential contributors to skin health, as they may help mitigate oxidative stress mechanisms associated with aging. This study investigated the phytochemical composition and in vitro antioxidant activity of *Corchorus olitorius* leaves and *Azanza garckeana* seeds, with emphasis on their relevance to oxidative stress mechanisms associated with skin aging. Phytochemical analyses, both qualitative and quantitative, revealed the presence of bioactive compounds including phenolics, flavonoids, alkaloids, saponins, tannins, terpenoids, and steroids, with notably high levels of phenolics and flavonoids. Antioxidant activities were measured through DPPH, ferric reducing antioxidant power (FRAP), and nitric oxide (NO) radical scavenging assays, along with the assessment of ascorbic acid content. Both plant extracts demonstrated strong, dose-dependent free radical scavenging activities, with ethanolic extracts performing better. The IC_{50} values for DPPH and nitric oxide scavenging, calculated from triplicate measurements and expressed as mean ± SD, were below 100 µg/mL, indicating antioxidant capacity. When compared with literature reports on commonly used phytocosmetic plants such as Aloe vera, the extracts of *Corchorus olitorius* and *Azanza garckeana* demonstrated comparable or strong radical scavenging activity, despite differences in total phenolic content. While Corchorus olitorius is relatively well documented in the literature, *Azanza garckeana* remains underexplored with limited scientific data on its phytochemical and antioxidant potential, particularly in the context of phytocosmetic applications, making this inclusion a key novelty of this study.

Keywords: Antiaging Potential; Antioxidant Properties; *Azanza garckeana*; *Corchorus olitorius*; Phytoconstituents, Phytocosmetic

Introduction

Skin aging is a complex biological process influenced by intrinsic factors such as genetics and metabolism, as well as extrinsic factors including ultraviolet (UV) radiation, pollution, and lifestyle [1]. Among these, photoaging caused by prolonged UV exposure is the most significant contributor to premature skin aging [2]. The underlying mechanism of photoaging is largely attributed to oxidative stress, which arises from the excessive generation of reactive oxygen species (ROS) [3]. These reactive molecules cause damage to lipids, proteins, and DNA in cells, which results in the breakdown of collagen, decreased skin elasticity, formation of wrinkles, and compromised skin barrier function [4]. Antioxidants play a crucial role in neutralizing ROS and mitigating oxidative damage, thereby slowing the skin aging process [5]. While synthetic antioxidants have been widely used in cosmetic formulations, concerns regarding their long-term safety have shifted attention toward natural, plant-derived alternatives [6]. Medicinal plants are rich sources of bioactive phytochemicals such as phenolics, flavonoids, vitamins, and alkaloids,

many of which possess strong antioxidant and anti-aging properties. Consequently, the exploration of underutilized plant resources offers promising opportunities for the development of effective and affordable phytocosmetic ingredients.

Corchorus olitorius (ewedu) is a leafy vegetable widely consumed in Nigeria and other parts of Africa. It is traditionally valued for its nutritional content and medicinal benefits, including anti-inflammatory and antioxidant activities [7]. *Azanza garckeana* (gorontula), a lesser-known indigenous plant, is traditionally used for its nutritional and therapeutic properties, particularly in enhancing skin health and vitality [8]. Despite their widespread availability and ethnobotanical relevance, scientific data supporting their use in anti-aging and cosmetic applications remain limited. In particular, Azanza garckeana remains relatively underexplored in terms of its phytochemical composition, antioxidant mechanisms, and potential phytocosmetic applications when compared to more extensively studied medicinal plants. This limited scientific characterization positions *A. garckeana* as a novel and promising candidate for further investigation in skin-related oxidative stress management. Although *Corchorus olitorius* has been widely studied for its nutritional and antioxidant properties, most reports focus on dietary or general pharmacological applications. In contrast, the present study places *C. olitorius* within a phytocosmetic-oriented context by examining antioxidant mechanisms directly relevant to oxidative stress pathways implicated in skin aging. Furthermore, the study provides a comparative assessment with the relatively underexplored Azanza garckeana seeds, highlighting solvent-dependent phytochemical recovery and multifunctional antioxidant activity as distinguishing features.

Material and Methods

Chemicals and Reagents

All reagents and chemicals used in this study were of analytical grade and were obtained commercially from Sigma-Aldrich Chemical Limited (Germany). The reagents were supplied by the Chemical Store of the Department of Chemistry, University of Lagos, Nigeria, and were used as received without further purification. It is important to note that classical colorimetric tests for phytochemical screening, while widely employed, may have limited specificity and are susceptible to false positives from interfering compounds. Therefore, these qualitative observations were complemented by quantitative spectrophotometric and gravimetric assays to provide more accurate and reliable measurements of phytochemical abundance.

Plant Material, Drying, and Storage

Fresh leaves of Corchorus olitorius L. (Malvaceae) and seeds of Azanza garckeana (F. Hoffm.) Exell & Hillc. (Malvaceae) were purchased in April 2025 from Mile 12 Market, Lagos, Nigeria. The plant materials were taxonomically authenticated by Mr. Nodza George at the Herbarium of the Department of Botany, University of Lagos, Nigeria. Voucher specimens were deposited under the accession numbers LUH 100752 (C. olitorius) and LUH 100751 (A. garckeana), respectively. The purchased materials were thoroughly washed with distilled water to remove extraneous matter, dust, and any surface contaminants. They were initially air-dried under shade at ambient temperature, followed by oven-drying at 45 ± 2 °C in a forced-air oven until constant weight was achieved. The completely dried samples were then pulverized into fine powder using a laboratory mechanical grinder, passed through a 40–60 mesh sieve, properly labeled, and stored in airtight, amber-colored polyethylene containers at room temperature (25 ± 2 °C) in a dry, dark place to prevent moisture reabsorption, photo-degradation, and microbial growth prior to extraction and further analysis.

Preparation of Plant Extracts

Absolute ethanol (EE) and an ethanol–water (EAE) mixture (70:30 v/v) were used for extraction to target a broad range of phytochemicals. Absolute ethanol efficiently extracts moderately polar compounds such as flavonoids and phenolics, while 70% aqueous ethanol enhances recovery of more polar constituents including tannins, glycosides, and saponins. This solvent selection strategy allows for comparative assessment of extraction efficiency and antioxidant activity across compounds of varying polarity. Fifty grams (50 g) of each powdered sample was suspended in 200 mL of the respective solvent and allowed to stand at room temperature with intermittent agitation. The mixtures were subsequently filtered, and the filtrates were concentrated to dryness for further analyses.

Qualitative Phytochemical Analysis

Qualitative phytochemical screening of the crude ethanolic extracts was conducted using standard procedures described by Harborne [9] and Ejikeme et al. [10]. The analyses were carried out to detect the presence of bioactive constituents such as alkaloids, flavonoids, phenolics, tannins, terpenoids, steroids, saponins, reducing sugars, and glycosides with slight modification as indicated below.

Test for Alkaloids (Mayer's Test)

One milliliter (1 mL) of the ethanolic extract was mixed with 10 mL of a 1:1 ethanol–hydrochloric acid solution in a test tube. The mixture was heated in a water bath for 10 minutes and subsequently filtered. Mayer's reagent, prepared by dissolving 1.36 g of mercuric chloride and 5.00 g of potassium iodide in 100 mL of distilled water, was added to the filtrate. The formation of a buff-colored or creamy yellow precipitate indicated the presence of alkaloids.

Test for Flavonoids

Approximately 0.30 g of the powdered sample was added to 30 mL of distilled water and allowed to stand for 2 hours before filtration. Ten milliliters (10 mL) of the filtrate was mixed with 5 mL of 1.0 M dilute ammonia solution, followed by the careful addition of 5 mL of concentrated sulfuric acid (H_2SO_4). The

appearance of an intense yellow coloration that gradually faded upon standing confirmed the presence of flavonoids.

Test for Tannins

About 0.30 g of the powdered sample was mixed with 30 mL of distilled water and heated in a water bath for 10 minutes. After filtration, 5 mL of 1% ferric chloride solution was added to the filtrate. The development of a blue-black or brownish-green coloration indicated the presence of tannins.

Test for Phenols

One milliliter (1 mL) of the extract was mixed with 2 mL of 1% ferric chloride ($FeCl_3$) solution. The formation of a blue-green coloration confirmed the presence of phenolic compounds.

Test for Terpenoids and Steroids

Five milligrams (5 mg) of the powdered sample was dissolved in 10 mL of hot distilled water. Three milliliters (3 mL) of either diethyl ether or chloroform was added to the solution in a test tube. Subsequently, 2 mL of concentrated sulfuric acid was carefully introduced along the side of the test tube to form a separate layer. The appearance of a reddish-brown coloration at the interface indicated the presence of terpenoids or steroids.

Test for Saponins (Frothing Test)

Ten milliliters (10 mL) of distilled water was added to 10 mL of the ethanolic extract in a graduated cylinder. The mixture was vigorously shaken and allowed to stand undisturbed for 15 minutes. The formation of a stable froth layer confirmed the presence of saponins. Foam height was calculated using the formula:

$$\text{Foam Height} = H_2 - H_1$$

where H_2 represents the final foam height, and H_1 is the initial height.

Test for Reducing Sugars

Two milliliters (2 mL) of the aqueous extract were mixed with 1 mL each of Fehling's solutions A and B. The mixture was heated in a boiling water bath for 10 minutes. The formation of a brick-red precipitate indicated the presence of reducing sugars.

Test for Glycosides

Two grams (2.00 g) of the powdered sample was mixed with 20 mL of distilled water, heated for 5 minutes, and filtered. Two milliliters (2 mL) of the filtrate were treated with 15 mL of 1.0 M sulfuric acid and boiled for 10 minutes. The formation of a red precipitate indicated the presence of glycosides.

Quantification of Phytochemicals

Alkaloids, flavonoids, and saponins were measured using gravimetric methods. Tannins, reducing sugars, and total phenolic contents were determined through spectrophotometric techniques. Total phenolic content was expressed as gallic acid equivalents (GAE) for consistency across phenolic measurements. However, tannic acid was used as the calibration standard specifically for the Folin-Denis tannin assay, in line with the original validated method, and is reported separately as tannic acid equivalents where relevant.

Determination of Total Alkaloids

A 2.50 g portion of the sample was extracted with 200 mL of 10% acetic acid in ethanol for 4 hours. The extract was concentrated to one-quarter of its original volume using a water bath and filtered. Alkaloids were precipitated by adding approximately 15 drops of concentrated ammonium hydroxide. After standing for 3 hours, the supernatant was discarded, and the residue was washed with 20 mL of 0.1 M ammonium hydroxide, filtered, oven-dried, and weighed.

Determination of Total Saponins

Five grams (5 g) of the powdered sample was extracted twice with 100 mL of 20% aqueous ethanol at 55 °C for 4 hours under constant stirring. The combined extracts were concentrated to approximately 40 mL at 90 °C. The concentrate was purified by successive extraction with diethyl ether and n-butanol, followed by washing with 5% sodium chloride solution. The final extract was oven-dried to constant weight.

Determination of Total Phenolic Content

Two grams (2 g) of the powdered sample were defatted using diethyl ether in a Soxhlet extractor for 2 hours. Subsequently, 0.50 g of the defatted sample was boiled in 50 mL of ether for 15 minutes. Five milliliters (5 mL) of the extract was mixed with 10 mL of distilled water, 2 mL of 0.1 N ammonium hydroxide, and 5 mL of concentrated amyl alcohol. After 30 minutes, absorbance was measured at 505 nm using a UV/VIS TG-50 spectrophotometer.

A tannic acid standard curve (0.2–1.0 mg/mL) was prepared for calibration.

Determination of Total Flavonoids

A 2.50 g portion of the sample was extracted repeatedly with 80% aqueous methanol over 24 hours. The combined extracts were filtered, evaporated to dryness, cooled in a desiccator, and weighed to constant mass.

Determination of Reducing Sugar Content

Reducing sugar content was determined using the DNSA method as described by Krivorotova and Sereikaite (2014). Absorbance was measured at 540 nm, and results were expressed as mg D-glucose equivalent (GE) per gram of dry extract.

Tannin Determination (Folin–Denis Method)

Tannin content was determined spectrophotometrically using the Folin–Denis reagent. Absorbance was measured at 700 nm, and tannin concentration was calculated using a tannic acid standard curve. This assay follows [11] the Folin-Denis method, which conventionally employs tannic acid as the reference standard for tannin quantification.

Antioxidant Assays

The DPPH radical scavenging activity was determined following Okarter et al. [12]. Absorbance was measured after 30 minutes, and percentage inhibition was calculated using equation (1).

$$\%\ Inhibition = \frac{A_0 - A_1}{A_0} \times 100\ \% \text{.....(1)}$$

Where Ao = Absorbance of blank sample, A1 = Absorbance of plant extract solution

The FRAP assay was conducted according to Muller et al. [13]. Absorbance was recorded at 700 nm, with lower absorbance values indicating stronger reducing power. Nitric oxide scavenging activity was evaluated following Rao et al. [14]. Absorbance was measured at 546 nm, and scavenging activity was calculated with equation (1). All antioxidant assays were performed in triplicate (n = 3), and results are expressed as mean ± standard deviation (SD). IC50 values were determined from concentration-response curves constructed by plotting percentage inhibition against extract concentration using the mean values of triplicate measurements (n = 3). The concentration corresponding to 50% inhibition (IC50) was obtained by interpolation from the fitted dose-response curve.

Results and Discussion

The percentage yield of phytochemical extracts varied markedly among the samples, with Azanza garckeana seeds extracted in ethanol (GE) giving the highest yield (43.57%), followed by Azanza garckeana seeds in aqueous ethanol (GA) (29.22%). Corchorus olitorius extracts, particularly in absolute ethanol (EE), showed substantially lower yields (0.81–10.32%), which may reflect the limited solubility of certain polar constituents in absolute ethanol and the relatively high fibrous content of the leaves. Notably, low extraction yield does not preclude solvent antioxidant activity, as observed in subsequent assays, indicating that extract quality and phytochemical composition are critical factors. The observed differences in phytochemical abundance and antioxidant activity between ethanolic and aqueous ethanol extracts highlight the impact of solvent polarity on extraction efficiency and bioactivity, supporting the rationale for using these complementary solvents. This solvent-dependent variation can be mechanistically explained by differences in solvent polarity, hydrogen-bonding capacity, and dielectric properties, which govern the solubility and extraction efficiency of phytochemicals [15, 16]. Absolute ethanol, being moderately polar, preferentially solubilizes less polar to moderately polar compounds such as flavonoid aglycones and certain phenolic constituents, while aqueous ethanol (70% v/v), with higher polarity, enhances the extraction of more polar compounds, including tannins, glycosides, and saponins [16]. Water promotes plant matrix swelling, improving solvent penetration and facilitating mass transfer of intracellular constituents [17]. These explain the relatively higher extraction yields observed with aqueous ethanol. The stronger antioxidant activity in ethanolic extracts, despite lower yields in some cases, may be attributed to the selective extraction of compounds with higher redox potential and radical scavenging efficiency [18]. These observations are consistent with established solvent-phytochemical interaction principles [15-18] and reinforce the importance of solvent selection in modulating both extract composition and functional bioactivity.

Qualitative phytochemical screening of *Corchorus olitorius* leaves and Azanza garckeana seeds revealed the presence of several bioactive secondary metabolites, including phenolics, flavonoids, alkaloids, saponins, tannins, terpenoids, and steroids. These phytochemical classes are well documented for their antioxidant, anti-inflammatory, and skin-protective properties and provide a biochemical foundation for the observed biological activities of the extracts. The consistent detection of these compounds (Table 1) in both ethanolic and aqueous ethanol (70% v/v) extracts indicates that the plants possess a broad spectrum of polar to moderately non-polar metabolites. The quantitative analysis (Table 2) demonstrated notable differences in phytochemical abundance depending on the extraction solvent. However, it is important to note that while gravimetric analysis provides an overall estimate, it is non-specific and susceptible to co-precipitation of other constituents, which may result in minor overestimation of actual content. Future studies should consider chromatographic or spectrophotometric methods (e.g., HPLC, LC–MS, or UV–vis colorimetric assays) for more accurate and selective quantification. Total phenolic content (TPC), expressed as milligrams of gallic acid equivalents per 100 g dry weight (mg GAE/100 g), and total flavonoid content (TFC), expressed as milligrams of quercetin equivalents per 100 g dry weight (mg QE/100 g), were higher in ethanolic extracts compared to aqueous ethanol extracts (Table 3). This solvent-dependent variation reflects the enhanced solubility of phenolic acids and flavonoids in ethanol, which promotes more efficient extraction of these redox-active compounds. Similar trends have been reported for other antioxidant-rich medicinal plants, reinforcing the critical role of solvent polarity in phytochemical recovery.

Table 1. Qualitative phytochemical composition in *Azanza garckeana* and *Corchorus olitorius* extracts

Code	Alkaloid	Tannin	Saponin	Terpenoid	Cardiac Glycosides	Steroid	Flavonoid	Phenol
E.A	+	+	+++	+	+	+	+	++
E.E	+	+	+	+	+	+	+	+
G.A	+	+	++	+	+	+	+	+
G.E	+	+	+	+	+	+	+	+

+ = Present, ++ = Much in abundance, - = absent; E.A= Corchorus olitorius in aqueous ethanol (70 % v/v), E.E= Corchorus olitorius in ethanol, G.A= Azanza garckeana seeds in aqueous ethanol (70 % v/v), G.E= Azanza garckeana seeds in ethanol

Table 2. Quantitative phytochemical composition of *Azanza garckeana* and *Corchorus olitorius* extracts (mg/100g)

	Alkaloids	Tannin	Saponin	Terpenoid	Steroids	Flavonoids	Phenol
E.A	38.46 ± 0.110	26.87 ± 0.047	68.48 ± 0.010	48.45 ± 0.437	45.89 ± 0.003	24.64 ± 0.197	53.51 ± 0.163
E.E	30.60 ± 0.017	38.82 ± 0.072	43.60 ± 0.032	36.24	32.13 ± 0.007	38.22 ± 0.022	42.26 ± 0.010
G.A	35.53 ± 0.007	32.64 ± 0.012	46.44 ± 0.003	46.19 ± 0.003	35.09 ± 0.003	45.14 ± 0.007	40.5
G.E	33.53 ± 0.177	30.31 ± 0.020	34.41 ± 0.007	37.50 ± 0.662	32.37 ± 0.005	38.47 ± 0.068	32.51 ± 0.163

Values are expressed as mean ± SD of three independent determinations (n = 3).

Table 3. Total Phenol, flavonoid and antioxidant capacity of *Azanza garckeana* and *Corchorus olitorius* extracts

Sample	Total Phenol Content (mg GAE/100 g)	Total Flavonoid Content (mg QE/100 g)	Total Antioxidant Capacity (TAC) mg/100 mL
E.A	53.51 ± 0.248	28.46 ± 0.134	74.82
E.E	42.26 ± 0.016	30.19 ± 0.052	78.65
G.A	40.5 ± 0.016	27.54 ± 0.309	75.62
G.E	32.50 ± 0.247	28.54 ± 0.218	72.45

E.A= Corchorus olitorius in aqueous ethanol (70 % v/v), E.E= Corchorus olitorius in ethanol, G.A= Azanza garckeana seeds in aqueous ethanol (70 % v/v), G.E= Azanza garckeana seeds in ethanol; All values are expressed Values are expressed as mean ± SD of three independent determinations (n = 3).

Table 4. Ascorbic acid content of *Azanza garckeana* and *Corchorus olitorius* extracts

Sample	Volume of $Na_2S_2O_3$ (mL)	Vitamin C mg/100g
Corchorus olitorius	2.00	12.24
	2.10	12.26
Azanza garckeana	1.50	10.56
	1.60	10.58

The Ascorbic acid content of Azanza garckeana and Corchorus olitorius extracts have been highlighted in Table 4. The antioxidant potential of the plant extracts was evaluated using complementary in vitro assays, including DPPH radical scavenging, ferric reducing antioxidant power (FRAP), and nitric oxide (NO) scavenging assays, to capture multiple mechanisms of antioxidant action. In the DPPH assay, both C. olitorius and *A. garckeana* extracts exhibited strong, concentration-dependent radical scavenging activity within the tested range of 25–200 µg/mL. The ethanolic extracts demonstrated superior performance, with IC_{50} values below 100 µg/mL (Table 5), indicating potent hydrogen- and electron-donating capacity. The enhanced DPPH scavenging activity observed for ethanolic extracts correlates closely with their higher phenolic and flavonoid contents, supporting the established role of polyphenols in neutralizing free radicals through proton transfer and resonance stabilization mechanisms [19]. Ferric reducing antioxidant power (FRAP) analysis revealed a progressive increase in reducing ability with increasing extract concentration, confirming the capacity of the extracts to act as effective electron donors. FRAP results, expressed as absorbance values reflecting the reduction of Fe^{3+} to Fe^{2+}, were consistently higher for ethanolic extracts than for aqueous ethanol extracts. This finding indicates a stronger redox potential and reinforces the contribution of phenolic hydroxyl groups to metal ion reduction. Unlike radical scavenging assays, FRAP does not measure inhibition but rather reducing strength, and the observed trend highlights the complementary antioxidant behavior of the extracts [20]. Nitric oxide scavenging activity further demonstrated the antioxidant and anti-inflammatory potential of the plant extracts. Both plants showed concentration-dependent inhibition of nitric oxide radicals, with IC_{50} values (µg/mL) indicating moderate to strong scavenging capacity (Table 5).

Table 5: DPPH, FRAP and NO radical scavenging activity of Corchorus olitorius and Azanza garckeana extracts obtained using ethanol and aqueous ethanol (70 % v/v) as solvent at various concentrations.

Plant	Extraction solvent	Concentration (µg/mL)	DPPH Inhibition (%)	FRAP (µmol Fe^{2+}/g)	NO Inhibition (mol TE/g)
***Corchorus olitorius* (*Corchorus olitorius*)**	Aqueous ethanol (70 % v/v)	25	45.77 ± 0.100	0.037 ± 0.001	34.77 ± 0.100
		50	44.76 ± 0.205	0.157 ± 0.001	53.36 ± 0.005
		75	76.68 ± 0.055	0.235 ± 0.001	66.63 ± 0.005
		100	78.99 ± 0.005	0.377 ± 0.001	72.99 ± 0.005
	Ethanol (100 %)	25	44.36 ± 0.155	0.037 ± 0.001	36.52 ± 0.155
		50	54.43 ± 0.445	0.158 ± 0.004	56.38 ± 0.005
		75	74.21 ± 0.320	0.241 ± 0.007	68.71 ± 0.180
		100	80.15 ± 0.005	0.412 ± 0.000	74.70 ± 0.155
***Azanza garckeana* (*Azanza garckeana*)**	Aqueous ethanol (70 % v/v)	25	45.67 ± 0.020	0.035 ± 0.001	30.67 ± 0.020
		50	42.71 ± 0.055	0.162 ± 0.000	51.36 ± 0.005
		75	74.53 ± 0.145	0.249 ± 0.001	62.53 ± 0.145
		100	75.22 ± 0.100	0.408 ± 0.001	70.22 ± 0.100
	Ethanol (100 %)	25	44.77 ± 0.100	0.032 ± 0.000	36.37 ± 0.015
		50	53.56 ± 0.205	0.148 ± 0.000	54.33 ± 0.010
		75	73.63 ± 0.005	0.204 ± 0.000	66.66 ± 0.120
		100	78.99 ± 0.005	0.406 ± 0.000	74.39 ± 0.065
Ascorbic acid	Control	25	45.67 ± 0.020	0.162 ± 0.000	38.77 ± 0.010
		50	54.71 ± 0.055	0.213 ± 0.001	58.93 ± 0.050
		75	74.53 ± 0.145	0.433 ± 0.001	72.71 ± 0.180
		100	88.22 ± 0.100	0.486 ± 0.000	86.70 ± 0.155

Values are expressed as mean ± SD of three independent determinations (n = 3).

Nitric oxide is a key mediator of oxidative stress and inflammation, particularly in skin aging processes, where excessive NO contributes to collagen degradation and cellular damage [21]. The ability of the extracts to scavenge nitric oxide radicals, therefore, suggests their relevance in mitigating oxidative pathways associated with photoaging and inflammatory skin conditions [22].

The ascorbic acid content of the extracts, expressed as milligrams per 100 g (mg/100 g), further contributed to their antioxidant profile (Table 4). Ascorbic acid is a vital antioxidant involved in collagen biosynthesis, UV protection, and neutralization of reactive oxygen species [23]. Aloe vera extracts were found to have higher total phenolic content (TPC) compared to Corchorus olitorius and Azanza garckeana seed extracts [24-26], with antioxidant content at least five times greater than Corchorus olitorius and up to seven times that of Azanza garckeana. However, in reactive oxygen species (ROS) inhibition, Corchorus olitorius and Azanza garckeana exhibited stronger antioxidant activity, evidenced by higher DPPH inhibition percentages and lower IC_{50} values. This indicates that while Aloe vera's higher phenolic content might suggest superior antioxidant performance, the specific types of phenolic compounds, such as catechin and quercetin, present in Corchorus olitorius and Azanza garckeana, play a role in their enhanced antioxidant effectiveness. This observation suggests that antioxidant efficacy is influenced not only by total phenolic quantity but also by the presence of highly active phenolic subclasses, including quercetin, catechin, and other low-molecular-weight antioxidants with high radical scavenging efficiency. The involvement of compounds such as quercetin or catechin is inferred from the literature [27] and requires chromatographic confirmation and a standardization of extraction conditions, assay protocols, or concentration normalization in future experiment for a more critical comparison.

The novelty of this work does not lie in the first report of antioxidant activity for C. olitorius, but in its comparative and mechanistic evaluation alongside A. garckeana within a phytocosmetic-relevant framework, emphasizing antioxidant quality, solvent effects, and complementary redox mechanisms. The combined phytochemical and antioxidant findings demonstrate a strong relationship between chemical composition and biological activity. The superior performance of ethanolic extracts across multiple antioxidant assays underscores the importance of solvent selection in maximizing bioactive yield. The presence of multiple antioxidant mechanisms, radical scavenging, metal ion reduction, and nitric oxide inhibition, suggests a synergistic interaction among phytochemicals within the extracts, enhancing their overall efficacy. Although qualitative associations were observed, no formal correlation analysis was performed, which should be addressed in future studies. Given the well-established role of oxidative stress in skin aging, the demonstrated antioxidant properties of C. olitorius and A. garckeana suggest potential relevance to phytocosmetic applications, warranting further biological validation. The ability of these extracts to neutralize free radicals, reduce oxidative intermediates, and inhibit nitric oxide formation provides a scientific basis for their traditional use and highlights their promise as sustainable, plant-based alternatives to synthetic antioxidants. Overall, the integration of phytochemical profiling with in vitro antioxidant evaluation reveals that Corchorus olitorius leaves and Azanza garckeana seeds are rich sources of natural antioxidants. Their strong, concentration-dependent antioxidant activities, favorable IC_{50} values, and multifunctional redox behavior underscore their relevance in combating oxidative stress and supporting skin health [28]. These findings justify further investigation through in vivo studies, formulation development, and safety assessments to advance their application in anti-aging and phytocosmetic products. However, a limitation of this study is the absence of chromatographic or spectrometric identification of individual antioxidant compounds. Future studies employing HPLC or LC–MS analysis are necessary to elucidate the specific phytochemicals responsible for the observed activity. Also, the study employed established literature-based protocols; formal validation parameters (linearity, LOD, LOQ, recovery) were not determined and represent a limitation to be addressed in our future work. It is important to note that while in vitro antioxidant activity provides mechanistic insight, direct anti-aging efficacy in biological or dermatological systems requires further investigation.

Conclusion

This study demonstrates that ethanolic extracts of Corchorus olitorius leaves and Azanza garckeana seeds contain diverse phytochemical constituents, including phenolics, flavonoids, alkaloids, saponins, tannins, terpenoids, and steroids, with ethanolic extracts yielding higher total phenolic and flavonoid contents compared to other solvents. In vitro antioxidant assays showed strong, concentration-dependent free radical scavenging activity (DPPH and ABTS), ferric reducing antioxidant power (FRAP), and nitric oxide inhibitory effects, with IC_{50} values below 100 µg/mL for the most active extracts. The presence of ascorbic acid in the extracts further contributed to their antioxidant performance. A key novelty of this study lies in the comparative evaluation of the relatively underexplored Azanza garckeana seeds alongside the well-characterized Corchorus olitorius leaves, thereby contributing new insights into its phytochemical and antioxidant potential within a phytocosmetic context. These findings provide scientific support for the traditional use of these plants in contexts where oxidative stress mitigation is relevant and indicate that their phytochemical profiles and in vitro antioxidant capacity are comparable to those reported for other commonly studied antioxidant-rich plant materials, despite relatively lower total phenolic content in some cases. The results highlight the potential synergistic contribution of multiple bioactive compounds rather than reliance on any single class of metabolites. While these in vitro data establish a promising foundation for further investigation, no in vivo, clinical, or

formulation studies were conducted in this work. Therefore, prospective research, including in vivo antioxidant and anti-aging models, toxicity profiling, stability testing of potential formulations, and clinical evaluation, is required to determine whether these extracts may be suitable for development into nutraceutical, cosmetic, or therapeutic products.

Author Contributions

AKW designed and supervised the study; JO conducted the experiment; CPN, ISO and SDU analysed and interpreted the data; AKW, CPN, ISO and SDU wrote the first and final draft of the manuscript. All authors reviewed and approved the final version of the manuscript for publication after acceptance.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

Grok, Grammarly, and QuillBot AI were utilised to support drafting, language editing, and the improvement of the manuscript's clarity and readability. EndNote (version 20) was used to manage the references and citations. All authors have carefully reviewed and verified the content of the manuscript and take full responsibility for the accuracy, integrity and presentation of the work therein

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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