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A REVIEW OF ANTIOXIDANT APPLICATIONS AND PHYTOCHEMICAL CONSTITUENTS OF *ANACARDIUM OCCIDENTALE* LEAF EXTRACT

[2]Edet, P.I., & *[1]Samuel, H.S.
[1]Department of Chemical Sciences, Federal University Wukari, Taraba State
[2]Department of Chemistry Education, Federal College of Education Obudu

***Corresponding author email:** humphreysedeke@gmail.com

Abstract
The tropical plant Anacardium occidentale, often known as cashew, is well-known for its many uses in traditional medicine and cooking. This review sheds light on the possible medicinal and nutritional benefits of A. occidentale by examining its antioxidant activities and phytochemical ingredients. The plant's abundance of bioactive substances, such as tannins, flavonoids, phenolic acids, and other secondary metabolites, enhances its antioxidant properties. The capacity of A. occidentale to neutralize reactive oxygen species has been associated with its antioxidant potential, as it helps to reduce inflammation and oxidative stress. This paper looks at the various uses of antioxidants produced from cashews in functional foods, medicines, and food preservation. The synergistic interactions between the phytochemical elements are also covered, highlighting the significance of using a comprehensive strategy to maximize the health-promoting qualities of plants. Comprehending the phytochemical composition and antioxidant applications of A. occidentale not only adds to the growing body of knowledge regarding natural antioxidants but also lays the groundwork for future research into the plant's potential therapeutic uses in the management and prevention of disorders linked to oxidative stress.

Keywords: Anacardium Occidentale, Cashew, Antioxidants, Phytochemicals, Phenolic Acids

Introduction

Anacardium occidentale L. which is known as cashew plants is one of the tropical culinary herbs that provide various benefits to human health. In Southern Asia countries like Thailand, Malaysia and Indonesia, *A. occidentale* leaves are usually consumed raw (*ulam*) with white rice. *A. occidentale* is reportedly helping in digestion, urination, blood circulation and constipation (Yadav &Agarwala, 2011). Previous studies by Hoffman and Geotz, (2008) reported that *A. occidentale* leaves extract has antimicrobial properties against *S. aureus*, *E. coli* and *P. aeruginosa* bacteria and Chabi (2014) reported that *A. occidentale* leaves extract possesses antimicrobial effect against *S. aureus*, *E. coli*, *P. aeruginosa* and *S. epidermis* bacteria. *A. occidentale* is an important source of carbohydrates, protein and minerals such as calcium, selemum, manganese and iron in which the bioavailability depends on the level of interactions with various anti-nutrients (FAO, 2001). B-complex vitamins are abundant in it as well. Its chemical composition protects against cancer, heart disease, heavy menstruation, and tumour growth in addition to its culinary purposes. (Oyetaya & Ogunrotimi, 2012). *Anacardium occidentale* creates an addition to the massive amount of contaminants in the environment that come from harvesting crops. Ajileye et al. (2015) discovered that *Anacardium occidentale* leaf as shown in Figure 1 is an important antioxidant molecule and a source of nutrients that could be added to the diets of people and animals rather than becoming a waste product or a source of pollution for the environment. Therefore, it is a good source for dye extraction. In extracting dye from plants, different techniques can be used. Examples of such techniques are maceration and soxhlet extraction.

Plants can be macerated, or dyed, by soaking them in an appropriate solvent in a closed container. This process is called maceration. When cold maceration is carried out at room temperature, the plant and solvent are combined, and the combination is left for many hours with periodic shaking or stirring. Eventually, the extract is separated from the plant fragments by straining. (Malidi &Altikriti, 2010; Neha & Vidya, 2011).

Figure 1. Anacardium occidentale leaf (Oyetaya & Ogunrotimi, 2012)

Temperature in maceration can be cold or hot. This type of technique requires no special apparatus like the soxhlet. Soxhlet extraction is a technique that places a specialized piece of glass ware in between a flask and a condenser. The refluxing soxhlet repeatedly washes the solid extracting the desired compounds into the flask. The technique is mostly carried out for colourant identification. The instrument's temperature is consistently kept much below the solvent's boiling point. To remove every chemical from the plant portion needed for dye application, the solvent is cycled through multiple cycles. The most common method for giving fibres, yarns, and fabrics colour is dye application. According to a review of the literature, the first attempts to describe natural dyes were undertaken to determine which dyes were used on ancient textiles that were discovered during archaeological digs or preserved in museums. For this, a variety of methods have been used, such as UV visible, mass spectroscopy, thin-layer chromatography (TLC), high-performance thin-layer chromatography (HPTLC), and high-performance liquid chromatography (HPLC) (Boy et al., 2018).

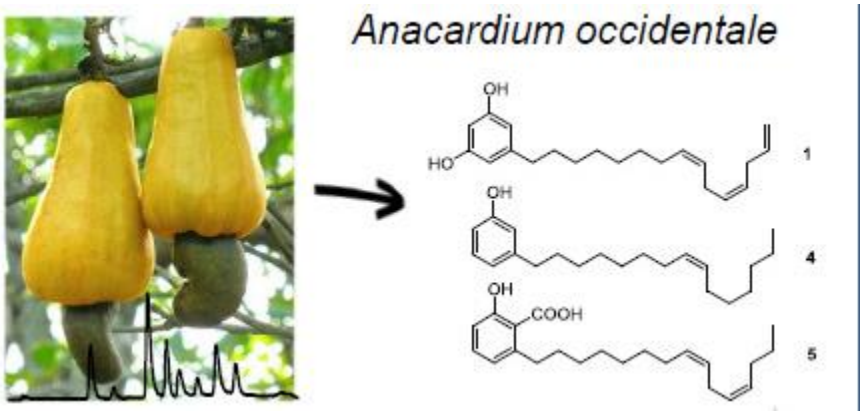

Figure 2. Structures of some Phytochemical components of A. occidentale

Antioxidants are becoming more and more sought after because of their critical function in preventing oxidative stress, a physiological imbalance linked to the development of many chronic diseases. With its abundance of phytochemicals, such as tannins, flavonoids, phenolic acids, and other secondary metabolites, A. occidentale has become a highly promising contender in this field (De Sousa et al., 2016). Together, these substances provide the plant with its antioxidant potential, opening up interesting possibilities for research in nutritional and medicinal contexts. The objective of this review is to present a thorough analysis of the phytochemical components and antioxidant uses of A. occidentale. Through an exploration of the molecular makeup as seen in figure 2 and an explanation of the mechanisms by which these substances function as antioxidants, we want to uncover the possible health advantages associated with A. occidentale.

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Biological properties of *A. occidentale*

The cashew tree contains phenolics with bioactivities. Utilizing methanol, hexane, and ethyl acetate as solvents, Razali et al. (2008) examined the extracts of cashew shoots (Anacardium occidentale) for total phenolic content and antioxidant activity. The strongest antioxidant was found in the hexane extract, whereas the methanolic extract exhibited the best DPPH ion scavenging activity. Furthermore, the rutin and quercetin-like antioxidant activity of the methanolic extract was observed. Additionally, cashew leaf extract possesses antibacterial activities against bacteria like Pseudomonas, Shigella Salmonella Typhimurium, Escherichia coli, and Stapphylococcus aureus. The compound's ability to inhibit the test organisms is demonstrated by the presence of flavonoids, tannins, glycosides, terpenoids, etc. In addition, Nassr-Allah, (2009) reported that cashew leaf extracts had greater activity than the stem bark extracts it shows higher activity than the aqueous extracts. El-Shemy (2007) investigated the antimicrobial activity of extracts from the leaves and stem bark of cashews. Numerous biological characteristics have been discovered for Anacardium occidentale, often known as cashew. A study found that the leaf extract of Anacardium occidentale had anti-inflammatory and antioxidant properties (Samuel & Ekpan, 2023). According to a different study, cashew nut shell liquid (CNSL), which is made from the cashew nut shell, contains cardol and anacardic acid. It also functions as a vesicant, causing blisters that resemble burns on human skin. Furthermore, the scope of the recent study was to determine the chemical composition and bioactivities of the crude ethanolic extract (CEE) and its constituent fractions. The study discovered that in addition to having potential as an anti-cancer drug, the extract and its fractions demonstrated antioxidant and anti-inflammatory properties (Johari & Khong, 2019).

Antimicrobial Applications of Cashew Leaves Extract

The antibacterial and antifungal activity of using cashew leaf extracts in treating human bacterial infections includes;

i. Venereal disease

These are infections that are frequently transmitted by sexual activity, particularly oral, anal, and vaginal sex (Varghese et al., 2013). There are viruses and bacteria among the microorganisms involved. According to Dahake et al. (2009), cashew leaf and bark can be used as a therapeutic tool because cashew extract has been shown to have antibacterial properties.

ii. Skin disease and dermatomycosis

Skin disorders are ailments related to the skin. Fungal species are the primary cause of dermatomycosis, a skin illness; these organisms often include species of Candida, Trichophyton, and Cryptococcus (Salomon et al., 2018). It has been observed that the extract of cashew bark and leaf killed or inhibited these organisms (Akinpelu & Ojewole, 2001). The bioactive elements of the bark and leaf, such as triterpenoids, phenolic acids, and volatile oils, which Ifesan et al. (2013) discovered were effective against fungal isolates, are responsible for the antifungal activity of both. Based on the site(s) and quantity of hydroxyl groups in the phenol group, these phenolic compounds have been demonstrated to be hazardous to microorganisms, with data suggesting that higher hydroxylation leads to increased toxicity (Geissman, 1963). Phenolic toxicity to microorganisms is hypothesized to be caused by oxidized chemicals inhibiting enzymes, potentially by a reaction with sulfhydryl groups or by more general interactions with proteins. (Aiswarya et al., 2011).

iii. Thrush

There are numerous studies on the antifungal properties of phytochemicals and plant extracts (Jaiswal et al., 2017). Candida albicans can induce thrush, a condition that affects the vagina or mouth. In 2017, Runjala and Kella documented the antifungal activity of cashew leaf extract on two fungi; for C. albicans, the ethanolic and petroleum ether extracts' minimum inhibitory concentrations (MICs) were determined to be 15.62 and 31.25 µg/mL, respectively. Also, a zone of inhibition of 17 mm was found to be higher in the ethanolic extract compared to 13 mm in the petroleum ether extract. The antibacterial activity against Candida albicans is attributed to the triterpenoids, according to Malaka et al. (2018). Triterpenoids disrupt the cytoplasmic membrane of this organism which is often indicated by the leakage of intracellular constituents (Yuliana et al., 2014).

iv. Malaria

There have been reports of the amebicidal, antioxidant, and astringent qualities of Anacardium occidentale leaves and bark. Treatment for malaria involves the use of extracts (Razalia et al., 2008; Orwa et al., 2009). Cashew has been used widely in the treatment of malaria, according to Dike et al. (2012). The antibacterial efficacy of cashew leaf and stem extracts against Plasmodium spp., the malaria-causing organism, has been attributed to tannin content; however, the exact mechanism of action remains unclear. (Alara et al., 2021).

v. Inflammation

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Cashew leaf extract has been shown to have anti-inflammatory properties by Pawar and Pal (2002). Greater analgesic and anti-inflammatory effects were demonstrated by the acetone-soluble portion of the methanolic extract. In carrageen and dextran-induced rat paw oedema, the hydrolysable and non-hydrolysable tannins from cashew bark that were injected into the rats showed evident anti-inflammatory effects, according to Thomas et al. (1985). The tannins also prevented mice from writhing in response to acetic acid, and they were discovered to counteract the effects of specific inflammatory mediators on permeability in rats and prevent leukocyte migration to an inflammatory location. The extract's potential to reduce inflammation may also stem from its ability to suppress inflammatory cells that produce nitric oxide. (Olajide et al., 2004; Etim et al., 2023).

Phytochemical constituents of A*nacardium occidentale* Leaf Extract

Alkaloids, Flavonoids, and Phenolic acids from the leaf shoots of two varieties of *Anacardium occidentale*, flavonol glycosides have been identified by Pham et al. (2023). The total phenolic content of the red variety's leaf shoots was nearly double that of the yellow type overall. Shahrajabian and Sun, (2023). reported that the predominant flavonoid in cashew leaves is quercetin (125 mg/100 g), while the predominant phenolic acid is chlorogenic acid (13.5 mg/100 g). Anthocyanidins of cyanidin and peonidin are two more phenolic compounds found in the leaves. According to Kamtchouing et al. (1998), the main constituents of the leaf oil are (E)-β-ocimene (29%), α-copaene (14%) and δ-cadinene (9%), the fruit oil is composed of palmitic acid (20%) and oleic acid (20%), and the floral oil is composed mostly of β-caryophyllene (26%), methyl salicylate (13%) and benzyl tiglate (61%). Anacardic acid, cardol, and cardanol are the main phenolic components of A. occidentale. Furthermore, it has been shown that A. occidentale's leaves and bark have tannins, flavonoids, and phenolic acids. Moreover, the phytochemical study of the fruit extracts of A. occidentale contains phenols, alkaloids, anthraquinolones, flavonoids, glycosides, tannins, and terpenoids. Further investigation into the biological activities and prospective applications of A. occidentale is warranted due to the potential therapeutic characteristics attributed to its ingredients (Oyagbemi et al., 2023).

Conclusion

Research on the phytochemical components and antioxidant uses of Anacardium occidentale, or cashew, indicates a diverse range of bioactive substances that support the plant's wide range of medicinal and nutritional uses. The complex combination of anacardic acids, flavonoids, tannins, phenolic compounds, and other phytochemicals highlights this plant's versatility and potential benefits for human health. As demonstrated by its capacity to counteract reactive oxygen species and lessen oxidative stress, A. occidentale possesses strong antioxidant properties that make it a useful asset in the field of natural antioxidants. Its uses in food preservation, pharmaceuticals, and the creation of functional foods are highlighted in the reviewed literature, demonstrating its adaptability across a range of industries. The synergistic interactions among the phytochemical elements of A. occidentale are strongly linked to its success in various applications. These molecules work together in a way that not only strengthens the plant's antioxidant defences but also adds to its anti-inflammatory, antibacterial, and possibly anticancer effects. This combination increases A. occidentale's total biological activity and it has numerous health benefits. A. occidentale emerges as a viable option as we traverse the complex field of natural antioxidants, providing a comprehensive strategy for treating illnesses associated with oxidative stress. Notwithstanding the strong evidence exhibited in this investigation, additional study is necessary to clarify the exact modes of action, ideal dose, and possible adverse reactions linked to its ingestion. The phytochemical components and antioxidant uses of Anacardium occidentale reveal an engrossing story about a plant that is becoming increasingly prominent in both conventional medicine and scientific discourse. Cashew's diverse range of bioactive chemicals makes it an appealing option for academics, healthcare practitioners, and nutritionists to further investigate and realize its full potential for improving human health.

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