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Review

Pharmacological properties of cashew (*Anacardium occidentale*)

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***Anacardium occidentale* L. is a tree native to Brazil, which is rich in phenolic lipids. Nowadays, the cashew bark (Cashew Nut Shell Liquid) has received great attention in the pharmaceutical industry, due to its economy, abundance and important chemical compounds. Net of cashew nut shell is classified according to the method of production of: (1) net of the shell of natural cashew nut (60-65% anacardic acid; 15-20% cardol and 10% of cardanol) and (2) liquid from the technical cashew nut shell (60-65% of cardanol, 15-20% cardol and 10% of polymeric material). This work aims to report the pharmacological properties of liquids from cashew nut shells. Results suggest that both liquids have antifungal, antibacterial, antiparasitic, anti-tumor, antiulcerogenic, molluscicides, antimutagenic and antioxidant activities. Natural cashew nut liquid is non-genotoxic, whereas technical liquid is genotoxic in prokaryotes and eukaryotes, although there is no evidence of their mutagenic effects on eukaryotic cells. In conclusion, the excellent antioxidant and non-mutagenic activities of cashew nut shell liquid (CNSL) provide opportunities for CNSL in the cosmetic and/or pharmaceutical industries, but continuous study is needed to allow safe and efficacious preparations.**

Key words: Cashew liquid, cosmetics, pharmacological, pharmaceutical, preparation.

INTRODUCTION

The Anacardiaceae family has 76 genera divided into five tribes (Anacardiaceae, Dobineae, Rhoeae, Semecarpeae and Spondiadeae) covering about 600 species (Correia et al., 2006). *Anacardium occidentale* is an abundant

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tree in the Northeast of Brazil and the states of Piauí, Ceará and Rio Grande of Norte. It represents 90% of cashew production in Brazil. This species is evident for its antioxidant (Melo-Cavalcante et al., 2003), antigenotoxic, antimutagenic (Melo-Cavalcante et al., 2011), antiulcerogenic (Behravan et al., 2012), anti-inflammatory (Olajide et al., 2004), antibacterial, antifungal and larvicides (Behravan et al., 2012) activities. Also, it is a tree rich in anthocyanins, carotenoids, ascorbic acid (vitamin C), flavonoids and other polyphenols as well as mineral components. The bark and leaves are used in folk medicine (Konan and Bacchi, 2007).

In addition, the true fruit of cashew releases a liquid rich in phenolic compounds, known as liquid from chestnut shell- cashew nut shell liquid (CNSL). The components of cashew nut shell liquid depend on the method of production and are classified into two general categories: natural CNSL (LCCI) and technical CNSL (CTCL) liquids. LCCI contains 60-65% of anacardic acid, 15-20% cardol, 10% cardanol and trace amount of metilcardol, while CTCL contains 60-65% of cardanol, 15-20% cardol, and trace amount of polymeric methyl-cardol l material (Kumar et al., 2002). Both of the liquids also contain trace amount of phytosterols, triacontane and others (Andrade et al., 2011).

Though the pharmacological activities reported for CNSL is linked to pharmaceutical consumption, more analysis is needed, especially of its genotoxic effects. Assessment of genotoxic and carcinogenic potentials in drug development is crucial before approving and making it available in the market as pharmaceutical products.

Thus, this review aimed to take a picture of *A. occidentale*, highlighting its chemical compositions and related biological activities.

MORPHOLOGY AND GEOGRAPHICAL DISTRIBUTION OF *A. OCCIDENTALE*

A. occidentale has a height of 5-10 m, but in clay land can reach up to 20 m. It has a crooked trunk of 25-40 cm in diameter. The leaves are oval, obovais, leathery, glabrous; rosy when young; it has vináceas flowers, arranged in terminal panicles (Lorenzi, 2008). According to Gomes (2010), cashew tree is spread around the world, between latitudes 27ºN in Southern Florida and 28ºS of South Africa; and also in low latitude regions, near the equator, between the parallel 15ºN and 15ºS, in coastal areas, typically tropical South America, Africa and Asia. *A. occidentale* is common among the Northeastern states such as Ceará, Piauí and Rio Grande do Norte (Lubi and Thachil, 2000). The family Anacardiaceae covers over 70 genera in which more than 600 species are distributed in tropical, sub-tropical and temperate regions in the world (Engels et al., 2012). The family is rich in important secondary metabolites with varieties of interesting biological activities (Abu-Reidah et al., 2015).

CHEMICAL COMPOUNDS PRESENT IN *A. OCCIDENTALE* AND ITS BIOLOGICAL ROLES

Both yellow and red fruits of *A. occidentale* possess ferulic acid, caffeic acid, sinapic acid, gallic acid, and ellagic myritine (Moo-Huchin et al., 2015). Flavonoid contents in yellow and red cashew may be 12.1 ± 0.3 and 6.4 ± 0.4 mg/g, respectively. The compound, camferol-3-O-glucoside is the major constituent in both varieties, followed by camferol-3-O-arabinofuranoside and quercetin-3-O-glucoside (Shukri and Alan, 2010). The extract of cashew fibers has 11 carotenoids in which auroxantins and β- criptoxantins account for about 50% (Abreu et al., 2014).

In the phytochemical analysis of cashew leaves, it is reported that it has (E) -β-ocimene, α-copaene and δ-cadienol; while the fruits contain palmitic, oleic acids, furfural, 4-hydroxydodecanoic acid, lactone, (E) -hexenal, (Z) -hex-3-enol and haxadecanol (Maia et al., 2000). Cashew is rich in anacardic acid, cardanol and cardol along with other alkyl phenolic compounds (Trevisan et al., 2006). It is also evident to have monomeric phenols, flavonoids, glycosides such as myricetin and quercetin hexoside, pentoside, rhamnosides and glycosidic anthocyanidins (Michodjehoun-Mestres et al., 2009). The leaves are rich in alkaloids, essential oils, tannins (Ayepola and Ishola, 2009), saponins, cardenolides and others (Onasanwo et al., 2012). In addition, hydrolysable tannins, phenols, flavones, flavonols, xanthones, chalcones, catechins (Santos et al., 2013), terpenoides and other phenolic compounds (Doss and Thangavel, 2011) have also been reported. Cashew shells also contain a significant amount of gallic acid (345.16 ± 16.24 mg) (De Abreu et al., 2013) and their leaves contain cardanol, cardol (Leitão et al., 2013) and palmitate, oleate, linoleate sitosterol,, sitosterol, stigmasterol, 3-O-β-D-galactopyranoside sitosterol, 3-O-β-D-galactopyranoside stigmasterol, 3-O-β- D-glucopyranoside. Stem bark is used for a mixture of sisterol anacardic acids (mono- and diene), alkaloids, tannins and anacardic acids (Chaves et al., 2010).

A. occidentale is known for its analgesic and gastroprotctive activities. The cashew nut extract at a dose of 200 mg/kg was found to have non-ulcerogenic effect on rats (Behravan et al., 2012). A similar activity was observed with the hydroethanolic extract of cashew leaves, where tannins were suggested as being responsible for moieties (Konan and Bacchi, 2007). Vanderlinde et al. (2009) reported that the acetone extract of cashew stem bark in rodents contains antibodies, and has anti-inflammatory and antinociceptive effects. The dichloromethane extract of cashew leaves is also suggested to have an analgesic effect on rats (Onasanwo et al., 2012). The traditional medicine practitioners in Amazon Region are still using cashew for the treatment of diarrhea, dermatitis, headache, and infectious diseases (Lizcano et al., 2010). One study

reported that the methanol extract of cashew stem bark at a dose 200 mg/kg protected mice from lipopolysaccharides induced septic shock (Olajide et al., 2004).

Boiled extract from the new leaves of cashew has for wound healing property (Mazzetto et al., 2009), while the adult leaf extract inhibits the action of the enzyme tyrosinase, demonstrating a therapeutic potential for skin pigmentation problems (Abdul et al., 2008). A recent study showed anti-ulcer actions by the hydro-ethanolic extract of cashew (0.1%), leaving the increased gastric acid section. This demonstrates its anti-*Helicobacter pylori* effect (Ajibola et al., 2010). The aqueous extract of leaves of *A. occidentale* showed hypoglycaemic activity in streptozotocin induced diabetic rats at a dose of 175 mg/kg, where repeated administration of this dose (twice/day) significantly reduced the blood glucose level ($p < 0.01$) by 43% in diabetic rats (Sokeng et al., 2001).

Petroleum ether and ethanolic extracts of cashew leaves showed antimicrobial activity against *Bacillus subtulis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherchia coli*, *Candida albicans* and *Aspergillus niger* (Dahake et al., 2009; Doss and Thangavel, 2011; Onasanwo et al., 2012); the latter extract had more effect on Gram-positive bacteria (Doss and Thangavel, 2011). The CNSL derivative, 2-hydroxy-6-pentadecylbenzamide was more active against *S. aureus*, *E. coli* (Pokharkar et al., 2008), *A. flavus*, *Fusarum* sp., *A. fumigafus*, *A. flavus* and *A. niger* (Kannan et al., 2009). The action of anacardic acid (6-pentadecylsalicylic acid) alone and in combination with methicillin was investigated against methicillin-resistant *S. aureus* (Muroi and Kubo, 1996; Tan and Chan, 2014). There are also reports that anacardiac acid and its newly synthesized benzylamine analogs are antibacterial (Kubo et al., 1999; Reddy et al., 2012) and contain anacardiac acid used against *H. pylori* (Castillo-Juarez et al., 2007).

CNSL at 2000 mg/kg also suggested its anti-*Aedes aegypti* with the median lethal concentration (LC_{50}) by 90% (Guissoni et al., 2013). The salt, sodium anacardate was also found effective against the same species (Farias et al., 2009). However, Oliveira et al. (2011) suggested cardanol ($LC_{50} = 8.20 \pm 0.15$ ppm) as a strong larvicidal agent than the anacardic acid (LC_{50} 12.4 ± 0.10 ppm).

The leaf extract (25-250 mg/ml) as well as processed juice (cajuína) inhibits 1,1-dipheny-picrylhydrazyl (DPPH) radicals (Queiroz et al., 2011). CNSL and its compounds were also proved to have antioxidant potential (Andrade et al., 2011; Oliveira et al., 2011). The antioxidant activity order observed for the cashew components was: CNSL > cardanol = hydrogenated cardanol and alkylated> hydrogenated cardanol (Lima et al., 2008).

Cashew pulp juice and methanol extract of stem bark (500-2000 µg/ml) have antigenotoxic activity against *Salmonella typhimurium* and Chinese hamster lung fibroblasts (V79 cells), respectively (Barcelos et al., 2007a). According to Melo-Cavalcante et al. (2005), cashew pulp (cajuína) protected *S. typhimurium* (TA102) from damage induced by aflatoxin B1 (AFB1), while the methanolic extract of bark (500-2000 µg/ml) of Chinese hamster (V79) in doxorubicin (0.75 mg/ml) induced damage (Barcelos et al., 2007b). In addition, there are reports for anticlastogenic (*in vivo*) (Melo-Cavalcante et al., 2011) and antimutagenic potentials of the cajuína in *S. typhimurium* TA98 (Chen and Chung, 2000). The latter one may relate to its tannic acid (Chen and Chung, 2000).

Toothpastes without fluoride used by children containing cashew and mango were tested for their antimicrobial activity; they significantly inhibited *Streptococcus mutans*, *S. sobrinus* and *Lactobacillus acidophilus* (Carvalho et al., 2011). Otherwise, the inhibition of the microorganism, *S. mutans* and the formation of its biofilm open the door for its application in dental caries (Furtado et al., 2014). The aqueous extract of cashew has hypoglycemic activity (Alexander-Lindo et al., 2004).

Anacardic acid and lunasin, derived from cashew and now seen as having anti-cancer properties, arrest the cell cycle at S mitotic phase (Hsieh et al., 2011). Otherwise, caspase-independent apoptosis inhibition in pituitary adenoma and lung adenocarcinoma cells (Seong et al., 2013) and histone acetyltransferases and nuclear factor kappa B (NF-κB) may be a potential target in chemotherapy (Sung et al., 2008). There are other evidences for its anticancer activity (Schultz et al., 2010; Wu et al., 2011; Huang et al., 2014); where the benzamide derivatives, 2-isopropoxy-6-pentadecyl-N-pyridin-4-ylbenzamide, 2-ethoxy-N-nitrophenyl) -6-pentadecylbenzamide and 2-ethoxy-6-pentadecyl-N-pyridin-4-ylbenzamide strongly inhibit HeLa cell lines (Chandregowda et al., 2009).

An alcohol or its metabolites may lead to hyperacetylation of histone thus overexpression of factor GATA4, which is linked to cardiac malfunctions (Wang et al., 2012). In a recent study, the anacardic acid in pregnant female rats at a dose of 5 mg/kg (intraperitoneal) produced an inhibitory effect on histone H3K9 hyperacetylation induced by alcohol. In addition, a reduced acetylation in the promoter region of the GATA4 fetal hearts of mice was also reported. It was also observed that the abortion rates, stillbirths and intestinal timpanismos decreased in mice, thus demonstrating the cardio-protective activity of anacardic acid (Peng et al., 2014).

Aurora kinase enzymes play an important role in chromosome segregation and cell division. They are of three types: A, B and C (Bischoff and Plowman, 1999). Deregulation of aurora kinase can result in mitotic abnormalities and genetic instability leading to defects in centromere function in chromosome alignment, and cytokinesis (Fu et al., 2007). In several types of cancer, there is a relationship with overexpression of kinase A and B (Murata-Hori and Wang, 2002). Through a virtual

Table 1. Biological activities found in the LCC and its constituents.

Activities	CNSL and its constituents	References
Genotoxic	CNSL	Oliveira Galvão et al., 2014
Antimicrobial	Derived from CNSL (2-hydroxy-6-pentadecylbenzamide), anacardic acid	Pokharkar et al., 2008; Kannan et al., 2009; Tan and Chan, 2014.
Antioxidant	LCCI, CTCL, alkylated and hydrogenated cardanol, cardanol, anacardic acid and its derivative (benzyl amine), urea and thiourea derivative anacardic acid	Andrade et al., 2011; Abreu et al., 2014.
Anticholinesterase	LCCI	Andrade et al., 2011
Larvicidal	CTCL, LCCI, anacardic acid	Andrade et al., 2011; Oliveira et al., 2011; Guissoni et al., 2013.
Sunlight protector (UV_A and UV_B)	LCCT	Romeiro et al., 2006.
Anti-*Helicobacter*	CNSL	Kubo et al., 1999.
Antitumor /anticancer	Anacardic acid, cardol	Stepanenko et al., 2004; Sung et al., 2008; Tocco et al., 2009; Schultz et al., 2010; Wu et al., 2011; Teerasripreecha et al., 2012; Huang et al., 2014; Peng et al., 2014.
Mutagenic and genotoxic	Anacardic acid	Alam-Escamilla et al., 2015;
Non-cytotoxic and genotoxic	Anacardic acid pendacylsalicylic	Alam-Escamilla et al., 2015;
Non-mutagenic	Anacardic acid and anacardic acid methyl ester	Carvalho et al., 2011;
Anti-dermatitis	Cardanol, cardol and anacardic acid	Diogenes et al., 1995
Non-genotoxic	Cardol	Navarro et al., 2014;
Anticholinesterase	Cardol	Oliveira et al., 2009.

evaluation, it was found that anacardic acid could be fitted into the aurora kinase enzyme A and B; and thus, could activate the aurora kinase A-mediated phosphorylation of histone H3 by modifying the structure of the enzyme and increasing its activity (Kishore et al., 2008). The drug sildenafil (VIAGRA) is a potent inhibitor of 5-fosfadiesterase (Terrett et al., 1996). This is the key enzyme used for the regulation of smooth muscle tone, playing an important role in erectile dysfunction (Beavo and Reifsnyder, 1990). A sildenafil analog was synthesized from anacardic acid (Paramashivappa et al., 2002).

However, the resorcinolic lipid (cardol) was also reported for its antimicrobial (Kubo et al., 1999), antitumor, molluscicide, tyrosinase inhibitory (Zhuang et al., 2010), and liposome formation (Przeworska et al., 2001) activities. In addition, it can prevent and repair damage done to DNA (Stepanenko et al., 2004). A recent study indicated that a new resorcinolic lipid, 3-heptyl-3,4,6-trimethoxy-3H-isobenzofuran-1-one (AMS35AA) alone produced neither genotoxic nor mutagenic effects in mice (Navarro et al., 2014). Otherwise, both cardanol and cardol exhibited antiproliferative properties with LC_{50} ranging from 41.3 to 52.4 mg/ml and 43.8 to 53.5 µg/ml in cancer cell lines (Teerasripreecha et al., 2012).

Nowadays, cardol has gained interest (Kubo et al., 1994) along with other natural compounds such as coumarin (Finn et al., 2005) for their inhibitory activity against tyrosinase (Tocco et al., 2009), a multifunctional enzyme that has copper involved in melanin biosynthesis. Tyrosine catalyzes the ortho-hydroxylation of tyrosine to dopaquinone, which spontaneously polymerizes to melanin. Melanogenesis inhibitors are used to whiten the skin of patients treated with pigmentation disorders, such as overproduction of melanin (Hartong et al., 2006) and Addison's disease (Pandya and Guevara, 2000).

Oliveira et al. (2011) found the anticholinesterase activity of CNSL constituents, although cardol, cardanol, carbachol and anacardic acids were previously reported for their cholinesterase inhibitory activity (Rosenberry et al., 2008). Some of the biological activities of LCC and its chemical compounds are presented in Table 1.

OTHER FEATURES AND PROCESSING

India is the pioneer in the CNSL production. Unlike Brazil, their method of processing is semi-automatic, with lower performance generating a lot of CNSL as a byproduct. The cashew agribusiness in Brazil comprises 12 companies (8 in Ceará, 3 in Rio Grande do Norte and 1 in Piauí) focusing on the export of cashew kernels. They

have the capacity to process up to 360 tons of brown, 70,000 tons of almonds and 45,000 tons of CNSL per year (Mazzetto et al., 2009). CNSL is a product considered as having very low value (Rios Façanha et al., 2007). It is purchased for oil processing and then resold at high prices, because of its widespread use in the production of resins and polymers as in the USA and India. However, Ceará State was the only one still standing out in the export of CNSL in the years 2012 and 2013, despite the large bundle in exports in 2013. Among the major producers of Chestnut in the Northeast, Piauí is the only one who did not export LCC (Sindicato Das Indústrias Do Açúcar E De Doces E Conservas Alimentícias Do Estado Do Ceará-Disponível, 2014).

Cashew fruit (nut) is in the form of rim that grows on the end of the pseudo called cashew (Rozas-Muñoz et al., 2012). The cashew nut is characterized as having almond, cotyledon and a liquid. The former one is the edible part, widely consumed as snacks to accompany drinks or ingredients for confectionery and bakery products. The cashew nut contains rich amount of tannins, mono- and polyunsaturated fatty acids, proteins, sugars (Venkatachalam and Sathe, 2006) and others such as (+) - catechin, (-) - epicatechin, β-carotene, lutein, and α-tocopherol (Trox et al., 2011). According to Gómez-Caravaca et al. (2010), anacardic acid is the main component present in raw LCCI and CNSL roasted in extracting the press cold, then followed by cardol, 2-methyl cardol and cardanol. The latter one exists in high amount in the roasted oil. However, the phenolic compounds vary by the roasting temperature applied (Chandrasekara and Shahidi, 2011).

The cashew nut is formed by three protective fabrics: Epicarp outer integument, spongy flesh, whose alveoli can be filled by the CNSL; and cored by inner cavity (Ogunsina and Bamgboye, 2014). The liquid from it is considered as viscous, dark, caustic with long chain saturated and unsaturated phenols, which is a mixture of meta-alkylphenols variably with unsaturated benzene rings (18-27%/nut) (Lomonaco et al., 2009; Velmurugan et al., 2014). The cashew nut trade began in the early 1920s when India was a pioneer in the processing and marketing as an industry. Today, India is the largest cashew producer in the world with a production of 665,000 tons/year (Anonymous, 2009). The CNSL and almond allow for a range of industrial applications including synthetic polymers (Lubi and Thachil, 2000) and bioactive compounds (Paiva et al., 2000).

CONTENTS OF CASHEW AND THE EXTRACTION PROCESSES OF CASHEW LIQUIDS

There are several processes for the production of CNSL: Cold extraction (by presses), solvent extraction, thermal-mechanical process (temperature approximately 190°C) by which CNSL and residual cake were obtained by 18 and 55%, respectively. The husks are heated to 80°C and subjected to pressing subsequently to obtain LCC and a residual cake. When CNSL is subjected to a decarboxylation at 180°C with 15 rpm agitation in a variable time, the anacardic acid turns to cardanol. This liquid is called technical CNSL (CTCL) (Mele and Vasapollo, 2008). Then, the CNSL is filtered and stored in metal drums or tanks (Paiva et al., 2000). The cold LCCI obtained by this process contains anacardic acid, cardanol, cardol and polymeric materials by 62, 6.99-60, 10-23 and 30%, respectively (Lochab et al., 2014); while LCCT is evident to have cardanol (56.24%) and cardol (59.9%) along with other constituents such as phytosterol (10.68%), β-sitosterol (9.22%), stigmasterol (1.46%), triacontanes (4.66%) and anacardic acid (1.79%) (Andrade et al., 2011). The vacuum pyrolysis extraction (temperature: up to 500°C and pressure: at 720 mm of Hg) primarily produces cardanol and cardol. In the extraction with supercritical carbon dioxide (SC-CO_2), it was found that the fraction contained mostly cardanol (70-90%) with traces amount of anacardic acid and cardol. The highest percentage of cardanol (85%) is obtained with 300 bars at 60°C using the SC-CO_2 extraction (Patel et al., 2006).

The phenolic lipids ($C_{15}H_{31}$) are either saturated and unsaturated (Suresh and Kishanprasad, 2005) and the anacardic acid has a carboxylic acid grouping in the ortho position, differing from the other phenolic lipids (Patel and Bandyopadhyay, 2006). According to Bloise et al. (2012), the cardanol consists of a rich amount of phenolic lipids: 3-n-pentadecylphenol (20-30%), 3- (pentadeca-8-enyl) phenol (70 -80%), 3- (pent-deca-8,11-dienyl) phenol (5%), and 3- (pentadeca-8,11,14-trienyl) phenol (< 5%) (Patel and Bandyopadhyay, 2006). The cardol (5-n-pentadecylresorcinolic acid) has a similar structure of tocopherol and a long chain of saturated hydrocarbons or lacks it (Kozubek and Tyman, 1999; Patel and Bandyopadhyay, 2006; John and Vemula, 2006). Among the phenolic compounds, trienes constitute the greatest amount followed by monoenes, dienes (Nishiyama et al., 2000). There are also evidences of xantoproteins, carbohydrates, sitosterol, stigmasterol, β-amyrin lupeol, catechin, epicatechin minerals (e.g. - Na, Mg, P and Ca) and vitamins (e.g. - A, B2, B6 and B12) in the caju chestnut husk (Kannan et al., 2009). However, the climate, geography, botany, origin and the extraction processes also have effect on the chemical composition of the CNSL (Gedam and Sampathkumaran, 1986; Rodrigues et al., 2006; Ologunde et al., 2011).

INDUSTRIAL APPLICATIONS OF THE NET BARK OF CASHEW NUTS

Cardanol is applicable to prepare surfactants, gel, nanotubes and nanofibres; unlike carbon nanotubes, it provides integrity in internal and external surfaces, thus the opportunity for the delivery of biomolecules and therapeutic agents (Balachandran et al., 2013). Otherwise

it has non-aggressive odor, low volatility, high boiling point (Mazzetto et al., 2009), excellent stability at very low temperature (-70°C), good thermal insulation and stability (Attanasi et al., 1996).

The CNSL is now been one of the valuable sources for bio-fuel and can be used directly in diesel engine (Velmurugan et al., 2014; Vallinayagam et al., 2014). Cardanol has also been used as an antioxidant. Derivatives of polymers and resins (Jaillet et al., 2014) can be incorporated as anti-corrosion, waterproof, flame retardants, surface coating, and rubber friction modification materials (Chuayjuljit et al., 2007). The resins obtained from the CNSL are considered as flexible and have greater solubility in organic solvents, thus may be used as resistance to bases and acids (Sadavarte et al., 2009). Cardanol are also used for reducing brittleness and improving the flexibility of the blades (Blazdell, 2000). Both cardol and cardanol have been used in various applications such as adhesives, fuel additive (Suwanprasop et al., 2004; Vasapollo et al., 2011), plasticizing (Alexander and Thachil, 2010), cleaning, disinfectants, germicides and health care for workers (Prabhakaran et al., 2001). Seeds, nirmali (Srimurali et al., 1998) impregnated with zirconium coconut shell (Sathish et al., 2007) and clays have been used as adsorbents for the removal of fluoride from water (Alagumuthu and Rajan, 2010). Evidence shows that United States and Britain during the World War II used CNSL as an insulator of high voltage cables (Gomes, 2010).

Although there are several reports on the biological activity of CNSL and in many non-clinical *in vivo* and *in vitro* trials, its actual cytogenetic activity mechanism prior to recommendation for pharmaceutical formulations and/or cosmetic application is yet to be found out.

CONCLUSION

This review favored the understanding of the similarities between chemical compounds and their biological activities isolated from *A. occidentale*. The reported activities were antioxidant, anti-inflammatory, anti-diarrheal, antinoceptive, anticancer, antimicrobial, antitumor and antimutagenic, which are important for pharmaceutical and cosmetic formulations. Although, a number of in *vivo* and *in vitro* non- / pre-clinical studies were observed during this revision, in order to ensure safety, profile of the chemical moieties isolated from cashew prior to mass manufacturing is crucial. Thus it should be emphasized that this study may be helpful in that noble path-length.

Conflict of interest

The authors have declared that there is no conflict of interests.

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