



Biological activity of the *Cocos Nucifera* L. and its profile in the treatment of diseases: A review

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ABSTRACT

The Cocos nucifera is a palm tree known as coconut. This review has analyzed the scientific production on the biological activity of this plant species in the treatment of diseases. We have included 14 papers through search in databases, in the period from 2002 to 2011. The results have indicated that most of the studies were published in international journals, however, produced by Brazilian citizens. In the analysis, it was found that nine papers describe the biological activities of bark fibers and fruit peels of the C. nucifera. This plant has the following therapeutic indications: antioxidant, antimicrobial, leishmanicide, anthelmintic, anti-inflammatory, antinociceptive, antineoplastic, pro-inflammatory and non-toxic in addition to treating diabetes and prostatic hyperplasia. Future investigations should be developed in the search for further biological activities and consolidation of the previously reported, aiming applicability of this plant, with a view to obtaining less aggressive treatments for the human being.

Keywords: Biological therapy; *Cocos nucifera* L.; Plant extracts.

INTRODUCTION

Plants have been used since ancient times as food sources and for treating several diseases that affect the human being. Since the last two decades of the XX century, it is observed a growing worldwide trend of the use of plants as a therapeutic resource, influenced by economic, social and cultural factors. [1]

The use of plants as an alternative treatment has been encouraged by the World Health Organization, through programs. In Brazil, the Ministry of Health has invested in the applicability of complementary therapies in the routine of healthcare services, being that one of them is the institution of the National Policy on Integrative and Complementary Practices (PNPIC), in 2006, in reference to the manifestation of popular knowledge in health, in order to achieve a new therapeutic approach, which fosters and promotes the universalization of access to users of the National Health System/SUS. [2]

One study reported that plant extracts were effective in controlling several diseases, as well as the involvement of researchers from the fields of pharmacy and medicine in the investigation of biological activities of medicinal plants guided by the popular use. [3] In this context, one should encourage the participation of the nursing professional at a

higher level than a user of new technologies, as well as its engagement in the development of technological innovations in this area, with a view to fostering the health promotion by means of actions that might be implemented by the SUS. [4]

The Brazil holds the largest variety of plants in the world, but less than 10% were assessed with respect to their biological aspects. The Brazilian flora has about 55 thousand species, which corresponds to approximately 22% of the universe of plant species known in the planet. [5]

The *Cocos nucifera* Linn. is a palm tree belonging to the *Palmae* family, which is popularly known in Brazil as coconut tree. Coconut is the fruit produced by the coconut tree, a plant species of tropical region, originating from the Asian continent, more precisely from the region of Indo-Malaysia. This palm tree was introduced in Brazil by the Portuguese settlers, with a good adaptation. [6] The coconut tree has a worldwide known relevance, both for consumption “*in natura*” and for industrial purposes.

The Brazilian Northeast has satisfactory soil and climatic conditions for its cultivation. [7] Given this ascertainment, *C. nucifera* has potential for the development of researches that seek further evidence of its biological activity. The coconut shell has a chemical composition similar to the wood, and is suitable for the extraction of phenolic compounds (tannins, flavonoids and xanthonenes), which are responsible for the antimicrobial, antiulcerogenic, anti-inflammatory and antineoplastic activities. [8-10]

Based on the aforementioned, the study objective was to analyze the scientific production on the biological activity of the coconut tree in the treatment of diseases. This study is justified for serving as a benchmark for synthesizing scientific evidence of the biological potential of the *C. nucifera* against several diseases that affect the human being.

EXPERIMENTAL SECTION

We opted for the integrative review method with sights to gather and synthesize the existing knowledge on the biological activity of the *C. nucifera* L., referring to its profile for the treatment of diseases. This type of review favors discussions about methods, research outcomes and considerations for the development of future studies. [11-12]

In this review, we have adopted the following steps: establishing the research question; search in the literature to identify the chosen theme; selection of the studies to be included; literature assessment; analysis and synthesis of data. [11] To conduct the review, the following question was formulated: What knowledge has been produced on the biological activities of the extracts from different parts of the *C. nucifera* L.?

For the selection of the papers, we have consulted the following databases: National Library of Medicine (MEDLINE), Latin American and Caribbean Health Sciences (LILACS), Chemical Abstracts Service (SciFinder Scholar/CAS), Brazilian Nursing Database (BDEnf) and Scientific Electronic Library Online (SciELO), using the following descriptors and their combinations in Portuguese, Spanish and English languages: coconut *and* biological activity *or* antimicrobial activity.

We searched for papers that could answer the review question, adopting as inclusion criteria: papers published in the period from 2002 to 2011 in national and international journals (Portuguese, Spanish and English); which describe the biological activity of the *C. nucifera*, with abstracts and full texts available online; as to the exclusion criteria, they were: papers related to the pulp and the water of the coconut tree fruit and items that are not associated to the biological use. 180 productions were identified. Next, we carried out the reading of the abstracts and the selection of the productions to be read in their full versions; thus, the final sample was comprised of 14 papers.

To collect data from the papers, we have elaborated a form that included information about paper identification, study objectives, methodological characteristics of the research, data analysis, results, discussion and conclusions. [11] The presentation of results and discussion of data was performed in a descriptive way, thereby allowing the applicability of this review in the practice of basic researches, as well as highlighting the importance of the involvement of the nursing professional in this type of investigation.

RESULTS

We have analyzed 14 papers that met the inclusion criteria, located in the following databases: six in the SciFinder Scholar / CAS, five in MEDLINE, two in LILACS and one in SciELO. Of these, 13 are in English and one is in

Portuguese. There were no publications on this topic in journals of Nursing. Table 1 presents some information about the papers of the review, and Table 2 presents a synthesis of the selected papers.

Table 1 - Papers included in the integrative review. Maceió/AL, Brazil, 2013.

Paper title	Journal	Publication country	Language	Year
1. Comparative in vitro antioxidant activity of different parts of <i>C. nucifera</i> on reactive oxygen and nitrogen specie [9]	Int. J. Pharm. Pharm. Sci.	India	English	2011
2. Preliminary phytochemical screening and anti-bacterial activity of <i>C. nucifera</i> L. root [10]	Res. J. pharm. Biol. Sci.	India	English	2011
3. <i>In vitro</i> antilisterial properties of crude aqueous and n-hexane extracts of the husk of <i>C. nucifera</i> [13]	Afr. J. Biotechnol.	Nigeria	English	2011
4. In vitro antibacterial properties of crude aqueous and n-hexane extracts of the husk of <i>C. nucifera</i> [14]	Molecules	South Africa	English	2011
5. Effect of ethyl acetate extract from husk fiber water of <i>C. nucifera</i> in Leishmania braziliensis infected hamsters [15]	Rev. Bras. Farmacogn.	Brazil	English	2011
6. Anthelmintic activity of <i>C. nucifera</i> L. on intestinal nematodes of mice [16]	Res Vet Sci.	Brazil	English	2010
7. Avaliação toxicológica e efeito do extrato acetato de etila da fibra de <i>Cocos nucifera</i> L. (Palmae) sobre a resposta inflamatória <i>in vivo</i> [17]	Rev. Bras. Plantas. Med.	Brazil	Portuguese	2009
<i>Resume</i>				
<i>Continuation</i>				
8. American palm ethnomedicine: a meta-analysis [18]	J. Ethnobiol. Ethnomed.	Poland	English	2009
9. Characterization of the antinociceptive and anti-inflammatory activities from <i>Cocos nucifera</i> L. (Palmae) [19]	J. Ethnopharmacol.	Brazil	English	2009
10. The husk fiber of <i>Cocos nucifera</i> L. (Palmae) is a source of anti-neoplastic activity [20]	Braz. J. Med. Biol. Res.	Brazil	English	2007
11. Antinociceptive and free radical scavenging activities of <i>C. nucifera</i> L. (Palmae) husk fiber aqueous extract [21]	J. Ethnopharmacol.	Brazil	English	2004
12. Leishmanicidal activity of polyphenolic-rich extract from husk fiber of <i>C. nucifera</i> L. (Palmae) [22]	Res. Microbiol.	Brazil	English	2004
13. The effect of a catechin-rich extract of <i>Cocos nucifera</i> on lymphocytes proliferation [23]	Phytother Res.	Brazil	English	2003
14. Antimicrobial and antiviral activities of polyphenols from <i>C. nucifera</i> L. (Palmae) husk fiber extract [24]	Res. Microbiol.	Brazil	English	2002

Table 2 - Summary of papers included in the integrative review. Maceió/AL, Brazil, 2013

Nº of the Paper/Objective	Methodology		Results	Therapeutic Indication
1. Assessing the activity of the <i>C. nucifera</i> as antioxidant agent [9]	<i>In</i> experimental	<i>vitro</i>	Total phenol tests have revealed an antioxidant action	Antioxidant
2. Gauging the antibacterial activity of the <i>C. nucifera</i> [10]	<i>In</i> experimental	<i>vitro</i>	Active extract for <i>S. aureus</i> and <i>P. aeruginosa</i>	Antibacterial activity
3. Assessing the extracts of the bark of the <i>C. nucifera</i> for Listeria Infection [13]	<i>In</i> experimental	<i>vitro</i>	The extract was active against 30, and the aqueous 29 different strains of <i>Listeria</i>	Antilisterial activity
4. Testing the antimicrobial potential of the crude extracts of the bark of the <i>C. nucifera</i> [14]	<i>In</i> experimental	<i>vitro</i>	The aqueous extract was active against 17 and 31, and the n-hexane 21 and 38 bacteria and vibrios (comma-shaped), respectively	Antibacterial activity
5. Assessing the extract of the fibers of the <i>C. nucifera</i> against <i>L. braziliensis</i> [15]	<i>In</i> experimental	<i>vivo</i>	Absence of immune stimulation, however, the animals have improved	Control of the <i>L. braziliensis</i>
6. Assessing the anthelmintic activity of the extract of the coconut bark [16]	<i>In</i> experimental	<i>vivo</i>	Mice treated with the extract showed decreased parasitic load	Control of the bowel nematodes
<i>Resume</i>				
<i>Continuation</i>				
7. Investigating the ethyl acetate extract of the <i>C. nucifera</i> on the topical inflammation [17]	<i>In</i> experimental	<i>vivo</i>	The extract has phenols and steroids, was non-toxic and did not inhibit inflammation	Non-toxic
8. Analyzing studies on the medicinal uses of american palm tress [18]	Review study		Of the studied palm trees, 106 are considered medicinal agents	Study for the revision of the Palmae species
9. Testing extract and fractions of the <i>C. nucifera</i> for inflammation and pain [19]	<i>In</i> experimental	<i>vivo</i>	Played as analgesic and inhibited the paw edema induced in rats	Analgesic and anti-inflammatory
10. Investigating the antitumor activity of the bark fiber of the <i>C. nucifera</i> [20]	<i>In</i> experimental	<i>vitro</i>	Extracts e fractions of the <i>C. nucifera</i> have antitumor activity [20]	Source of antineoplastics
11. Assessing the analgesic and anti-free radical effect of the bark of the <i>C. nucifera</i> [21]	<i>In vitro</i> e <i>in vivo</i> experimental		Absence of skin and ocular irritation in cases of topical application. <i>In vitro</i> had anti-radicalar action [21]	Non-toxic to the skin and ocular mucous. It is anti-radicalar
12. Assessing the <i>C. nucifera</i> against <i>L. Amazonenses</i> [22]	<i>In vitro</i> e <i>in vivo</i> experimental		The MIC of the extract inhibited parasite growth in mice	Leishmanicide potential
13. Assessing the catechins of the <i>C. nucifera</i> as antitumor agent [23]	<i>In</i> experimental study	<i>vitro</i>	Proliferation and cell viability in K562 cells and normal lymphocytes	Antitumor
<i>Resume</i>				
<i>Continuation</i>				
14. Assessing the antimicrobial activity of the <i>C. nucifera</i> [24]	<i>In</i> experimental	<i>vitro</i>	Showed activity against <i>S. aureus</i> and Acyclovir-resistant	Antibacterial

DISCUSSION

The studies from 1 to 4, 10 and 14 were *in vitro* experiments; from 5 to 7, 9 and 10 were *in vivo*; the 8 was a kind of meta-analysis review; the studies 11 and 12 used *in vitro* and *in vivo* experiments in the same research. Although most of the papers are originated from Brazilian citizens, the publications in English languages were predominant, meaning that there is a concern to internationalize the knowledge produced in our country.

It was found a higher incidence of Brazilian studies in relation to the rest of the world, being that this is possibly influenced by the favorable conditions for the cultivation of this plant in the Brazilian territory. As to the authorship, nine studies were conducted by Brazilian researchers and five were held by foreigners, who were from the following countries: India, Nigeria, Poland and South Africa. The professional category of the researchers was not identified, but all studies were performed in experimental research laboratories of universities, involving more than one area of knowledge.

Of the seven *in vitro* experimental studies, four assessed the antimicrobial activity of barks, fibers of the fruit and roots of the *C. nucifera*; two of them sought to investigate the inhibition of the proliferation of neoplastic cells in the fruit peels, as well as the isolated catechins from this same part; and one study used several parts by testing the antioxidant activity of this plant.

The *in vitro* studies have identified that the *C. nucifera* has antimicrobial activity against *S. S. aureus*, *P. aeruginosa*, *Escherichia coli*, *Enterococcus faecalis*, *Streptococcus faecalis*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Serratia marscens*, *Salmonella* sp., *Staphylococcus epidermidis*, *Micrococcus luteus*, *Vibrio vulnificus*, *V. fluvialis*, *Vibrio* sp. *V. metschnikovii*, *V. parahaemolyticus* [9-10,14] [9 to 10,14] and *Listeria. Monocytogenes* [13] - which is a pathogenic bacteria capable of causing meningitis and inducing abortion. [14] In addition, it was found that the crude extract and the catechins of the bark fibers showed activity against human herpes simplex virus type 1, resistant to Acyclovir, but it is inactive for the fungi *Candida albicans*, *Fonsecaea pedrosoi* e *Cryptococcus neoformans*. [24]

About the antitumor potential, it was found two studies reporting this activity against the proliferation of K562 cells, responsible for the occurrence of Myeloid Leukemia. Both the extract of the bark fibers [20] and the isolated catechins from the bark of the *C. nucifera* [24] produced a dose-dependent inhibition, assessed by the MTT assay [(4,5-dimethylthiazol-2 yl)-2,5-diphenyl tetrazolium bromide (MTT)] – which is a colorimetric method of reducing the tetrazolium salt that assesses the cytotoxicity of the tested sample [25] and of cycle studies by flow cytometry, in order to check up the antiproliferative effect on the K562 cell line. [26].

The antioxidant activity was found in a paper that investigated the potential of different parts of the *C. nucifera*⁽⁹⁾ through methods of reducing capacity of total phenols - spectrometric quantification of phenolic compounds using the Folin-Ciocalteu reagent and through the kidnapper activity of the free radical 2,2-diphenyl-1-picryl-hidrazila - DPPH. [9] The antioxidants are inhibitors of the oxidation process, even in relatively small concentrations and, therefore, have a pretty diversified physiological role in the body. Antioxidant constituents of plants act as removers and converters of these radicals in less reactive species. [27]

Of the four *in vivo* experimental papers, one assessed the leishmanicide potential of the extract of the bark of the *C. nucifera*. In this study, 12 hamsters were used, divided into three groups, where the group 1 received only the extract; the group 2 was infected with *L. braziliensis* and the group 3 was infected with *L. braziliensis* and treated with the extract. In these animals, it was found that the serum dosages of the blood test have proved the non-elimination of the etiologic agent, due the lack of stimulation of the immune system. Nonetheless, the animals showed improvements in physical conditions [15], indicating that their ethnobotanist use to treat this disease should be further studied.

The papers six worked with rats in the intent of assessing the anthelmintic activity of extracts of the *C. nucifera*. The animals were infected and distributed into six groups. Four groups were treated with the extract at different dosages, one with the standard drug and the other with 3% dimethylsulfoxide as a negative control. It was observed that the butanolic extract at a dose of 1000 mg/Kg of body weight reduces the parasitic load. Phytochemical tests have revealed the presence of triterpenes, saponins and tannins condensed in this extract. [16]

Two studies investigated the anti-inflammatory action of extract of the barks of the *C. nucifera*. In the paper seven, besides the anti-inflammatory activity, toxicity tests also were conducted. The essays were conducted using mice, being that the topical inflammation was induced by xylene applied in the ear; they were treated with single daily doses of the extract by means of the orogastric tube. At the end of the experiment, the animals were sacrificed to count the totality of leukocytes, weighing their ears, liver, spleen, thymus, and kidney. It was not detected toxic effect and neither reduction of the induced inflammation. [17] The paper nine used rats to assess analgesia and anti-inflammatory activity of the extract, and fibers fractions from the bark of the *C. nucifera*, indicating results consistent with the antinociceptive and anti-inflammatory action. [19]

A kind of meta-analysis review was found in the paper eight. It has identified 703 papers that argue about the worldwide palm trees. Of these, 106 reported the medicinal use, with emphasis on the *C. nucifera*, which showed

biological activities in the treatment of gastrointestinal and breathing disorders, skin and microbial diseases, musculoskeletal system pains, prostatic hyperplasia, diabetes and leishmaniasis. [18]

Of the selected papers, two conducted *in vitro* and *in vivo* experimental studies. In the study 11, it was performed *in vitro* experiment for investigating the antioxidant activity of the bark fibers of the *C. nucifera*, through the DPPH test; as to the antinociceptive activity, it was assessed *in vivo*, using mice in hot plate and writhing tests, noting that the extract administration has attenuated the response to the pain induced by acetic acid and to the heat due to the hot plate. Furthermore, there was the dermal toxicity test in rabbits, whose response was the lack of toxicity. [21]

In the study 12, it was programmed *in vitro* assay, using promastigotes of *L. amazonensis* before the polyphenolic extracts of the bark fibers of the *C. nucifera*, for an incubation period of 24 hours in a cultivation medium. The minimum inhibitory concentration of this extract was 10 µg/mL, being that it was considered active. Given this result, it was conducted an *in vivo* pre-treatment of the peritoneal macrophages of mice with 10 mg/mL of the same extract, decreasing by 44% the rate of aggregation of these macrophages and promastigotes of the *L. amazonensis*. These results indicate new perspectives for the development of phytoterapeutic agents against leishmaniasis. [22]

Regarding the methodological framework, there was a predominance of quantitative and experimental studies with focus on the basic research (93%) and use of a meta-analysis (7%), demonstrating the need for more studies that address this type of review.

The treatment of data in the 14 explored papers consisted in the use of statistics with experimental design, through the descriptive statistics (mean, variance, standard deviation, confidence interval, significance level and coefficient of variation), mean comparison tests (Tukey, Duncan and Dunnett), variance analysis (ANOVA), correlation and relationship tests, as well as the use of software programs [Statsoft version 5.0, GraphPad Prism 3.0, Statistical Analysis System 4.1]. The statistics is a science responsible for the interpretation of data of a research, aiming to understand the encountered situations to draw conclusions about the study object. [28]

The use of plants, in particular, *C. nucifera*, with activity against several diseases represents a potential source to access to the most deprived population, enabling the discovery of new therapies that present a treatment of difficult or onerous prognosis. Nevertheless, like any other form of treatment, those originating from plants should also be used with safety and efficacy. [29]

In this perspective, the nurses in the performance of their duties, especially in the field of public health, might guide the users interested in making use of the natural medicine, provided that it is scientifically substantiated. [30] It should also be mentioned that these professionals are enhancing their interest in participating in research groups that target this line of investigation, since the field of basic research in nursing is a new horizon to be explored, with the possibility of promoting the profession for meeting the policies for technological innovation of our country.

Given the above, it is asserted that there is strong evidence for the medicinal use of the *C. nucifera*, since it has various biological activities to assist in the treatment of some pathologies, recommending the continuation of basic experimental researches in search of new phytoterapeutic agents.

CONCLUSION

Regarding the 14 analyzed papers, it was found that most of them describe the biological activities of the bark fibers and fruit peels of the *C. nucifera*, being that studies on the leaves and stem were not found. The identified biological activities have therapeutic indication towards the following topics: antioxidant, antimicrobial, leishmanicide, anthelmintic, anti-inflammatory, antinociceptive/analgesic, antineoplastic, pro-inflammatory and non-toxic, in addition to treating diabetes and prostatic hyperplasia.

The studies were conducted in the laboratory of experimental research by involving more than one area of knowledge. This thematic has been the target of investment of health policies and technological innovation in Brazil, which makes crucial the continuation of pre-clinical and clinical studies aiming to achieve the applicability of extracts of the *C. nucifera* in human beings, with the prospect of obtaining natural treatments, which are less aggressive for the patient.

The involvement of the many areas of knowledge in this type of research is important, because it facilitates the gathering of skills in the quest to improve the health conditions of the population. In this context, nursing should be engaged, since it might contribute to the investigation process, from its beginning until its ending.

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