Research, Society and Development, v. 11, n. 17, e167111736940, 2022
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i17.36940

Natural products from the Brazilian Caatinga as a sustainable source of phytocosmetics: a review

Produtos naturais da Caatinga brasileira como fonte sustentável de fitocosméticos: uma revisão

Productos naturales de la Caatinga brasileña como fuente sustentable de fitocosméticos: una revisión

Received: 10/24/2022 | Revised: 11/28/2022 | Accepted: 12/21/2022 | Published: 12/24/2022

Paloma Maria da Silva
ORCID: https://orcid.org/0000-0003-4890-1310
Universidade Federal de Pernambuco, Brasil
E-mail: paloma.mariasilva@ufpe.br
Luiz Paulo Bezerra da Rocha
ORCID: https://orcid.org/0000-0002-0555-063X
Universidade Federal de Pernambuco, Brasil
E-mail: luiz.paulor@ufpe.br
Larissa Gomes de Arruda
ORCID: https://orcid.org/0000-0003-2535-7244
Universidade Federal de Pernambuco, Brasil
E-mail: larissagarruda@ufpe.br
Bruno Vinicius Souza da Silva
ORCID: https://orcid.org/0000-0003-4890-1310
Universidade Federal de Pernambuco, Brasil
E-mail: bruno.viniciuss@ufpe.br
Thiago Felix da Silva
ORCID: https://orcid.org/0000-0001-8532-9128
Universidade Federal de Pernambuco, Brasil
E-mail: thiagofelix.felix@hotmail.com
Wêndeo Kennedy Costa
ORCID: https://orcid.org/0000-0001-7925-6794
Universidade Federal de Pernambuco, Brasil
E-mail: wendeocosta@gmail.com
Weslley Felix de Oliveira
ORCID: https://orcid.org/0000-0002-6571-6216
Universidade Federal de Pernambuco, Brasil
E-mail: weslley.felix@ufpe.brr
Valquiria Bruna Guimarães Silva
ORCID: https://orcid.org/0000-0003-1026-4184
Universidade Federal de Pernambuco, Brasil
E-mail: valquiria.guimaraes@ufpe.br
Marcia Vanusa da Silva
ORCID: https://orcid.org/0000-0002-2221-5059
Universidade Federal de Pernambuco, Brasil
E-mail: marcia.vanusa@ufpe.br
Maria Tereza dos Santos Correia
ORCID: https://orcid.org/0000-0003-4920-9975
Universidade Federal de Pernambuco, Brasil
E-mail: maria.tscorreia@ufpe.br

Abstract

Natural extracts are described in the literature as biomolecules that have, among others, antioxidant and photoprotective properties. In addition, other advantages allow its use, such as low toxicity and high biodegradability. The skin is an organ that is constantly exposed to oxidative stress, including ultraviolet (UV) radiation, air pollutants and chemicals. These factors directly lead to premature skin aging. The interest in active substances from Brazilian biodiversity, especially the Caatinga Biome, highlighting the attention and research of the pharmaceutical sector and cosmetic industries, to study the insertion of natural biomolecules of plant origin, to demonstrate to consumers the safety and efficacy of these products. However, the objective of this review is to present plants from the Brazilian Caatinga that have biological activities that act in the preventive process of skin care and that have potential for the production of phytocosmetics. This integrative review was produced through a search carried out from January to April 2022. This bibliographic search was carried out in specialized databases (PubMed, Scopus and Science Direct), the manuscript selection was based on the inclusion criteria: articles with studies of plants collected in the region of the Caatinga Biome for the development or tests for skincare in the cosmetic area (in vivo and/or in vitro) with natural extracts that contain

keywords in the title, abstract or full text, in the years between 2010 and 2022. Presenting results for the antioxidant, photoprotective and cytotoxicity assays of plants of the Arecaceae family.
Keywords: Caatinga; Plant extracts; Phytocosmetics; Skincare.

Resumo
Os extratos naturais são descritos na literatura como biomoléculas que possuem, entre outras, propriedades antioxidantes e fotoprotetoras. Além disso, outras vantagens permitem seu uso, como baixa toxicidade e alta biodegradabilidade. A pele é um órgão que está constantemente exposto ao estresse oxidativo, incluindo radiação ultravioleta (UV), poluentes do ar e produtos químicos. Esses fatores levam diretamente ao envelhecimento prematuro da pele. O interesse por substâncias ativas da biodiversidade brasileira, especialmente o Bioma Caatinga, destacando a atenção e pesquisa do setor farmacêutico e das indústrias cosméticas, para estudar a inserção de biomoléculas naturais de origem vegetal, para demonstrar aos consumidores a segurança e eficácia desses produtos. No entanto, o objetivo desta revisão é apresentar plantas da Caatinga brasileira que apresentam atividades biológicas que atuam no processo preventivo de cuidados com a pele e que tenham potencial para a produção de fitocosméticos. Esta revisão integrativa foi produzida por meio de uma busca realizada no período de janeiro a abril de 2022. Essa busca bibliográfica foi realizada em bases de dados especializadas (PubMed, Scopus e Science Direct), a seleção do manuscrito foi baseada nos critérios de inclusão: artigos com estudos de plantas coletadas na região do Bioma Caatinga para o desenvolvimento ou testes para skincare na área cosmética (*in vivo e/ou in vitro*) com extratos naturais que contenham palavras-chave no título, resumo ou texto completo, nos anos entre 2010 e 2022. Apresentando resultados para os ensaios antioxidantes, fotoprotetor e citotoxicidade das plantas da família Arecaceae.
Palavras-chave: Caatinga; Extratos vegetais; Fitocosméticos; Skincare.

Resumen
Los extractos naturales se describen en la literatura como biomoléculas que poseen, entre otras, propiedades antioxidantes y fotoprotectoras. Además, otras ventajas permiten su uso, como la baja toxicidad y la alta biodegradabilidad. La piel es un órgano que está constantemente expuesto al estrés oxidativo, incluida la radiación ultravioleta (UV), los contaminantes del aire y los productos químicos. Estos factores conducen directamente al envejecimiento prematuro de la piel. El interés en las sustancias activas de la biodiversidad brasileña, especialmente del Bioma Caatinga, destacando la atención y la investigación de las industrias farmacéutica y cosmética, para estudiar la inserción de biomoléculas naturales de origen vegetal, para demostrar a los consumidores la seguridad y eficacia de estos productos. Sin embargo, el objetivo de esta revisión es presentar plantas de la Caatinga brasileña que tienen actividades biológicas que actúan en el proceso preventivo del cuidado de la piel y que tienen potencial para la producción de fitocosméticos. Esta revisión integradora se produjo a través de una búsqueda realizada de enero a abril de 2022. Esta búsqueda bibliográfica se realizó en bases de datos especializadas (PubMed, Scopus y Science Direct), la selección de manuscritos se basó en los criterios de inclusión: artículos con estudios de plantas recolectados en la región del Bioma Caatinga para el desarrollo o pruebas para el cuidado de la piel en el área cosmética (in vivo y/o in vitro) con extractos naturales que contengan palabras clave en el título, resumen o texto completo, en los años entre 2010 y 2022 Presentamos resultados de ensayos antioxidantes, fotoprotectores y citotóxicos de plantas de la familia Arecaceae.
Palabras clave: Caatinga; Extractos de plantas; Fitocosméticos; Protección de la piel.

1. Introduction

The skin is an organ that is frequently exposed to oxidative stresses, including ultraviolet radiation, atmospheric pollutants and chemicals (Montagner & Costa, 2009). These factors directly contribute to premature skin aging (de Oliveira Araújo et al., 2020). The use of products that help in the maintenance and natural balance of the skin is important, these products are known as cosmetics, and may have synthetic or natural additives to improve the performance of their activity (Almeida, 2019).

Cosmetics that have natural additives are known as phytocosmetics, as they are based on substances of natural and plant origin, which can be an oil, extract or essential oil, and the biological effect determines the action of the product (Romero et al., 2018). According to ANVISA's RDC 211/05, phytocosmetics can be used on various external parts of the human body, such as skin, hair system, nails, lips, teeth and mucous membranes of the cavity oral, with the objective of cleaning, perfuming, altering the appearance and/or correcting body odors and/or protecting them and keeping them in good condition. In addition, they must follow quality and sustainability standards, complying with strict certification standards (Isaac et al., 2008). Therefore, medicinal plants, especially natural extracts that are already used for therapeutic purposes (Pinto et al., 2020), can serve as a source of compounds (Berlinck et al., 2017).

These phytocosmetics have additives that include a natural active, of plant origin, either an extract or oil, whose action defines the activity of the product, preventing its replacement by synthetic substances (de Oliveira Araújo et al., 2020). These natural products have numerous advantages that allow their use, such as low toxicity (Senigalia et al., 2020), potential antioxidant agents (Gunathilake et al., 2018), photoprotective action (da Silva Lima et al., 2020), which can be applied for skincare (Aziz et al., 2014). These advantages are due to its chemical compounds, such as flavonoids, glycosides, patuletin and eupafoline derivatives, alkaloids, phenolic compounds, flavonoids, tannins, saponins, steroids and triterpenoids, which are described as important antioxidant (Granato et al., 2018), anti-inflammatory (Dalastra et al., 2019) and photoprotective agents (Dantas et al., 2020).

The interest in actives from Brazilian biodiversity has received worldwide attention from the pharmaceutical and cosmetic industries, which are researching the insertion of natural biomolecules of plant origin to prove to the consumer the safety and efficacy of products in cosmetic uses (Oliveira, 2015). This interest is due to the Brazil has one of the richest flora in the world and the few existing studies of these products justify the search for further development in this area. As research and demand in this area expands, it is possible that the discoveries of new biologically active molecules will be evidenced (Almeida et al., 2017).

The Caatinga phytogeographic domain is in the same situation, covering almost 800 thousand km2 in Northeast Brazil. The diversity of species makes the Caatinga the richest semi-arid region in terms of fauna and flora in the world. This region has a xerophilous vegetation, with plant characteristics that are affected by the long and irregular drought, high temperatures and high ultraviolet radiation, allowing specific qualities to the plants of this place and that can increase the demand by the cosmetic industry for the production of phytocosmetics (Zeppelini et al., 2013).

Therefore, the present study aims to carry out a review that presents plants from the Caatinga that act in this preventive process and that have potential for the production of phytocosmetics.

2. Methodology

This integrative review was based on the model proposed by (Tavares De Souza et al., 2010), through a search carried out from January to April 2022. This bibliographic search was carried out in specialized databases (PubMed, Scopus and Science Direct), in addition to articles present in the Google Scholar Virtual Library, using various combinations of the following keywords, in English and Portuguese: Brazil, Caatinga, cosmetics, natural cosmetics, phytocosmetics, biocosmetics, toxicity, antioxidant, skin care products, skin care, natural sunscreen, natural protector. The selection of the manuscript was based on the inclusion criteria: articles with studies of plants collected in the region of the Caatinga Biome for the development or tests for skincare in the cosmetic area (in vivo and/or in vitro) with natural extracts that contain keywords in the title, abstract or full text, in the years between 2010 and 2022. Articles with studies of purified, synthetic or semi-synthetic compounds, or with plants collected in other regions of Brazil and with dates that do not agree with the inclusion proposal, were excluded. In this investigation, we identified 125 articles; however, 28 articles were selected, as the others did not meet the inclusion criteria or were indexed in two or more databases and were considered only.

3. Results and Discussion

The development of phytocosmetics is growing since it meets the basic needs of the human, in addition to improving the quality of life, which also results in physical health in terms of personal hygiene (Ndhlovu et al., 2019). In addition, other advantages of its application include sustainable alternatives, employing technologies that are less harmful to the environment, and not containing synthetic assets that can be toxic when used (Harhaun et al., 2020). The search for plants with potential for this cosmetic use leads us to a more conscious look, both in relation to their use and the use of their constituents, that is, whether in the form of extracts or isolated actives. Because it is these compounds that gain space in the cosmetic industry (Nadeeshani Dilhara Gamage et al., 2022).

In phytochemical terms, the bioactive compounds found in the plants of the Caatinga, shown in Table 1, have properties that enhance the defense against predators and against ultraviolet radiation, as they present substances that are expressed due to the climate of the Caatinga (de Araújo et al., 2021). The Caatinga occupies the entirety of the state of Ceará and part of the territory of Alagoas, Bahia, Maranhão, Minas Gerais, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe. Among these states, the main botanical families present in the Caatinga are Anacardiaceae, Fabaceae, Rhamnaceae, Sapotaceae, Arecaceae and Bromeliad (Fonseca et al., 2018), such as shown in Table 1.

These families include plants in which the main compounds present are tannins and flavonoids and that are described in the literature as potent antioxidant agents (Melo et al., 2011). Providing protection from the harmful effects of ultraviolet radiation (Saraiva et al., 2015), and are used as anti-inflammatory, healing, antifungal, antimicrobial and do not present toxicity for use (de Queiroz et al., 2010; Luna et al., 2022). These phenolic compounds, in the general definition, are those structures that have a common phenolic arrangement, an aromatic ring with a benzene nucleus, coupled to at least one hydroxyl substituent, free or belonging to an ester, ether or heteroside. This group includes tannins and procyanidins, coumarins, flavonoids and anthocyanins, which are candidates for the prevention of pathological conditions such as photoaging and skin cancer, mainly due to their shared antioxidant effects (Merecz-Sadowska et al., 2021).

The botanical species present in Table 1 were verified in the list of plants (accessed 12 July 2022), they are:, Spondias tuberosa, Schinus terebinthifolius, Caesalpinia pyramidalis, Amburana cearensis, Mimosa caesalpiniaefolia, Anadenanthera colubrina, Ziziphus joazeiro, Sideroxylon Obtusifolium, Copernicia prunifera, Bromelia laciniosa, are plants that have in their chemical constitution compounds that allow their activities to be promising for the prevention of diseases related to the skin. For this, determination of photoprotective, antioxidant and cytotoxic activities of the plants listed above were carried out. The evaluation of the antioxidant activity of the extracts generally was carried out by the method of scavenging DPPH free radicals. While for the in vitro photoprotection assay, it was by the Mansur methodology. In addition to the various methodologies to assess cytotoxicity. Among so many positive characteristics present in the plants described in Table 1, one of the main qualities is that some species, such as Spondias tuberosa, Schinus terebinthifolius, Ziziphus joazeiro, Mimosa caesalpiniaefolia Sideroxylon obtusifolium, Copernicia prunifera and Bromelia laciniosa, showed no toxicity for the methodologies tested. Noting that in the face of the problem of consumption of medicinal plants, toxicity is one of them. Naturally, plants produce a diversity of secondary metabolites that are continuously related to plant protection mechanisms against predators and pathogens (Campos et al., 2016).

Toxic species are those that produce compounds that cause harmful metabolic changes in humans and animals. The toxicity exhibited by plant species shown in the Table 1, for xample, Caesalpinia pyramidalis, Amburana cearensis, Anadenanthera colubrina, may be related to factors relating to individuals, plants, exposure patterns and environmental concerns (Bochner et al., 2012). Acute or chronic poisonings caused by plants are difficult to diagnose and the relationship between symptoms and consumption and/or exposure to certain species is difficult to establish. In terms of public health, poisonings caused by plants have a great impact. In the Northeast of Brazil, 24 cases were recorded in 2017, most of them in children aged 5 to 9 years, according to the National System of Toxic-Pharmacological Information (SINITOX).

All species under analysis were described with potential for the ability to scavenge free radicals according to the tested methodology (DPPH). This was due to the presence of compounds, such as tannins and flavonoids that are described in the literature as an antioxidant agent. For solar protection factor tests, it is necessary to follow a standard established by the Brazilian health surveillance agency, which recommends that the value be equal to or greater than an SPF of 6 (Brasil, 2010). However, the species that fit the pattern were Spondias tuberosa, Schinus terebinthifolius Raddi and Amburana cearensis. The other species were either not described in the literature or are incorporated into nanotechnologies and have been described as a possibility of being a photoprotector.

Table 1 - Botanical families of the Caatinga with potential for the development of phytocosmetics.

Popular Name Scientific name Family	Collection location	Part used	Preparation	Major compounds	Action	Therapeutic indication	Reference
Umbuzeiro Spondias tuberosa Arruda (Anacardiaceae)	Pernambuco	Sheet Bark Branches	Methanolic extracts Ethanolic extract	Flavonoids, cinnamic derivatives, triterpenes and steroids	By the DPPH radical scavenging method (%), the leaves showed strong antioxidant capacity (> 60%). The SPF values obtained with the extract of the branches were 15.50 ± 0.41, showing values above those indicated by the National Health Surveillance Agency. The ethanolic extract of the bark had no cytotoxic effects on human epidermoid cancer cells. In the assessment of acute toxicity, the liver and kidney did not show morphological changes.	Treatment of inflammation, infections, venereal diseases, digestive diseases, diarrhea. (de Sousa Araújo et al., 2008) (de Freitas Lins Neto et al., 2010)	(Barbosa et al., 2016), (de Araújo et al., 2021) (Brasil, 2010)
Aroeira-vermelha *Schinus terebinthifolius* Radd i (Anacardiaceae)	Bahia Pernambuco	Leaf, stem and bark	Ethanolic extract	Tannins, flavonoids alkaloids	All samples tested showed antioxidant activity, presented as a percentage of consumption of the DPPH radical, which varied between 60.37% and 85.76%. In Concentration (2 mg mL $^{-1}$) the SFP was 26.82. In the acute and subacute toxicity	Anti-inflammatory, healing, antitumor, fungicidal and in the treatment of ulcers. (Bendaoud et al., 2010) (Carlini et al., 2013)	(Oliveira et al., 2013). (Lima et al., 2009), (M. B. S. Oliveira et al., 2020).

Catingueira *Caesalpinia pyramidalis* Tul. (Fabaceae)	Piauí Rio Grande do Norte	Bark Folhas	Aqueous extracts	Flavonoids, triterpenes and phenylpropanoids	tests, treatments with the ethanolic extract of the bark were not toxic and did not cause morphological changes. The results showed that *C. piramidalis* bark has a high capacity for scavenging radicals, performed by the DPPH method, with results (IC50 = 16.98 ± 1.34 µg/mL). *Caesalpinia pyramidalis* presented a sun protection factor of 5 ± 1.0. In embryotoxicity tests, the addition of leaves to the diet of pregnant rats was responsible for skeletal anomalies in fetuses and prenatal mortality.	Antipyretic, anti-inflammatory, expectorant, depurative and in the treatment of intestinal infections and bronchitis (Leal et al., 2000)	(Cartaxo et al., 2010), (Câmara et al., 2017), (Martins et al., 2016)
Cumaru *Amburana cearensis* (Allemão) A.C. Smith (Fabaceae)	Bahia	Bark and leaves	Ethanolic extract	Tannins and gallic acid, terpenes and saponins, steroids and lipid derivatives	The ethanol extract of the bark and leaves showed results of 94.55%, 93.63% respectively, determined by the DPPH assay. Amburana Ceará expressed FPS equal to 12.21	Treatment of asthma, cough, bronchitis, inflammation and spasms (Leite, 2005)	(dos Santos et al., 2016). (Nunes et al., 2018), (Lataliza et al., 2019)
Sabiá *Mimosa caesalpiniaefolia* Benth. (Fabaceae)	large northern river Piauí	Sheet	Aqueous extracts Ethanolic extract	Phenols, anthocyanins, steroids and catechin, tannins	The bark powder extract was cytotoxic in two cell lines (murine fibroblasts and human keratinocytes). Antioxidant activity through DPPH radical capture, obtained results of 62.70 (mg/L). There is no report on photoprotection activity. The ethanol extract showed low cytotoxicity against Artemia salina (LC50 of 1765 mg/L) and murine macrophages (706.5 mg/L) and showed no	Healing, bronchitis (de Albuquerque et al., 2007)	(J. C. G. de Oliveira et al., 2020), (Monção et al., 2014)

					toxicological effect or androgenic activity in rats.		
Angico *Anadenanthera colubrina* (Vell.) Brenan (Fabaceae)	North of Minas Gerais	Shells	Ethanolic extract	Tannins, alkaloids and saponins	Tested by the DPPH stable free radical methodology, resulting in the reduction of up to 94.8% of the 2,2-diphenyl-1-picrylhydrazyl radical. The sun protection factor was 1.08. In the toxicity test, a high mortality of *Artemia salina* specimens was observed at concentrations above 50 µg/mL.	Respiratory problems, Inflammation, Diarrhea, Cough, Bronchitis, Influenza (Cartaxo et al., 2010)	(Damascena et al., 2014), (Pessoa et al., 2015), (de Almeida Andrade et al., 2019), (dos Santos Silva et al., 2020)
Juazeiro *Ziziphus joazeiro* Mart. (Rhamnaceae)	Ceará	Shells Bark	Methanolic extracts Aqueous extract	Polyphenols, triterpenes, steroids and flavonoids	Antioxidant activity by the DPPH method, resulting in (27.94 ± 13.84 g/g of DPPH). They can be considered promising in terms of their photoprotective potential. In the cytotoxicity test with mammalian fibroblasts, the leaf extract was not toxic.	Antifungal, antibacterial, antioxidant, antipyretic, anti-inflammatory and astringent (C. de Almeida et al., 2005)	(de Oliveira Almeida et al., 2020), (Brito et al., 2020), (Andrade et al., 2019)
Quixaba *Sideroxylon Obtusifolium* (Roem. & Schult.) T.D.Penn. (Sapotaceae)	Paraíba Ceará	Fruits Leaves	Extracted with acetone Methanolic extract	Anthocyanins	Radical scavenging activity (%) by the DPPH method, resulting in a scavenging of 70.15%. There is no report on photoprotective activity. The leaf extract was not cytotoxic and promoted an increase in the cell viability of human keratinocytes.	Inflammation treatment, wound healing and uterine cleansing (Júnior et al., 2011)	(Figueiredo & Lima, 2015) (de Souza et al., 2020)
Carnaúba *Copernicia prunifera*	Ceará Piauí	Fruits Leaves	Ethanol extract	Tannin,	It showed high antioxidant activity of 3549±184 g/g by DPPH. Photoprotection results linked to nanotechnology.	Applications in the pharmaceutical, food industry industry, cosmetics and lubricants	(B. C. de Almeida et al., 2016), (Aline et al., 2017),

(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i17.36940

(Mill.) H.E. Moore (Arecaceae)				Phenolic compounds, anthocyanins, flavonoids	The cytotoxicity assay did not demonstrate damage to connective cells in mammals up to 200 Mm.	(Barman et al., 2011)	(da Silva Andrade et al., 2018)
Macambira *Bromelia laciniosa* Mart. ex Schult. & Schult.f. (Bromeliaceae)	Pernambuco	Leaves	Ethanolic extract	Flavonoids, tannins, lignans, monoterpenes, diterpenes, steroids and triterpenoids	It exhibited excellent free radical scavenging activity, with an IC50 value of 18.51 ± 2.90µg/ml. Determined by the DPPH method. Plant extracts showed photoprotective action, showing to be interesting for the development of new studies aiming at their incorporation in photoprotective cosmetic formulations. In the acute toxicity tests with the ethanolic extract of the leaves, no physiological changes were observed.	antinoceptive, antioxidant, antimicrobial (Amendoeira et al., 2005)	(de Lima-Saraiva et al., 2014) (J. Almeida, 2019)

Source: Authors.

Tannins, for example, represent heterogeneous, water-soluble, high-molecular-weight polyphenolic compounds widely distributed in the plant kingdom, and act as chemical defenses against predators and UV radiation in very different concentrations. This group of tannins has potential applications as prevention and treatment of several types of tumors, including skin cancer (Bhattacharya et al., 2011). The mechanism of action of tannins is related, at least in part, to the common properties of hydrolysates and condensates, as they exert potent antioxidant and free radical scavenging activities.

In cosmetics, the use of plant parts made up of tannins stems mainly from their topical application as an astringent, through tannin-protein complexes that allow them to adhere to the outermost layers of the skin and mucous membranes, making them impermeable (Petchidurai et al., 2019). In this way, they exert a vasoconstrictor effect on superficial capillaries, limit the loss of liquids and prevent external aggressions, favor tissue regeneration and, thus, promote the healing of wounds, burns and inflammations. In addition to the aforementioned actions, they reduce the diameter of the pores of the sebaceous glands, they can be used for seborrheic skin, have antiseptic properties, as they can alter microbial metabolism by acting on microbial cell membranes (Benzidia et al., 2019).

Flavonoids are low molecular weight polyphenols present in all parts of plants. The chemical structure of flavonoids belongs to 1,3-diphenylacetone derivatives. Flavonoids are considered "plant pigments" because their color distinguishes the various existing pigments. They are mainly located in the cuticle and in the epidermal cells of the leaves, guaranteeing the protection of tissues against the harmful effects of UV radiation. They also have antioxidant (Shen et al., 2022), sedative properties and exert anti-inflammatory effects (Sandra Liliana et al., 2021), which explains the predominant use of plants and/or extracts as a drug or cosmeceutical (Cefali et al., 2021).

Research on different substances of natural origin with antioxidant properties has been growing in recent years, mainly due to the importance of these substances from an economic and medical point of view, and the growing appreciation of natural products. The study of antioxidant potential also has important ecological and physiological implications, since organisms such as algae, animals and land plants use these antioxidants as one of their main defense fronts in the face of oxidative stress conditions (Hughes et al., 2021). Therefore, several in vitro assays are available to assess the antioxidant potential of different extracts and substances. Evidence suggests that antioxidants from foods and natural products can mitigate the main component of skin aging caused by sun exposure (Guo et al., 2020).

The skin is the largest organ of the human being, which helps in the production of vitamin D when in contact with the sun's rays; however, prolonged exposure without protection causes changes in the skin (de Assis et al., 2021). Ultraviolet radiation can cause DNA damage, immunosuppression, chemical and histological changes in the epidermis, premature aging, cataracts and carcinogenesis, among other deteriorations. These changes in the skin caused by the sun cause a lot of inconvenience to individuals, interfering with daily activity. These damages can be minimized with the use of sunscreens due to their prophylactic and therapeutic action that do not present toxicity regarding their use (Alves et al., 2021).

4. Conclusion

The Caatinga biome is rich in plant diversity with photoprotective properties, in which active molecules can be extracted to protect the skin from external factors. Therefore, these active ingredients can be incorporated into cosmetic and cosmeceutical formulations to maximize the effect and add economic value. In addition, the cosmetics market grows every day, the demand for products with properties of natural origin, raw materials that provide scientific evidence that proves their effectiveness and safety, with antioxidant properties, which act by eliminating free radicals that promote damage to cells caused by UV light, and that helps prevent photoaging caused by external factors, in addition to not showing toxicity. In addition to being a sustainable alternative, technologies that are less harmful to the environment can be used and do not contain synthetic assets that can be toxic when used. Thus, enabling economic development through the production of phytotherapy and phytocosmetics using the resources of the biodiversity of the Caatinga can constitute a bioenterprise for family farming. Given the lack of resources on this situation and the potential impact on local economies, there is a need to broaden the discussion and reflection on relevant aspects of the bioenterprise to develop more strategic public tools for an effective innovation policy.

Acknowledgments

To the financial support of the Coordination for the Improvement of Higher Education Personnel (CAPES) The Federal University of Pernambuco (UFPE) for the availability and structure of the Biochemistry departments, to the professors and collaborators for writing the review article.

References

Aline, M. S., Cludio, H. de A. O., Csar, C. L. F., Marcos, V. de O. C., Francisco, F. M. da S., Maria, I. F. G., & Davide, R. (2017). Bromatological analysis, phytochemical and antioxidant potential of carnauba (Copernicia prunifera (Mill.) HE Moore) fruit. *African Journal of Food Science, 11*(11), 353–361.

Almeida, J. (2019). Núcleo de Estudos e Pesquisas de Plantas Medicinais (NEPLAME): um breve histórico, principais avanços e perspectivas. *Revista Virtual de Qu\'\imica*, *11*(2).

Almeida, M. R., Martinez, S. T., & Pinto, A. C. (2017). Chemistry of natural products: Plants that witness histories. *Revista Virtual de Quimica*, *9*(3), 1117–1153.

Alves, P. v, Querino, C. A. S., Rizzuti, B. F., Vaz, M. A. B., Querino, J. K. A. da S., & Pinho, J. A. do N. (2021). The importance of the concept of solar radiation in basic education: the perception of high school students about the theme. *Revista Brasileira de Ensino de F\'\isica*, *43*.

Amendoeira, F. C., Frutuoso, V. S., Chedier, L. M., Pearman, A. T., Figueiredo, M. R., Kaplan, M. A. C., Prescott, S. M., Bozza, P. T., & Castro-Faria-Neto, H. C. (2005). Antinociceptive effect of Nidularium procerum: a Bromeliaceae from the Brazilian coastal rain forest. *Phytomedicine*, *12*(1–2), 78–87.

Andrade, J. C., da Silva, A. R. P., dos Santos, A. T. L., Freitas, M. A., de Matos, Y. M. L. S., Braga, M. F. B. M., Bezerra, C. F., Gonçalo, M. I. P., Gomez, M. C. V., Rolóm, M., & others. (2019). Chemical composition, antiparasitic and cytotoxic activities of aqueous extracts of Ziziphus joazeiro Mart. *Asian Pacific Journal of Tropical Biomedicine*, *9*(5), 222.

Aziz, F. M., Darweesh, M. J., Rahi, F. A., & Saeed, R. T. (2014). In vivo and in vitro studies of a polar extract of Helianthus annuus (Sunflower) seeds in treatment of Napkin Dermatitis. *International Journal of Pharmaceutical Sciences Review and Research*, *24*(2), 1–3.

Barbosa, H. M., NASCIMENTO, J. N., Araujo, T. A. S., Duarte, F. S., Albuquerque, U. P., Vieira, J. R. C., Santana, E. R. B. D. E., Yara, R., Lima, C. S. A., Gomes, D. A., & others. (2016). Acute toxicity and cytotoxicity effect of ethanolic extract of Spondias tuberosa Arruda bark: hematological, biochemical and histopathological evaluation. *Anais Da Academia Brasileira de Ciências*, *88*, 1993–2004.

Barman, K., Asrey, R., & Pal, R. K. (2011). Putrescine and carnauba wax pretreatments alleviate chilling injury, enhance shelf life and preserve pomegranate fruit quality during cold storage. *Scientia Horticulturae*, *130*(4), 795–800.

Bendaoud, H., Romdhane, M., Souchard, J. P., Cazaux, S., & Bouajila, J. (2010). Chemical composition and anticancer and antioxidant activities of Schinus molle L. and Schinus terebinthifolius Raddi berries essential oils. *Journal of Food Science*, *75*(6), C466–C472.

Benzidia, B., Barbouchi, M., Hammouch, H., Belahbib, N., Zouarhi, M., Erramli, H., Daoud, N. A., Badrane, N., & Hajjaji, N. (2019). Chemical composition and antioxidant activity of tannins extract from green rind of Aloe vera (L.) Burm. F. *Journal of King Saud University-Science*, *31*(4), 1175–1181.

Berlinck, R. G. S., Borges, W. de S., Scotti, M. T., & Vieira, P. C. (2017). A qu\'\imica de produtos naturais do Brasil do século XXI. *Qu\'\imica Nova*, *40*, 706–710.

Bhattacharya, U., Mukhopadhyay, S., & Giri, A. K. (2011). Comparative antimutagenic and anticancer activity of three fractions of black tea polyphenols thearubigins. *Nutrition and Cancer*, *63*(7), 1122–1132.

Bochner, R., Fiszon, J. T., Assis, M. A., & Avelar, K. E. S. (2012). Problemas associados ao uso de plantas medicinais comercializadas no Mercadão de Madureira, munic\'\ipio do Rio de Janeiro, Brasil. *Revista Brasileira de Plantas Medicinais*, *14*, 537–547.

Brasil, C. F. do B. (2010). Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). In *Brazilian Pharmacopeia, 5a ed*. Atheneu.

Brito, S. M. O., AOBPB, M., de Oliveira, M. R. C., Vidal, C. S., de Lacerda Neto, L. J., Ramos, A. G. B., da Cruz, L. P., Nascimento, E. A., da Costa, J. G. M., Coutinho, H. D. M., & others. (2020). Gastroprotective and cicatrizing activity of the Ziziphus joazeiro Mart. leaf hydroalcoholic extract. *Journal of Physiology and Pharmacology: An Official Journal of the Polish Physiological Society*, *71*(3).

Câmara, A. C. L., Gadelha, I. C. N., Castro, M. B., Medeiros, R. M. T., Riet-Correa, F., & Soto-Blanco, B. (2017). Embryotoxic effects of Poincianella (Caesalpinia) pyramidalis leaves on pregnant rats. *Journal of Veterinary Diagnostic Investigation*, *29*(2), 137–142.

Campos, S. C., Silva, C. G., Campana, P. R. v, & Almeida, V. L. (2016). Toxicidade de espécies vegetais. *Revista Brasileira de Plantas Medicinais*, *18*, 373–382.

Carlini, E. A., Duarte-Almeida, J. M., & Tabach, R. (2013). Assessment of the Toxicity of the Brazilian Pepper Trees Schinus terebinthifolius Raddi (Aroeira-da-praia) and Myracrodruon urundeuva Allemão (Aroeira-do-sertão). *Phytotherapy Research*, *27*(5), 692–698.

Cartaxo, S. L., de Almeida Souza, M. M., & de Albuquerque, U. P. (2010). Medicinal plants with bioprospecting potential used in semi-arid northeastern Brazil. *Journal of Ethnopharmacology*, *131*(2), 326–342.

Cefali, L. C., Vazquez, C., Ataide, J. A., Figueiredo, M. C., Ruiz, A. L. T. G., Foglio, M. A., Lancellotti, M., & Mazzola, P. G. (2021). In vitro activity and formulation of a flavonoid-containing cashew pulp extract for the topical treatment of acne and the protection of skin against premature aging. *Natural Product Research*, *35*(23), 5243–5249.

da Silva Andrade, L. B., da Silva Julião, M. S., Cruz, R. C. V., Rodrigues, T. H. S., dos Santos Fontenelle, R. O., & da Silva, A. L. C. (2018). Antioxidant and antifungal activity of carnauba wax powder extracts. *Industrial Crops and Products*, *125*, 220–227.

da Silva Lima, A. D., de Sousa, R. G., & Lima, E. N. (2020). *Incremento da atividade fotoprotetora e antioxidante de cosméticos contendo extratos vegetais da Caatinga*.

Dalastra, V., Southier, N., Anaissi, F. J., Dalastra, J., & Yamazaky, R. K. (2019). Flavonoides presentes nos extratos da campomanesia xanthocarpa Berg. *Brazilian Journal of Development*, *5*(7), 8983–8991.

Damascena, N. P., Souza, M. T. S., Almeida, A. F., Cunha, R. S., Damascena, N. P., Curvello, R. L., Lima, A. C. B., Almeida, E. C. v, Santos, C. C. S., Dias, A. S., & others. (2014). Antioxidant and orofacial anti-nociceptive activities of the stem bark aqueous extract of Anadenanthera colubrina (Velloso) Brenan (Fabaceae). *Natural Product Research*, *28*(10), 753–756.

Dantas, L. V. B., da Silva Lopes, F. F., Alves, D. R., Frota, L. S., Cardoso, A. L. H., & de Morais, S. M. (2020). Avaliação Fitoqu\'\imica, quantificação de Fenóis e Flavonóides totais, Atividade antioxidante e antiacetilcolinesterase do extrato etanólico Da Tal\'\isia esculenta (Pitomba). *Brazilian Journal of Development*, *6*(8), 60597–60602.

de Albuquerque, U. P., de Medeiros, P. M., de Almeida, A. L. S., Monteiro, J. M., Neto, E. M. de F. L., de Melo, J. G., & dos Santos, J. P. (2007). Medicinal plants of the caatinga (semi-arid) vegetation of NE Brazil: a quantitative approach. *Journal of Ethnopharmacology*, *114*(3), 325–354.

de Almeida Andrade, B., Corrêa, A. J. C., Gomes, A. K. S., da Silva Neri, P. M., Sobrinho, T. J. da S. P., de Sousa Araújo, T. A., de Amorim, E. L. C., & others. (2019). Photoprotective activity of medicinal plants from the caatinga used as anti-inflammatories. *Pharmacognosy Magazine*, *15*(61), 356.

de Almeida, B. C., Araújo, B. Q., Carvalho, A. A., Freitas, S. D. L., Maciel, D. da S. A., Ferreira, A. J. S., Tempone, A. G., Martins, L. F., Alexandre, T. R., Chaves, M. H., & others. (2016). Antiprotozoal activity of extracts and isolated triterpenoids of 'carnauba'(Copernicia prunifera) wax from Brazil. *Pharmaceutical Biology*, *54*(12), 3280–3284.

de Almeida, C., e Silva, T. C. de L., de Amorim, E. L. C., Maia, M. B. de S., & de Albuquerque, U. P. (2005). Life strategy and chemical composition as predictors of the selection of medicinal plants from the caatinga (Northeast Brazil). *Journal of Arid Environments*, *62*(1), 127–142.

de Araújo, A. D., da Silva Oliveira, F. G., Lacerda, F. F., da Silva, C. E. S., dos Santos, B. S., Bezerra-Filho, C. M., de Azevedo Ramos, B., Harand, W., da Silva, N. H., Paiva, P. M. G., & others. (2021). Phytochemical screening, in vitro antioxidant, photoprotective and hemolytic activities of ethyl acetate extracts of the fruits and branches from Spondias tuberosa (umbu). *Research, Society and Development*, *10*(1), e38610111825–e38610111825.

de Assis, L. V. M., Tonolli, P. N., Moraes, M. N., Baptista, M. S., & de Lauro Castrucci, A. M. (2021). How does the skin sense sun light? An integrative view of light sensing molecules. *Journal of Photochemistry and Photobiology C: Photochemistry Reviews*, *47*, 100403.

de Freitas Lins Neto, E. M., Peroni, N., & de Albuquerque, U. P. (2010). Traditional knowledge and management of Umbu (Spondias tuberosa, Anacardiaceae): an endemic species from the semi–arid region of Northeastern Brazil. *Economic Botany*, *64*(1), 11–21.

de Lima-Saraiva, S. R. G., Saraiva, H. C. C., Silva, J. C., Neves, L. F., Damasceno, P. K. F., Branco, C. R. C., Branco, A., Amorim, E. L. C., & Almeida, J. R. G. S. (2014). Antinociceptive properties and acute toxicity of ethanol extract of Bromelia laciniosa Mart. ex Schult. f.(Bromeliaceae). *Tropical Journal of Pharmaceutical Research*, *13*(10), 1659–1666.

de Oliveira Almeida, J. I., Costa, F., Paulino, C. G., de Oliveira Almeida, M. J., Damaceno, M. N., dos Santos, S. M. L., & de Farias, V. L. (2020). Efeito da pasteurização sobre os compostos bioativos e a atividade antioxidante de polpa de frutos de Ziziphus joazeiro Mart. *Research, Society and Development*, *9*(5), e135953245–e135953245.

de Oliveira Araújo, M. S., das Dores Bezerra, T. M., da Silva, T. P., Silva, T. A., & Evangelista, G. B. B. (2020). USO DE FITOCOSMÉTICOS NO TRATAMENTO DA ACNE. *Revista Brasileira Interdisciplinar de Saúde*.

de Oliveira, J. C. G., Linhares, M. G., Linhares, L. G., Câmara, L. M. A., Bertini, L. M., & Alves, L. A. (2020). Capacidade antioxidante e caracterização fitoqu\'\imica de Mimosa caesalpiniaefolia. *Research, Society and Development*, *9*(8), e915986555–e915986555.

de Queiroz, A. C., de Lira, D. P., Dias, T. de L. M. F., de Souza, É. T., da Matta, C. B. B., de Aquino, A. B., Silva, L. H. A. C., da Silva, D. J. C., Mella, E. A. C., de Fátima Agra, M., & others. (2010). The antinociceptive and anti-inflammatory activities of Piptadenia stipulacea Benth.(Fabaceae). *Journal of Ethnopharmacology*, *128*(2), 377–383.

de Sousa Araújo, T. A., Alencar, N. L., de Amorim, E. L. C., & de Albuquerque, U. P. (2008). A new approach to study medicinal plants with tannins and flavonoids contents from the local knowledge. *Journal of Ethnopharmacology*, *120*(1), 72–80.

de Souza, T. de F. G., Pierdoná, T. M., Macedo, F. S., de Aquino, P. E. A., Rangel, G. de F. P., Duarte, R. S., de Barros Viana, G. S., Alves, A. P. N. N., Montenegro, R. C., Wilke, D. V., & others. (2020). Human keratinocyte (HaCaT) stimulation and healing effect of the methanol fraction from the decoction from leaf from Sideroxylon obtusifolium (Roem. & Schult.) TD Penn on experimental burn wound model. *BioRxiv*.

dos Santos, L. de O., Reis, M. R., Ogava, L. E., Leão, K. V., Machado, L. L., & de Lira, S. P. (2016). Avaliação da Atividade Antioxidante dos Compostos Fenólicos Presentes na Amburana cearensis. *Orbital: The Electronic Journal of Chemistry*, *1*(1), 44–49.

dos Santos Silva, E. L. G., Aguiar, H. T. V., & Freitas, R. F. (2020). Estudo fitoqu\'\imico, atividade antioxidante e tóxica da casca da Anadenanthera colubrina (Vell.) Brenan. *Biodiversidade*, *19*(2).

Figueiredo, F. J., & Lima, V. (2015). Antioxidant activity of anthocyanins from quixabeira (Sideroxylon obtusifolium) fruits. *Revista Brasileira de Plantas Medicinais*, *17*, 473–479.

Fonseca, C. R., Antongiovanni, M., Matsumoto, M., Bernard, E., & Venticinque, E. M. (2018). Oportunidades de conservação na Caatinga. *Ciência e Cultura*, *70*(4), 44–51.

Granato, D., Shahidi, F., Wrolstad, R., Kilmartin, P., Melton, L. D., Hidalgo, F. J., Miyashita, K., van Camp, J., Alasalvar, C., Ismail, A. B., & others. (2018). Antioxidant activity, total phenolics and flavonoids contents: Should we ban in vitro screening methods? *Food Chemistry*, *264*, 471–475.

Gunathilake, K., Ranaweera, K., & Rupasinghe, H. P. v. (2018). Change of phenolics, carotenoids, and antioxidant capacity following simulated gastrointestinal digestion and dialysis of selected edible green leaves. *Food Chemistry*, *245*, 371–379.

Guo, H., Guo, S., & Liu, H. (2020). Antioxidant activity and inhibition of ultraviolet radiation-induced skin damage of Selenium-rich peptide fraction from selenium-rich yeast protein hydrolysate. *Bioorganic Chemistry*, *105*, 104431.

Harhaun, R., Kunik, O., Saribekova, D., & Lazzara, G. (2020). Biologically active properties of plant extracts in cosmetic emulsions. *Microchemical Journal*, *154*, 104543.

Hughes, M. C. B., Williams, G. M., Pageon, H., Fourtanier, A., & Green, A. C. (2021). Dietary antioxidant capacity and skin photoaging: a 15-year longitudinal study. *Journal of Investigative Dermatology*, *141*(4), 1111–1118.

Isaac, V. L. B., Cefali, L. C., Chiari, B. G., Oliveira, C., Salgado, H. R. N., & Correa, M. A. (2008). Protocolo para ensaios f\'\isico-qu\'\imicos de estabilidade de fitocosméticos. *Revista de Ciências Farmacêuticas Básica e Aplicada*, *29*(1).

Júnior, W. S. F., Ladio, A. H., & de Albuquerque, U. P. (2011). Resilience and adaptation in the use of medicinal plants with suspected anti-inflammatory activity in the Brazilian Northeast. *Journal of Ethnopharmacology*, *138*(1), 238–252.

Lataliza, A. A. B., Cavalli, J., Amarante, C. B., Barbosa, D. B., Brandão, M. A. F., Dutra, R. C., & Rapozo, N. R. B. (2019). Antioxidant, cytotoxic, antiproliferative and acetylcholinesterase inhibition properties of the extract from Amburana cearensis. *Journal of Multidisciplinary Engineering Science and Technology*, *6*, 9336–9343.

Leal, L., Ferreira, A. A. G., Bezerra, G. A., Matos, F. J. A., & Viana, G. S. B. (2000). Antinociceptive, anti-inflammatory and bronchodilator activities of Brazilian medicinal plants containing coumarin: a comparative study. *Journal of Ethnopharmacology*, *70*(2), 151–159.

Leite, E. J. (2005). State-of-knowledge on Amburana cearensis (Fr. Allem.) AC Smith (Leguminosae: Papilionoideae) for genetic conservation in Brazil. *Journal for Nature Conservation*, *13*(1), 49–65.

Lima, L. B., Vasconcelos, C. F. B., Maranhão, H. M. L., Leite, V. R., Ferreira, P. A., Andrade, B. A., Araújo, E. L., Xavier, H. S., Lafayette, S. S. L., & Wanderley, A. G. (2009). Acute and subacute toxicity of Schinus terebinthifolius bark extract. *Journal of Ethnopharmacology*, *126*(3), 468–473.

Luna, E. M., Lopes, H. T. O., Rodrigues, F. A. Á., Coutinho, H. D. M., & de Oliveira, L. C. C. (2022). Antioxidant potential of the Caatinga flora. *Phytomedicine Plus*, 100240.

Martins, F. J., Caneschi, C. A., Vieira, J. L. F., Barbosa, W., & Raposo, N. R. B. (2016). Antioxidant activity and potential photoprotective from amazon native flora extracts. *Journal of Photochemistry and Photobiology B: Biology*, *161*, 34–39.

Melo, P. S., Bergamaschi, K. B., Tiveron, A. P., Massarioli, A. P., Oldoni, T. L. C., Zanus, M. C., Pereira, G. E., & Alencar, S. M. de. (2011). Composição fenólica e atividade antioxidante de res\'\iduos agroindustriais. *Ciência Rural*, *41*, 1088–1093.

Merecz-Sadowska, A., Sitarek, P., Kucharska, E., Kowalczyk, T., Zajdel, K., Cegliński, T., & Zajdel, R. (2021). Antioxidant properties of plant-derived phenolic compounds and their effect on skin fibroblast cells. *Antioxidants*, *10*(5), 726.

Monção, N. B. N., Costa, L. M., Arcanjo, D. D. R., Araújo, B. Q., Lustosa, M. do C. G., da França Rodrigues, K. A., de Amorim Carvalho, F. A., Costa, A. P. R., & Citó, A. M. das G. L. (2014). Chemical constituents and toxicological studies of leaves from Mimosa caesalpiniifolia Benth., a Brazilian honey plant. *Pharmacognosy Magazine*, *10*(Suppl 3), S456.

Montagner, S., & Costa, A. (2009). Bases biomoleculares do fotoenvelhecimento. *Anais Brasileiros de Dermatologia*, *84*, 263–269.

Nadeeshani Dilhara Gamage, D. G., Dharmadasa, R. M., Chandana Abeysinghe, D., Saman Wijesekara, R. G., Prathapasinghe, G. A., & Someya, T. (2022). Global Perspective of Plant-Based Cosmetic Industry and Possible Contribution of Sri Lanka to the Development of Herbal Cosmetics. *Evidence-Based Complementary and Alternative Medicine*, *2022*.

Ndhlovu, P. T., Mooki, O., Mbeng, W. O., & Aremu, A. O. (2019). Plant species used for cosmetic and cosmeceutical purposes by the Vhavenda women in Vhembe District Municipality, Limpopo, South Africa. *South African Journal of Botany*, *122*, 422–431.

Nunes, A. R., Rodrigues, A. L. M., de Queiróz, D. B., Vieira, I. G. P., Neto, J. F. C., Junior, J. T. C., Tintino, S. R., de Morais, S. M., & Coutinho, H. D. M. (2018). Photoprotective potential of medicinal plants from Cerrado biome (Brazil) in relation to phenolic content and antioxidant activity. *Journal of Photochemistry and Photobiology B: Biology*, *189*, 119–123.

Oliveira, C., Costa, S., Ribeiro, P. R., de Castro, R. D., & Fernandez, L. G. (2013). Avaliação da atividade antioxidante em amostras comerciais de Schinus terebinthifolius (aroeira vermelha). *Revista de Ciências Médicas e Biológicas*, *12*(3), 312–317.

OLIVEIRA, G. L. da S. (2015). Determinação da capacidade antioxidante de produtos naturais in vitro pelo método do DPPH•: estudo de revisão. *Revista Brasileira de Plantas Medicinais*, *17*, 36–44.

Oliveira, M. B. S., Valentim, I. B., Rocha, T. S., Santos, J. C., Pires, K. S. N., Tanabe, E. L. L., Borbely, K. S. C., Borbely, A. U., & Goulart, M. O. F. (2020). Schinus terebenthifolius Raddi extracts: From sunscreen activity toward protection of the placenta to Zika virus infection, new uses for a well-known medicinal plant. *Industrial Crops and Products*, *152*, 112503.

Pessoa, W. S., Estevão, L. R. de M., Sim\~oes, R. S., Mendonça, F. de S., Evêncio-Luz, L., Baratella-Evêncio, L., Florencio-Silva, R., Sá, F. B. de, & Evêncio-Neto, J. (2015). Fibrogenesis and epithelial coating of skin wounds in rats treated with angico extract (Anadenanthera colubrina var. cebil). *Acta Cirurgica Brasileira*, *30*, 353–358.

Petchidurai, G., Nagoth, J. A., John, M. S., Sahayaraj, K., Murugesan, N., & Pucciarelli, S. (2019). Standardization and quantification of total tannins, condensed tannin and soluble phlorotannins extracted from thirty-two drifted coastal macroalgae using high performance liquid chromatography. *Bioresource Technology Reports*, *7*, 100273.

Pinto, E. G., Cavalcante, F. S., & Lima, R. A. (2020). A fitoterapia no tratamento de pele: um estudo bibliográfico. *Biodiversidade*, *19*(3).

Sandra Liliana, P.-D., Manasés, G.-C., Enrique, J.-F., Rubén, R.-R., Cinthya, B.-P., Belen, M.-H. G., Alejandro, Z., & Maribel, H.-R. (2021). Isolation, chemical characterization, and anti-inflammatory activity of coumarins, flavonoids, and terpenes from Tagetes lucida. *Natural Product Research*, 1–6.

Saraiva, M. E., de Alencar Ulisses, A. V. R., Ribeiro, D. A., de Oliveira, L. G. S., de Macedo, D. G., de Sousa, F. de F. S., de Menezes, I. R. A., Sampaio, E. V. de S. B., & de Almeida Souza, M. M. (2015). Plant species as a therapeutic resource in areas of the savanna in the state of Pernambuco, Northeast Brazil. *Journal of Ethnopharmacology*, *171*, 141–153.

Senigalia, R. L. C., de Souza Ferreira, A. L., Kratz, D., Coelho, M. de F. B., dos Santos, A. S. R. M., & Castro, D. A. (2020). Toxicidade de extratos vegetais de plantas do cerrado de uso medicinal. *Brazilian Journal of Development*, *6*(8), 55308–55317.

Shen, N., Wang, T., Gan, Q., Liu, S., Wang, L., & Jin, B. (2022). Plant flavonoids: Classification, distribution, biosynthesis, and antioxidant activity. *Food Chemistry*, 132531.

Tavares De Souza, M., Dias Da Silva, M., & de Carvalho, R. (2010). *Revisão integrativa: o que é e como fazer Integrative review: what is it? How to do it?* (Vol. 8, Issue 1).

Zeppelini, D., Queiroz, G. C., Abrantes, E. A., Bellini, B. C., Medeiros, E. S. F., Oliveira, E. P., Silveira, T. C., Neves, A. C. R., Soares, A. F., Godeiro, N. N., & others. (2013). Diversity of Collembola (Arthropoda: Hexapoda) across different types of vegetation in Brazil. *International Journal of Biodiversity and Conservation*, *5*(3), 176–184.