Nonconventional food plants as the source of nutrition and secondary metabolites for diseases treatment.

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Abstract. Over the years, new generations have become more concerned about their lifestyle, trying to have a healthier routine through diet and physical exercise. Most plants can produce various secondary metabolites, compounds with wide spectra of effects within the plants including the defence. Many of these plant-based molecules can also beneficially affect human health and they are used in different forms for treatment of illnesses. Unconventional food plants are, for the most part, considered invasive in several regions. However, these plants are rich in nutrients and secondary metabolites, and their use is passed down from generation to generation in the states, where they are traditionally used. For this review, four different plants were researched, namely ora-pro-nobis (*Pereskia aculeata* Mill), milkweed (*Emilia sonchifolia* L.), purslane (*Portulaca oleracea* L.) and purple endive (*Lactuca canadensis* L.) and the presence of secondary metabolites in their parts can help maintain health and treat the more important recurring diseases (cardiovascular, metabolical and respiratory diseases and cancer) in the population. With this bibliographic review, we concluded that these four plants are excellent options for the treatment of various illnesses, in addition to all having antioxidant power. This study shows that they are good food options for the general population, especially those who live in situations of food insecurity or risk and those people in situations of malnutrition.

Keywords. Secondary metabolites, Nonconventional plant food, Diseases, Healthy eating.

1. Introduction

The new generations are increasingly concerned about taking care of their health, whether through diet or physical exercise. According to data (1), chronic non-communicable diseases, representing seven of ten most recurrent causes of death, are currently the most common diseases in the world population. That includes cardiovascular diseases (heart attack, stroke), metabolical (II. type diabetes), respiratory diseases (asthma, chronic obstructive pulmonary disease, pulmonary fibrosis, pneumonia), and cancer.

Nutrition is an essential factor in preventing diseases and maintaining health. In many plants, it is possible to find the presence of various secondary metabolites. These compounds protect the plant from biotic and abiotic stresses, and when consumed, they become a new source of nutrients and have pharmacological value (2). Secondary metabolites have been usually classified into three classes: terpenes, phenolic compounds, and nitrogenous compounds. These classes were divided into smaller groups according to biosynthesis, function, and importance.

Environmental influence derives secondary metabolites from primary metabolites (3). Some of these compounds are specific to certain plants. Other metabolites may be present in more than one species in different quantities. In this context, non-conventional food plants have proven to be a viable option for increasing the nutritional quality of the population in several countries. The growth of unconventional plants in food is due to the high levels of nutrients, minerals, and secondary metabolites in leaves, flowers, stems, or roots (4).

Knowledge about non-conventional food plants often comes from indigenous peoples, and this knowledge has been passed from generation to generation. With new scientific research methods, we now know the potential of these plants, not only in food but also in contributing to the sustainability and biodiversity of agricultural production

systems (5).

Some unconventional food plants stand out for their amount of nutrients and minerals or their ease of planting and maintenance. Due to these characteristics, some plants have been researched as alternative forms of disease prevention and treatment, like ora-pro-nobis (*Pereskia aculeata* Mill), milkweed (*Emilia sonchifolia* L.), purslane (*Portulaca oleracea* L.), and purple endive (*Lactuca canadensis* L.). Therefore, this literary review aims to present how the secondary metabolites of these non-conventional plants could help prevent the most common diseases in the world population.

Therefore, this literary review aims to present how the secondary metabolites of these non-conventional plants could help prevent the most common diseases in the world population. Several scientific article search platforms specialized in publishing research involving the agricultural area were used as well as specialized books. The selection of articles has been made based on some criteria: the period used for the review included the last twelve years (2012 to 2024), considering that older publications could contain outdated information. As they are plants that are easy to locate in Brazil, articles in both Portuguese and English were included, giving preference to Brazilian authors.

2. Ora-pro-nobis (*Pereskia aculeata* Mill)

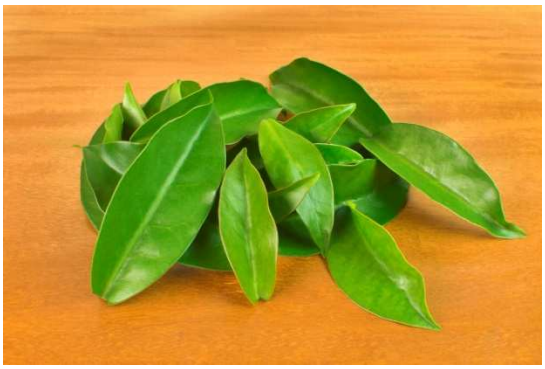

Fig 1 – Ora-pro-nobis leafs (6).

The ora-pro-nobis (*P. aculeata* Mill) is an unconventional food plant from the *Cactaceae* family that has great medicinal potential. It is also known as green meat, as it contains high levels of proteins in its leaves, which can be consumed fresh or cooked. According to Maciel et al. (7), the bioactive substances present in this plant are not cytotoxic to our skin cells. These substances have antioxidant and anti-glycating potential and are mostly composed of phytosterols and triterpenes. The research also included a chemical characterization of the plant, revealing the presence of twelve compounds, including the phytosterols campesterol, stigmasterol, sitosterol and triterpenes like taraxerol and taraxasterol.

In another study, it was confirmed that this plant, in addition to being an antioxidant, is also anti-inflammatory. Xu et al. (8) showed in their experiment that ora-pro-nobis exerted anti-inflammatory effects both *in vitro* and *in vivo*. *In vitro*, the ethanolic extract of *P. aculeata* acted to inhibit the secretion of anti-inflammatory factors in cells. *In vivo*, the extract reduced foot and joint swelling in rats with arthritis.

Ora-pro-nobis is a plant that can be taken orally without the risk of causing acute or chronic toxicity as was also confirmed by Silva et al. (9). The authors used an ethanolic extract of the plant leaf and administered it to 24 female Wistar rats, in three different doses. Eight different body tissues from each animal were used, and signs of toxicity, food intake, body weight, fluctuations in fecal excretion, and histopathological changes were evaluated. The result showed no differences, about toxicity, between animals fed with *P. aculeata* and animals that maintained a normal diet, validating the nutritional potential of this plant.

Souza et al. (10) showed that the extract of this plant may present not only anti-inflammatory but also antimicrobial and antifungal activity. It showed antimicrobial activity with Gram-positive (*Bacillus cereus* and *Staphylococcus aureus*) and Gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*) bacteria, which leads us to believe that the extract may have a broad antimicrobial spectrum. The antifungal activity was tested on four different fungi (*Penicillium expansum*, *Penicillium citrinum*, *Aspergillus niger*, and *Aspergillus versicolor*) and with three different solvents (petroleum ether, chloroform, and methanol). The three extracts were effective against *A. versicolor*, and the extract with petroleum ether was effective against *P. citrinum* and *A. versicolor*. This is due to phytosterols that may have antibacterial and antifungal activities (10).

In an unpublished study, Massocatto et al. (11) showed that *P. aculeata* could inhibit acetylcholinesterase, an enzyme whose main function is the propagation of nerve impulses, inactivating the action of the neurotransmitter acetylcholine and hydrolyzing it into acetate and choline (12).

Currently, acetylcholinesterase inhibitors have been used in the treatment of Alzheimer's disease (13). The study also showed that the *P. aculeata* extract showed selective activity against human chronic myeloid leukemia cell lines. In 2020, around 475 thousand cases of leukemia were estimated (14) and the plant could eventually play a role in a treatment of this disease in future.

3. Milkweed (*Emilia sonchifolia* L.)

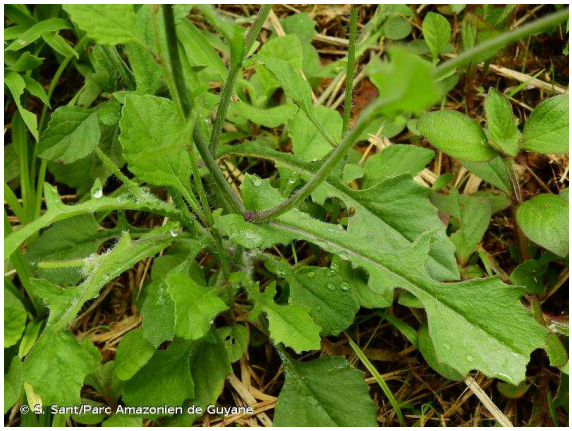

Fig 2 – Milkweed leafs (15).

Milkweed (*E. sonchifolia* L.) is a medicinal plant belonging to the *Asteraceae* family, known for containing a great diversity of medicinal plants. Milkweed leaves have tannins, saponins, flavonoids, alkaloids, and cardiac glycosides, and significant antioxidant activity (16). The presence of these compounds in milkweed leaves may be responsible for its medicinal use, showing that this plant has a future in the pharmaceutical industry.

E. sonchifolia is a plant that has low-fat content, which is positive for preventing or reducing obesity (17). The amount of ash from this plant was higher when compared to other plants, indicating a greater amount of minerals. This study also showed the presence of a small amount of proteins and carbohydrates, but a considered normal amount of crude fiber, which reduces the risk of cardiovascular diseases by lowering the cholesterol level. Another point was the presence of macro and micro minerals. Of the macro minerals estimated, calcium was the one that was in the greatest quantity, followed by potassium and magnesium, sodium was the macronutrient with the smallest quantity. The microminerals found were iron, copper, zinc, manganese, and chromium, from highest to lowest amount.

According to Narayanan et al. (18) the extract from the leaves of *E. sonchifolia* showed a toxicity effect on cancer cells *in vitro*, however, it did not affect normal cells. This study also showed that *E. sonchifolia* presented potential antidiabetic and anti-inflammatory activity *in vitro*, in addition, the copper nanoparticles present in the leaves had anti-bacterial action against *E. coli*, *Staphylococcus aureus*, *Pseudomonas*, *Enterobacter*, and *Bacillus*.

E. sonchifolia extract has a large amount of sesquiterpenoids, which is common in plants from the *Asteraceae* family, known for its anti-inflammatory, anti-tumor, antimicrobial, anthelminthic and anti-feeding (19) therapeutic power.

In addition to the large amount of sesquiterpenoids, *E. sonchifolia* also has a large amount of terpenoids. Eight terpenoid compounds that could be used as medicines against pancreatic cancer were analyzed. Of the eight compounds, the compound 2,4-diethoxy-6-hydroxy-8-formyl-3oxa-bicyclo(4.3.0)-cyclononan-7-ene was the one with the greatest potential for use as a medicine (20).

4. Purslane (*Portulaca oleracea L.*)

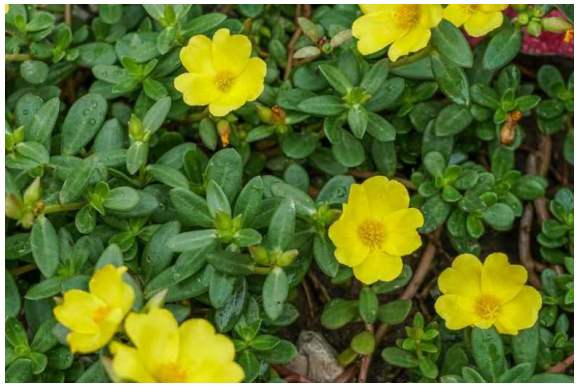

Fig 3 – Purslane leaf and flowers (21).

Purslane (*Portulaca oleracea*) is an annual herbaceous plant from the *Portulacaceae* family, known in folk medicine for being a useful plant for the maintenance of various diseases, with both the stem and leaves being used. Gatea et al. (22) showed that *P. oleracea* has a high level of polyphenols, flavonoids, and phenolic acids, with chlorogenic acid, quercetin, rutin, and caffeic acid being polyphenols found in greater quantities and in various parts of the plant, increasing their antioxidant effect. Formic, malic, tartaric, acetic, and propionic acids were not present, but the presence of oxalic acid was found, which limits the regular use of this plant.

In another research, the extract from the roots of *P. oleracea* was used for the management of diseases (23). Chemical analysis of the roots showed the presence of carbohydrates, steroids, triterpenes, cardiac glycosides, and saponins. The extract showed a certain level of inhibition of pathogens like *Klebsiella pneumoniae*, *Micrococcus luteus*, and *P. aeruginous*.

Clinical and experimental research was carried out to understand the effects of *P. oleracea* on respiratory, allergic, and immunological diseases (24). Through these studies, several pharmacological benefits were attributed to *P. oleracea*, such as anti-inflammatory, antioxidant, antitumor, antimicrobial, immuno-modulatory, and smooth muscle relaxation activities. These benefits showed that this plant is a possible therapeutic source in the treatment of various lung disorders, but also the treatment of immunological and allergic diseases.

The therapeutic effects of *P. oleracea* were tested in hepatogastric disorders as well (25). The application of this plant for this type of treatment has already been traditionally used by the countryside population. Studies have shown that this plant has a certain effect against hepatotoxic

agents, indicating its gastroprotective and hepatoprotective activity.

Its anti-inflammatory effects were also tested on human peripheral blood mononuclear cells with hydroalcoholic extract (26). The extract did not show cytotoxicity to cells and significantly reduced pro-inflammatory cytokines, TNF-a, and IL-6, confirming the anti-inflammatory activity of this plant.

5. Purple endive (*Lactuca canadensis L.*)

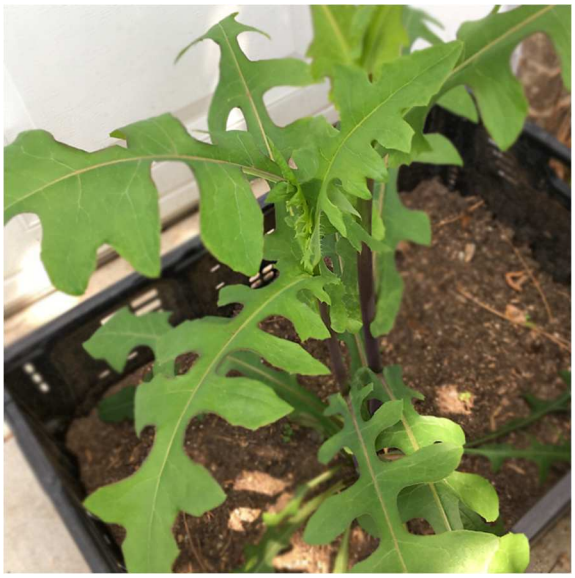

Fig 4 – Purple endive leafs (27).

Purple endive (*L. canadensis*) is a species of biannual lettuce, characterized by the presence of purple ribs in the center of the leaves and the presence of latex, and is used in salads or soups. According to Liberal et al. (28), leaves of purple endive have a good amount of slowly digestible carbohydrates and a high protein content, in addition to being low in lipids. There is the presence of malic and oxalic acids, with the latter is the most abundant acid, showing antioxidant potential when in conjunction with other acids, and can inhibit the virulence of oral pathogens. Oxalic acid is considered an antinutrient, but as these plants are not consumed in large quantities, it does not pose a health risk. Consumable species of the genera *Amaranthus* and *Colocasia* also contain this compound.

In the same study, 20 different types of fatty acids were characterized in the leaves of *L. canadensis*, including linoleic acid, palmitic acid, polyunsaturated fatty acids, and saturated fatty acids. These acids are known to promote several health benefits and the prevention of cancer and cardiovascular diseases.

The nutritional characterization of *L. canadensis* (29) showed that it has low to medium values of vitamin C, phenols, and antioxidants. The levels of macronutrients were considered intermediate, however, it presented a large amount of calcium and micronutrients, including zinc, boron, and manganese. In addition to being a plant with a high carbohydrate content.

A satisfactory amount of carotenoids was found in *L. canadensis*, which are pigments with preventive action in different types of diseases, such as cataracts and heart diseases (30). Tannins, substances that reduce the activity of the a-amylase enzyme, are also present in this plant and are important in the diet of patients with diabetes. An interesting piece of information is that the amount of carotenoids, tannins, and phenolic compounds in *L. canadensis* decreases linearly with the number of days after harvest.

Alkaloids, terpenes, flavonoids, and carbohydrates are also found in the leaf extract of *L. canadensis* (31). This extract was used as an anti-inflammatory medicine in rats, showing a reduction in edema in the rats' paws. The result shows the potential that the extract from *L. canadensis* leaves could also have in human treatment.

6. Conclusion

With this literature review, it is possible to conclude that the unconventional food plants described here are a healthy source of nutrients for human nutrition, mainly for those with food insecurity and malnutrition. Another important point is their use for maintaining health, such as the antioxidant compounds present in all the plants analysed, and their use in the treatment of some fungal and bacterial diseases and, in some cases, activity against cancer cells.

The antifungal activity of plant extracts leads us to believe that in the future, in addition to their use in human treatment, they can be used as natural antifungals in plants.

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