International Journal of Multidisciplinary Research and Growth Evaluation.

# Clitoria flower food and medicinal: A review

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## Article Info

**ISSN (online):** 2582-7138
**Impact Factor**: 5.307 (SJIF)
**Volume:** 04
**Issue:** 06
**November-December** 2023
**Received:** 12-09-2023;
**Accepted:** 15-10-2023
**Page No:** 494-497

**Abstract**
The World Health Organization defines a medicinal plant as any and all vegetables that present, in one or more organs, substances that can be used for therapeutic purposes or that are precursors of semi-synthetic drugs, while PANC's are vegetables from the past, present and future that are positively impacting academia, family farming, open-air markets, in addition to nutritionally enriching the school meals of several schools. From this perspective, the objective of this literature review was to report the benefits of bioactive, nutritional and medicinal compounds from the clitoris for human consumption. The scientific survey carried out resulted from the composition of 23 files collected in the Scielo, Google Scholar, Science Direct, Semantic Scholar databases with published articles. From reading several scientific researches, the rich potential of the clitoral flower as a natural dye was verified, due to its intense indigo blue pigmentation, nutritional benefits and the results obtained allow an expansion of the study with the determination of new functional properties for potential technological application.

**DOI:** https://doi.org/10.54660/.IJMRGE.2023.4.6.494-497

**Keywords:** Healthy Eating, Natural Dye, *Clitoria*, Edible Flower, PANC

## Introduction

Brazil has one of the greatest biological diversities in the world, with more than 46 thousand plant species, which has enormous potential to expand sources of food and nutrients for the entire population, valuing traditions and promoting culture and food security for the population. (Tuler; Peixoto; Silva, 2019) [22].

In this sense, although there is a wide variety of species in the country, it can be said that the production chain covers a minimum number of species. As a result, there is little food to meet the needs of the community, especially those in need, creating insecurity and opposing the right to food that everyone should have access to (Casemiro; Vendramini, 2020) [2].

Faced with this issue, Non-Conventional Food Plants (PANC) have great potential for food. Its use can occur in whole or in part, but its use is not widespread and is generally not present on our menu, although its occurrences are widespread throughout the country (Silva, 2022) [21].

The safe consumption of unconventional vegetables is supported by a series of scientific research that also supports their nutritional properties and highlights the importance of their bioactive compounds, however it is important to highlight that some may contain inedible parts, or even that their consumption only occurs after cooking, as toxic substances will be eliminated (Callegari; Matos Filho, 2017) [1].

Among PANC, some have, in addition to nutritional properties, other attractions for the industry such as their color. Clitoria ternatea is a plant frequently used as decoration due to its beautiful appearance, however, it can also be consumed and its flowers used due to their coloring potential, giving an intense and vivid blue. Clitoria flowers can be used in the food sector, in drinks, cakes, teas, chocolates, breads, among others. Furthermore, this plant contains many nutrients and bioactive compounds such as glycosides, alkaloids, phenols, steroids, tannins, resins, saponins and flavonoids (Manjula *et al*., 2013) [13].

A wide variety of polyphenols and anthocyanins are found in flower petals, which can bring many benefits in addition to their aesthetic and ornamental value (Pasukamonset; Kwon; Adisakwattana, 2016) [17].

The objective of this work is to illustrate an overview, systematic review and evaluation of evidence related to the consumption and knowledge of medicinal plants and PANC as a whole, since plant products offer a vast repertoire of chemical diversity that, in turn, time, it can provide a number of key structures, in addition to therapeutic challenges, diversity of chemistry and biodiversity.

**Methods**

The Scielo, Google Scholar, Science Direct, Semantic Scholar databases were consulted.

**Results and Discussion**

In addition to medicinal, cultural, technological and combustion purposes, human beings also consume plants for food purposes (ABREU *et al*., 2001). Within the varied spectrum of foods available to human beings there are non-conventional food plants (PANC), which are those that are not produced or consumed on a large scale, and can be cultivated or wild, native or exotic, spontaneous or not, as long as capable of being used as food (Kinupp, 2014).

In Brazil, small farmers considered several PANC harmful to their plantations, however, with the habitual use, they have now become part of the native vegetation where small farmers cultivate them without the need for inputs and appropriation and preparation of new lands, as they develop in natural environments (Barreira *et al*, 2015).

PANC have been widely used in the diet and as an alternative source of income for rural communities, promoting the local economy and nourishing peripheral communities, strengthening food sovereignty (Barreira *et al*, 2015). Its consumption can be strategic for maintaining dietary diversity, with low impact on agriculture and improving nutrition due to its high nutritional value (Ranieri, 2021).

**Clitoria ternatea**

Clitoria is included in the list of PANC plants and its popularization in Brazil has increased considerably, and we can also mention the increase in research related to this plant in several international magazines, especially in Asia where its application occurs routinely and is part of the daily life in this region.

Clitoria ternatea is a forage plant native to tropical Asia, belonging to the Fabaceae family, that is, the legume family. It was introduced to other territories such as India, the Arabian Peninsula, Africa, America, Madagascar and archipelagos in the Pacific Ocean.

In Brazil, it is considered naturalized and also receives other names such as butterfly bean, butterfly pea and cunhã. It can reach up to 6 meters in length. It has leaves with 5 or 7 dark green leaflets. Its blue flowers are its greatest attraction due to its varied uses, such as culinary and medicinal use. The consumption of its flowers occurs in a variety of ways, such as in cooked applications, in infusions, fresh and raw in salads (Dijigow, 2022) [4].

**Food and nutritional benefits**

Clitoria T. has nutritional properties, as well as coloring properties, arousing interest in the food sector. One of the biggest attractions for applying Clitoria is its coloring potential. Regarding nutritional properties, several studies report them, but there are few publications on these properties based on laboratory results (Manjula *et al*., 2013) [13].

It can be used in homemade recipes and has aroused the interest of researchers and industry to obtain a natural dye due to its color versatility and good thermal stability (Dijigow, 2022) [4].

Phenolic compounds are products of plant secondary metabolism that have one or more aromatic rings in their structure, which allows them to act as reducing agents (Schmidt, 2019). These compounds have antioxidant action through the primary mechanism, when the radical chain is neutralized, giving hydrogen to the free radical, and assuming the form of a stable radical.

However, the effectiveness of the oxidizing action depends on the concentration of the compound in the food and the chemical structure (Bomfim *et al*., 2017). Anthocyanins, for example, are bioactive compounds with antioxidant, antimicrobial, antidiabetic and anticancer properties. According to Khoo *et al*. (2016) they are used as functional food and food additives.

Anthocyanins are water-soluble pigments, which are structurally formed by glycosides and have a color spectrum varying between violet, red and blue, depending on the degree of hydroxylation, glycosylation pattern, methylation pattern of aromatic rings and pH (Schmidt, 2019).

In FB flowers, the predominant anthocyanins are ternatins A1, A2, B1, B2, D1 and D2, blue in color. There are also other compounds present in FB tea that are soluble and essential for the flavor and aroma of the tea, also containing proteins, flavonoids such as kaempferol and myricetin glycosides, fatty acids (palmitic, stearic, petroselinic, arachidic, behenic and phytanic), phytosterols such as campesterol, stigmasterol, β-sitosterol and sitostanol, polysaccharide tocols, vitamins and mineral salts. Due to the significant concentration of bioactive compounds, FB flowers can be used as natural sources of antioxidants, dyes and as a supplement in the food and pharmaceutical industries (Choo, 2021) [7].

**Medicinal benefits**

Several studies indicate that the consumption of Clitoria T. is beneficial and improves the functioning of the body and there has even been talk about its potential to prevent serious and degenerative diseases such as cancer and Alzheimer's (Nadia Shahnas, 2014) [14].

It has antioxidant capacity, contributing to the removal of free radicals and cellular protection, providing greater vitality to the body. Bioactive compounds can improve brain capacity and memory, which is why studies have been carried out to try and associate their use with the prevention of degenerative brain diseases. It is also the basis for other biological functions such as anti-inflammatory, anti-aging and preventing a wide range of cardiovascular diseases, cancer and diabetes (Rajendran *et al*. 2014) [19].

**Bioactive compounds**

Anthocyanins have been used to impart color to foods since ancient times. The term anthocyanin derives from the Greek words Anthos (=flower) and kyanos (=blue). It is one of the main coloring compounds in plants and is most conspicuous in bluish flowers and is located in cellular vacuoles (FREITAS, 2019).

They have the largest group of water-soluble pigments and

their pH depends on the surrounding environment. In acidic pH between 1.0 and 2.0 it has a red color, in neutral pH between 3.0 and 5.0 violet or blue coloration, pH 6.0 to 8.0 light blue coloration and base pH between 8.0 and 10.0 its color changes from light blue to green (Escher *et al*., 2019).

The flavylium ion present is responsible for the red color, while the neutral quinoidal base gives the blue tone and the ionic chalcone is responsible for the green color (Liu; Fu; Nian, 2014).

Ternatins or delphinidins 3, 30, 50-triglucosides are the main and most abundant anthocyanins present in Clitoria T petals. They have good temperature and storage stability, proving to be good substitutes for spirulina and genipin extracted mainly from seaweed and genipap. With therapeutic, antibacterial, antiproliferative, hypoglycemic effects, among other health benefits (Gamage; Lim; Choo, 2021) [7].

Flavonoids are phenolic compounds that have antioxidant properties with therapeutic effects, which neutralize free radicals, are characterized as natural pigments with an important antioxidant role and have effects on nutrigenomics. In the CT flower, the flavonoid found in greatest quantity is myricetin (Netravati *et al*., 2022).

Antioxidant activity is also the basis for other biological functions such as anti-inflammatory, anti-aging and preventing a wide range of cardiovascular diseases, cancer and diabetes (Rajendran *et al*. 2014) [19].

Several studies demonstrate that extracts from the Clitoria T. flower have phytochemicals with anti-cancer action, including ternatins, delphinidins, kaenpferol, quercetin, sitosterol and vitamins (tocopherols, inositol and pentanal). Phytochemicals also revealed their potential to inhibit the proliferation of tumor cells, contributing to angiogenesis and enhancing cell apoptosis and chemotherapy treatments (Purnamayanti; Budipramana; Gondokesumo, 2022) [18].

Furthermore, its bioactive compounds can serve to improve brain activity and memory, thus actively contributing to Alzheimer's disease, which demonstrates its versatility and importance for people's health (Nadia Shahnas, 2014) [14].

Results of the proximate composition analysis of the literature in table 1, it was found that Clitoria T. flowers had a good amount of fiber and low fat content, being beneficial for consumption, considering the daily recommendations of 25g of fiber and the fat intake limited to 30% of total calories consumed, established by the World Health Organization (WHO, 2023), for adult diets. The results also indicated a high content of calcium, magnesium, potassium, zinc, iron and sodium.

Minerals such as zinc and magnesium are essential for growth, bone development and other vital processes for the body. Iron can be used to prevent diseases such as anemia, while zinc plays an important role in protein synthesis (KISLICENKO, 2022).

## Conclusion

Brazil has the largest amount of biodiversity in the world, representing approximately 20-22% of all known plant species. Certainly, the area of plants is one of the most relevant fields of investigation in Brazil, as echoed by the large number of scientific articles published in peer-reviewed scientific journals.

Based on this bibliographic study, it can be reported that Clitoria ternatea is a Non-Conventional Food Plant that has great nutritional, medicinal and food potential.

The pigment from the clitoral flower has aroused the interest of the food industry for use as a natural dye and its use in industries and free trade depends, however, on more scientific research and mainly on the convincing of authorities and regulatory bodies in order to establish a protocol of food safety and ensure that they do not cause risks to consumer health.

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