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Watercress, as a Functional Food, with Protective Effects on Human Health Against Oxidative Stress: A Review Study

Mirna Clemente[1*], MarilisDallarmi Miguel[1], Caroline Gribner[1], Paula Francislaine Moura[1], Ana Angelica Ruscheweyh Rigoni[1], Luiz Claudio Fernandes[2], Obdulio Gomes Miguel[1]

[1]*Pharmaceutical Science Department, UFPR Brazil*

[2]*Physiology Departament UFPR Brazil*

Corresponding Author:** ***Mirna Clemente, *Pharmaceutical Science Department, UFPR Brazil*

Abstract: *Functional food may have beneficial effects or more target function in the body beyond adequate nutritional facts in a way, which is relevant to improve health and decrease the risk of chronic diseases. Moreover, Nasturtium officinale R. B, known (watercress), as a member of the Brassicaceae family, is related to cruciferous vegetables, such as broccoli, cabbage, which is suggested to benefit human health. This study aimed to investigate watercress in a regular diet based in clinical trials, demonstrating whether this plant might have properties to be applied to decrease diseases. The search was performed at the bases: MEDLINE, Science Direct, and SciELO, from March to June 2019. The terms used were "watercress," "Nasturtium officinale," and "clinical trials". Only four studies were included in this review. The finding supported that watercress ingestion may be helpful to decrease the hepatotoxicity, damage to DNA, provides adequate protection against exercise-induced oxidative stress and chemopreventive agent against lung cancer. In conclusion, the results might provide supportive evidence that watercress in a regular diet has demonstrated protective effects on human health against oxidative stress. We also recommend the implementation of public campaigns incentivizing people's vegetable consumption with functional properties, in order to o improve health.*

Keywords: *Watercress, Nasturtium Officinale, Clinical Trial, and Functional Food*

1. INTRODUCTION

Functional foods were introduced in Japan during the 1980s and are similar in appearance to traditional foods. Both of them have been consumed as part of a regular diet, in contrast to conventional food, the functional one has demonstrated many benefits, reducing risks of chronic diseases [1]. As a definition, functional food may have beneficial effects or more target function in the body beyond adequate nutritional which is relevant to improve health, well-being and decrease the risk of chronic diseases, not a pill, nor a capsule or any form of dietary supplement[2]. According to [3], the vegetable ingredients recognized as functional foods are; vitamins, flavonoids, polyphenolic acids, carotenes, isothiocyanates, and phytic acids.

Nasturtium officinale R. B, known as watercress, is a perennial dicotyledonous herbaceous plant,a member of the Brassicaceae family, and is usually found close to water [4]. In an international common name, watercress is known, in Italian "Crescione," in Portuguese, "Agrião," in German, "Brunnenkresse," in French, "Cresson" in Chinese "dou ban ca", in Spanish, "Berro", and in Iran "bulagote".

As a member of the Brassicaceae, watercress is related to cruciferous vegetables, such as broccoli, cabbage, radish, brussels, sprouts as well as mustard and kale [4]. The consumption of vegetables from Brassicaceae family are suggested to benefit human health, which are rich sources of sulfur-containing compounds called glucosinolates that impart a pungent aroma and a spicy or bitter taste [5] and phenylethylisothiocyanate (PEITC), which has been associated to reduce risk of cancer and oxidative stress[3][6][7]

Watercress contains some vitamins such as A and E, minerals (iron and copper), and is also rich in bioactive compounds, named polyphenols, glucosinolates and PEITC[8][9]. Therefore, this food can be collected from its natural habitats and used as a fresh or dried plant [10] and, its leaves have beenused in folk medicine as a diuretic, expectorant, hypoglycemic and many chronic diseases [7].

The present study aimed to provide an overview of the studies investigating the watercress in a regular diet, based on clinical trials, demonstrating whether this plant-food might have an essential role with its promising properties to be used on human health.

1.1. Characterization of Watercress *(Nasturtium officinale)*

The taxonomic description of Nasturtium *officinale R. Br*(table 1)[11] and figure 1 were adapted by [12].

Table1.*Taxonomic description of Nasturtium officinale R. Br.*

Subphylum	Magnoliophyte
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Brassicales
Family	Brassicaceae
Genus	Nasturtium
Specie	*Nasturtium officinale R. Br*

Figure1. *Nasturtium officinale R. Br.(Source:adapted by [12]*

Watercress is usually served in raw form in salads, soups, and other recipes and has long been used as a culinary food [13]. This plant-food is becoming one of the most important plants used as a functional food and modern cuisine, due to its abundant bioactive compounds [10]. Moreover, the culinary characteristic of thisvegetable, specifically their pungent odor and sour taste, and a high concentration of glucosinolate[5].

Nasturtium officinale R. Br. Species, was primarily found in Europe and Asia[8], and introduced into Australia, North America and South America [10].Therefore, this plant contains a traditional composition of vitamins B1, B2, B3, B5, B6, C, E, pro-vitamin A, folic acid and some minerals (copper, zinc, magnesium, calcium manganese, iron, phosphorus, andiodine), carbohydrates (fibers), lipids, and proteins[8][14].

Phenyethylisothiocyanate, called PEITC, which is also a bioactive compound present in high level of concentrations of watercress, as its precursor'sglucosinolate. Whenever this vegetable is interrupted, for instance during mastication, the enzyme myrosinase is released and induce the conversion of glucosinolate into PEITC as well as in the human intestine by microbial myrosinase[15][16].

2. Materials and Methods

The search was performed at the bases: Cochrane, Scopus, MEDLINE (PubMed via), Science Direct,SciELOand Lilacs, from March 2019 to June 2019. The searches terms used were; "watercress," and "*Nasturtium officinale*," and "clinical trials". No searches were done for unpublished works or annals of congresses.

Included criteria: We included watercress as a diet in clinical trials; limited the studies in the English language and watercress therapy time was not limited.

Excluded criteria: We excluded all kind of extracts, pills, tablets tea of *Nasturtium officinale;* case reports, editorials, abstracts, reviews, and letters or comments; andcombined with any other food or plant.

3. Results and Discussion

The literature search identified 2781" watercress"studies; 29 were selected afterreading the abstract, and only four were included after reading the full-text. The exclusion of the articles occurred with the repetition of the research or because they did not belong to the inclusion or exclusion criteria. We included studies published only in English, with full access, in the form of clinical trials, which evaluated the treatment with watercress as a regular diet. The information of the studies is described in table 2.

Table2.*Basic information of included studies*

Studies	Types of Studies	Population	Daily Dosage and Duration of Intake	Bioactive Compound	Results/ Outcomes
[17]	Randomized	11 healthy smokers	56.8 g of watercress at each meal for 3 days	PEITC	The results of this study support that PEITC inhibits the oxidative metabolism of NNK in humans, and support further development of PEITC as a chemopreventiveagent against lung cancer
[18]	Control group	10 healthy volunteers	Fresh watercress (equivalent to 50 g watercress) for 2 weeks	PEITC	The results suggest that the consumption of watercress causes a decrease in the levels of oxidative metabolites of acetaminophen,
[19]	Single-blind control and randomized	30 smokers and 30 non-smokers (men and women)	85 g raw watercress daily for for 8 weeks	b-Carotene glucosinolate	These funding support the theory that consumption of *Nasturtium officinale* can reduce risk of cancer via, decreasing damage to DNA.
[20]	Randomized and control study	10 healthy male subjects	85 g portion of raw watercress on a daily for 8 weeks	a-Tocopherol b-Carotene xanthophyll retinol	The present study suggests that dietary watercress intervention provides adequate protection against exercise-induced oxidative stress.

Functional food, which has a potential benefit on health, has been increasing around the world and scientific evidence is demonstrating its role in prevention and treatment of chronic diseases [3]. Moreover, many studies have shown that diets dominated by fruits and vegetables can promote human health [1].

On the other hand, it is believed, that sulfur-containing glucosinolate, present in cruciferous vegetables, is hydrolyzed by the action of the plant myrosinase enzyme into isothiocyanates upon cutting, cooking, chewing, and digestion [21]. Besides that, the effects of isothiocyanates have been reported in relation to oxidative stress and the metabolites involved [22].

Since,isothiocyanate is one of the most important bioactive compounds found in watercress, which has been recognized as an ingredient found in functional foods, watercress might be introduced into the list of these foods.

Furthermore, several studies have been reporting the benefits effects on human health produced by watercress, as raw and fresh food, juice, and extract (nutraceutical product). According to a systematic review study, the extract of *Nasturtium officinale*, which contained glucosinolate, phenolic, flavonoid and PEITC, demonstrated positive effects on the improvement of the immune system, hypercholesterolemia, hypoglycemic and anti-inflammatory activity, sex hormones synthesis, the preventive effect on renal stone formation and month ulcers [16]. In addition, some pharmacological activities with PEITC, such as anti-psoriatic, antibacterial, and anti-allergic activity, were demonstrated*in vitro* studies [10].

4. Protective Effects

Since the oxidative DNA damage can play a significant role in mutagenesis, cancer, and other human diseases, the decrease of the oxidative stress seems to be the best strategy possible to achieve by eating food rich in bioactive compounds [23]. Hence, cruciferous vegetables such as cauliflower,

broccoli, cabbage and watercress, have been extensively studied concerning their ability to protect or prevent the injuries caused by oxidation in living cells [24].

Therefore, it was demonstrated that the PEITC inhibits the oxidative metabolism of NNK (4-methylnitrosamino- 1-3-pyridyl-1butanone) in human blood. The NNK is a potent pulmonary carcinogen, which is believed to be one of the causes of lung cancer in smokers. This clinical trial was the first to describe the effect of watercress consumption on the metabolism of a lung carcinogen in people [17]. Besides that, it was further revealed, that 50 g of fresh watercress for two weeks, which was equivalent to a total intake of 13mg of PEITC, in ten healthy volunteers, caused a decrease in the level of oxidative metabolites of acetaminophen. This medication (acetaminophen) may cause a risk for hepatotoxicity. Hence, it was suggested that watercress ingestion might help to decrease the hepatotoxicity promoted by acetaminophen. [18].

Moreover, [19] demonstrated that 85 g of raw watercress for eight weeks with a high concentration of glucosinolate and b-carotene could protect lymphocyte DNA against damage in smokers. To corroborate to the last study, [22] demonstrated that animals supplemented for 15 days with watercress juice, explained the role of watercress as a diet component as a protective agent and [25] showed that the Swiss mice after watercress juice supplementation, had chemoprevention effects.

Finally,[20] suggestedthat short and long-term watercress ingestion had potential protective effects against exercise-induced DNA damage and lipid peroxidation.

In this present review, the four studies demonstrated some bioactive compounds, such as PEITC, glucosinolate, a-tocopherol, b-carotene, xanthophyll, and retinol. Besides that, all of them have shown protective effects. The finding supports the protective effect of watercress on human health against oxidative stress.

The limitation of this review was that only four studies were found in the literature, and unfortunately, two of them were old. Future studies with watercress in a regular diet in human health might be necessary. Since eating habits and trends in food consumption, have health and social impacts, this plant-food may be relevant to be used in human as a health promoter. Besides that, watercress should be introduced into the list of functional food.

5. CONCLUSION

In light of the preceding discussion, the results might provide supportive evidence that watercress in a regular diet has demonstrated protective effects on human health against oxidative damage. We also recommend the implementation of public campaigns incentivizing people's vegetable consumption with functional properties, creating a successful strategy to develop healthy eating habits, in order to o improve health, well-being and decrease the risk of chronic diseases,

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