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REVISIÓN

Antioxidants in the prevention and treatment of cancer

Antioxidantes en la prevención y tratamiento de cáncer

Camila Navas¹  , Carmen Viteri^{1,2}  

¹Universidad Técnica de Ambato. Facultad de Ciencias de la Salud, Carrera de Nutrición y Dietética. Ambato - Ecuador.

²Grupo de Investigación Mashkanapi Alli-Kawsai - Investigación en Salud.

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ABSTRACT

Cancer is considered the leading cause of death worldwide with 10 million deaths annually, the most prevalent are breast and lung cancer, and the main risk factors are overweight, smoking, sedentary lifestyle and a diet with low consumption of fruits and vegetables rich in antioxidants, Therefore, this review article has the objective of identifying the influence and relationship of the consumption of antioxidants in the prevention and treatment of cancer. For this purpose, a bibliographic review of the last 5 years was carried out in scientific databases such as Google Scholar, SciELO, PubMed, Elsevier, Web of Science. The languages used were Spanish, English and Portuguese, as a result it was obtained that oxidative stress damages DNA, which generates a process of carcinogenesis, and antioxidants have the ability to prevent oxidative stress by stabilizing free radicals, so it was concluded that antioxidants can prevent cancer if consumed from natural sources, however in their treatment there are divided opinions, so more research should be conducted in depth on the subject.

Keywords: Antioxidants; Cancer; Oxidative Stress; Antioxidant Diet.

RESUMEN

El cáncer se considera la principal causa de muerte a nivel mundial, con 10 millones de muertes anuales, los más prevalentes son el cáncer de mama y de pulmón, siendo los principales factores de riesgo son el sobrepeso, el consumo de tabaco, el sedentarismo, y una dieta con bajo consumo de frutas y verduras ricas en antioxidantes, el objetivo de la investigación fue identificar la influencia y relación del consumo de antioxidantes en la prevención y tratamiento de cáncer, para esto se desarrolló una revisión bibliográfica de los ultimo 5 años en bases de datos científicas como Google académico, SciELO, PubMed, Elsevier, Web of Science. Los idiomas que se utilizaron fueron Español, Inglés y Portugués, como resultado se obtuvo que el estrés oxidativo daña el ADN, por lo cual se genera un proceso de carcinogénesis, y los antioxidantes tienen la capacidad de evitar el estrés oxidativo por medio de la estabilización de radicales libres, concluyendo que los antioxidantes pueden prevenir el cáncer si se consumen alimentos de fuentes naturales, sin embargo en su tratamiento existen opiniones dividas, por lo cual se deben realizar más investigaciones a profundidad del tema.

Palabras clave: Antioxidantes; Cáncer; Estrés Oxidativo; Dieta Antioxidante.

INTRODUCTION

Since 2020, cancer has become the leading cause of death worldwide, causing approximately 10 million deaths. The most prevalent types include breast cancer, affecting 2,26 million women, followed by lung cancer affecting 2,21 million people, colorectal cancer with 1,93 million cases, prostate cancer presenting in 1,41 million patients, and finally skin and gastric cancer. In America in 2020, cancer was the second leading cause of death, with diagnoses in approximately 4 million people, a figure expected to increase to 6 million by 2040, with a mortality rate of 1,4 million. In our country, there were 29 273 new cases in 2020, with 15 123 patients losing their lives. Breast cancer has the highest prevalence at 12 %, followed by prostate cancer at 11 %, stomach cancer at 8 %, and thyroid cancer at 5 %.^(1,2)

The development of cancer involves various individual factors such as sex, age, genetic conditions, and environmental factors like pollution, viruses, radiation, and lifestyle choices as mentioned by the WHO, such as excessive tobacco consumption, above-normal body mass index, sedentary lifestyles, and a poor diet lacking in fruits and vegetables, all of which are considered cancer precursors.⁽³⁾

Additionally, cancer is characterized by promoting oxidative stress due to metabolic alterations in cells, malnutrition, and the treatment used to prevent its progression. Therefore, proper nutrition plays a crucial role in cancer prevention and treatment. Several studies have shown that adequate consumption of fruits and vegetables high in antioxidants can prevent and reduce oxidative stress, a factor in cancer development.^(4,5)

Currently, this topic generates significant controversy, as while some studies suggest that consuming supplements and antioxidant-rich foods aids in cancer prevention and treatment, others indicate they have no significant effects and may even be harmful. While they do reduce oxidative stress, without proper control of doses and consumption methods, they can be toxic or interfere with anticancer treatment, causing more harm.^(6,7,8)

Therefore, this review aims to identify the influence of antioxidant consumption on cancer prevention and treatment through research in updated scientific articles to provide an informative document based on scientific evidence.

METHOD

The literature review is based on searching scientific articles from 2018 to 2023 in databases such as Google Scholar, Scielo, PubMed, Elsevier, Web of Science, in Spanish, English, and Portuguese. Keywords like “antioxidants,” “cancer,” “oxidative stress,” “antioxidant diet,” “ROS,” and Boolean operators (AND/OR) were used for the search. Inclusion criteria included bibliographic reviews, systematic reviews, postgraduate theses, original articles, books, government documents, while monographs and articles without scientific bases were excluded. Documents with open access from the corresponding years and based on keywords and the topic of interest were filtered at the end of the search.

RESULTS

Oxidative Stress and Antioxidant Function:

According to a study by Escarza and López in 2020, through a literature review, free radicals are not harmful to health; they have various functions in the body, including cellular respiration, gene expression, and immune system protection. The problem arises when they increase excessively, usually due to inappropriate lifestyles, leading to overactivation in the pathways where reactive oxygen species (ROS) are generated and utilized, thus resulting in oxidative stress.⁽⁹⁾

In 2019, Agüero conducted a literature review research aimed at explaining the role of antioxidants in inhibiting the production of free radicals. The results showed that antioxidants are molecules capable of stabilizing reactive oxygen species by either destroying or donating an electron to the free radical, making it more stable. After this reaction, the antioxidant becomes a new free radical, but it is non-reactive and less aggressive, allowing it to easily bind with another antioxidant to maintain stability. There are two types of antioxidants: endogenous antioxidants, produced within the body, such as catalase, which acts in cases of hydrogen peroxide overproduction; superoxide dismutase, in which manganese, copper, and zinc act as cofactors to protect the body from superoxide anion; and glutathione peroxidase, which works with selenium to catalyze hydrogen peroxide, converting it into lipid hydroperoxide. Exogenous antioxidants include vitamins E, C, beta-carotene, among others, which act similarly but self-destruct, hence being called suicidal molecules. These molecules are present in foods and, in some cases, supplements developed in recent years. Each plays an important role in the body and is found in greater quantities in specific foods⁽¹⁰⁾ (Table 1).

Table 1. Antioxidants and Their Benefits

Antioxidant/antioxidant potential	Formula	Where the following are located	Results
Flavonoids	$C_6H_6O_{15102}$	Cenchrus echinatus L or cadillus, flaxseed, chia	Acts against breast cancer
Phenolic compounds	C_6H_6O	Guanabana, chincuya and linseed, Cenchrus echinatus L or cadillus	It acts against breast cancer and regulates oxidative stress.
Dienic alkaloid erysodine		Cenchrus echinatus L or cadillus, hemlock and bella donna, caffeine	Acts against breast cancer
Superoxide dismutase	$2O_2-(O_2-O_2-) + 2H^+ \rightarrow H_2O_2 + O$	+ Spirulina, barley, wheat and sprouts	Prevents premalignant lesions of the cervix, antioxidant, anticarcinogenic and antitumor effect.
Catalase	$2H_2O_2 \rightleftharpoons 2H_2O + O_2$	Cherry, banana, watermelon, kiwi fruit	Prevents premalignant lesions of the cervix, reduces tumor size, has antioxidant, antitumor and anti-inflammatory effects.
Catechin	$C_6H_6O_{15146}$	Green tea, blueberries, cocoa	Prevents prostate cancer
Zinc	Zn	Sesame, custard apple, dairy products, nuts	Diet prevents CaCu; dietary supplementation has no significant effect on reducing oxidative DNA damage.
Ascorbic acid	$C_6H_8O_6$	Soursop, custard apple, citrus fruits	Prevents cancer of CaCu, presents antioxidant properties
Vitamin E	$C_{28}H_{48}O_2$	Almonds, soursop, leafy green vegetables, nuts	Its deficiency is related to cancer, it has antioxidant and anti-inflammatory effects, its supplementation has no significant effects.
Phytochemicals		Fruits, vegetables and grains	Decreases oxidative stress by regulating the cell cycle and proapoptosis, antiapoptosis and survival pathways.
Lycopene	$C_{40}H_{56}$	Kidney tomato	Through diet it prevents prostate cancer and in early stages can reduce the size of the tumor, this as a supplement has no significant effects.
N-acetylcysteine	$C_5H_9NO_3S$	Legumes, dairy products, turkey, chicken	Diminishes tumor growth through supplementation
B-carotene	$C_{40}H_{56}$	Soursop, red, yellow and orange fruits and vegetables	Present in the diet protects the proliferation of oxidative stress, supplementation has no significant effect.
Vitamin D	$C_{27}H_{44}O$	Oily fish	Improved survival of patients with colorectal cancer
Glutathione peroxidase	GPX2	Spirulina	Anticarcinogenic, antioxidant and hepatoprotective effects
Lignan secoisolariciresinol di glucoside	$C_{32}H_{46}O_{16}$	Flaxseed, sesame	It has properties to reduce oxidative stress.
Selenium	See	Sesame, grains, red meats, liver	Reduces oxidative stress
Acetogenins	$C_{12}H_{18}$	Soursop, custard apple	Component in the development of anti-cancer drugs as this component has the ability to prevent the development of cancer-causing cells and tumors.
Anthocyanins	$C_{27}H_{31}ClO_{16}$	Soursop, blueberries, cranberries, red fruits	Act on oxidative stress
Protocatechuic acid	$C_7H_6O_4$	Passion fruit	Protects proliferation from oxidative stress, eliminates the function of the encoded protein SerpinB9, which is used as a prognostic and predictive biomarker of cancer.
Polyphenols	$C_6 - C_3 - C_6$	Albaca, passion fruit	Protects proliferation from oxidative stress
Ellagic acids	$C_{14}H_{6}O_8$	Grenada	Acts on oxidative stress, suppresses oxidative stress pathways, regulates gene expression and protects cellular components
Gallic acid	$C_7H_6O_5$		
Punicalagina	$C_{48}H_{28}O_{30}$		
Urolithins	$C_{13}H_8O_4$		
Eugenol	$C_{10}H_{12}O_2$	Albaca	Antioxidant and anti-inflammatory effects
Euclaptol	$C_{10}H_{18}O$		
Estragol	$C_{10}H_{12}O$		
Linalool	$C_{10}H_{18}O$		

Oxidative Stress and Cancer

In 2022, Holtz conducted a literature review research to explain why oxidative stress is a precursor to cancer. The results revealed that oxidative stress has the ability to cause DNA nitration, considered one of the major damages caused by it. Since DNA contains genetic information responsible for generating new biomolecules, its damage will disrupt all subsequent molecules.

Altered DNA within a cell undergoes synthesis and fixation, initiating a carcinogenesis process within the cell. Oxidative stress then plays a leading role, promoting the diffusion of mutated cells and modifying transcription factors responsible for cell growth and oncogenesis proliferation, thus promoting tumor growth. Finally, during the progression stage, reactive oxygen species (ROS) cause increased mutation rates, leading to damage in various tissues, rendering cells genetically unstable, and making the body more prone to metastasis.⁽¹¹⁾

Antioxidants and Their Relationship with Cancer

One of the most significant studies on the antioxidant effect against cancer was conducted in 2022. The study aimed to experiment the safety and protective effectiveness of the ethanolic extract of *Cenchrus echinatus* L., also known as sandbur, a plant native to America, on breast cancer induced by DMBA in *Rattus rattus*. In-depth analysis of *Cenchrus echinatus* revealed its high contents of phenolic compounds, free amino acids, alkaloids, and flavonoids. The study associated the cardioprotective, antioxidant, anti-ulcer, anticancer, and hepatoprotective activities with polyphenols. For the study, 20 mg of DMBA per rat, a carcinogenic compound inducing at least 4,7 mammary tumors in rats, was administered. The ethanolic extract was prepared by washing, dehydrating, pulverizing, and macerating the samples with ethanol for 7 days, followed by filtration and solvent removal. Fifty female rats were divided into 5 groups, with the first group receiving SSF 5 ml/kg, the second group receiving DMBA 20 mg each, and the remaining groups receiving the same DMBA dose along with extract at doses of 10, 100, and 200 mg/kg, administered orally. The experimental conditions showed that oral administration of this extract for 16 weeks protected against breast cancer and reduced tumor mass size, attributed to flavonoids inducing apoptosis and releasing cytochrome, which catalyzes the redox reactions of all cells.⁽¹²⁾

In 2022, Danay Ruiz and colleagues conducted a study aiming to identify the reaction of endogenous antioxidants to premalignant cervical lesions. The study involved 140 women aged 19 to 65, of which 96 had low-risk intraepithelial lesions, 54 had high-risk lesions, and 60 had no lesions. Spectrometry techniques were used to study the mechanism of action of superoxide dismutase and catalase enzymes and the accumulation of reduced glutathione. The results indicated that the body's antioxidant system exhibited a reduced mechanism of action, causing oxidative imbalance favoring premalignant lesion progression.⁽⁶⁾

Another study on prostate cancer involved a sample of 73,365 men evaluating the effect of green tea catechins, vitamin D, vitamin B, and folic acid in cancer prevention. A literature review was conducted, considering the quality of the included studies' methodology accompanied by meta-analysis for more reliable results. The findings revealed that catechins found in green tea had a greater impact on preventing prostate cancer.⁽¹³⁾

In 2020, a cross-sectional observational study was conducted on 202 women using a food frequency survey, with Student's t-test as the statistical analysis method. The objective was to evaluate how a high antioxidant diet may be related to the occurrence of cervical cancer. The results showed that women without any cervical neoplasia had a high consumption of zinc and vitamin C, with an average BMI of 25,23 kg/m². In contrast, women suffering from cervical cancer had a deficient intake of antioxidants and a BMI above normal ranges, demonstrating that consumption of antioxidant-rich fruits and vegetables is associated with the occurrence of cervical cancer. In Argentina in 2023, a descriptive cross-sectional study aimed to establish which elements and behaviors could be precursors for developing breast cancer. Anthropometric evaluations and food frequency surveys were conducted on 110 women with cancer, revealing that obesity and cancer are directly linked to poor diet and sedentary lifestyle, characterized by excessive consumption of refined grains, red meats, sugars, and a deficiency in white meats, fruits, and vegetables.^(14,15)

This is complemented by a study conducted in 2021, aiming to identify the dietary patterns of cancer patients. Fifty women aged 31 to 50 with cancer were evaluated, and information was collected through 24-hour dietary recalls, weight and height measurements to determine BMI, and subsequent analysis of energy intake, macro and micronutrients, and healthy BMI range. Results showed that 90 % of patients had excessive energy intake, and 55 % had deficient consumption of vitamins A, E, C, and zinc due to low intake of antioxidant fruits and vegetables. Similarly, in Asturias in 2019, 76 women diagnosed with cancer were investigated to evaluate various factors such as lifestyle, anthropometry, biochemical tests, and dietary intake as cancer precursors. The results were similar to the previous study, indicating that 59,2 % of evaluated women were sedentary, with a BMI exceeding 27,3 kg/m², 38,3 % body fat, a waist circumference of 92,2 cm, and low intake of fruits, vegetables, legumes, nuts, and high intake of red meats and sugary foods. Lastly, another study published in 2023 aimed to evaluate how a proper diet can provide an adequate amount of antioxidants in

oncology patients undergoing outpatient treatment. Anthropometric measurements, food frequency through a 24-hour recall, treatment type, and dietary antioxidant capacity were assessed using a database containing the composition and total amount of antioxidants in each food. The results showed that most patients had a high consumption of carbohydrates, proteins, and lipids, with vitamin C and E being the most relevant antioxidants in the diet. It was concluded that the antioxidant capacity of these patients' diet is related to the consumption of macronutrients and vitamins C and E. ^(16,17,18)

However, in 2020, in Brazil, the association between lifestyles such as smoking, alcohol consumption, sedentary behavior, and inadequate diet as risk factors for cancer was investigated. Lifestyles were classified based on surveys by sex and age group, grouped into prospective studies and meta-analyses. The result showed that diet represents only 6,2 % of the risk for cancer, with smoking being the main precursor of cancer in both men and women at 20,8 %, followed by alcohol consumption at 10,1 %.⁽¹⁹⁾

On another study aimed to explain how oxidative stress is generated and regulated, as well as the cellular signaling pathways affected by oxidative stress. A literature review was conducted across several databases such as PubMed, MedLine, BioMed, and SciELO. The results revealed that natural phytochemical properties obtained through diet have the ability to reduce oxidative stress by regulating the cell cycle and pro-apoptosis, anti-apoptosis, and survival pathways. Therefore, they are considered anticancer agents due to their relationship with reactive oxygen species (ROS).⁽²⁰⁾

Effectiveness of Dietary Antioxidants and Antioxidant Supplements

The aim was to identify if the consumption of antioxidants through diet and supplementation has the same effect on preventing oxidative stress by eliminating prooxidant factors. A comprehensive literature review was conducted across scientific databases, revealing that antioxidants consumed through diet have a greater impact on oxidative stress, particularly phenolic compounds capable of donating electrons and stabilizing molecules due to containing hydroxyl groups. In contrast, antioxidant supplements such as Zinc, despite being consumed for a prolonged period, did not show significant effects in reducing oxidative damage to DNA. To confirm the aforementioned in 2023, another literature review was conducted across scientific databases like SCIELO, SCOPUS, PUBMED, among others, aiming to identify if lycopene consumption as a dietary supplement can reduce risk factors in adult patients with prostate cancer. Nine studies were analyzed, of which only three mentioned that lycopene supplementation has a protective effect, while the remaining studies indicated no significant reduction in prostate-specific antigen. However, in 2019, different results were found through a literature review, aiming to identify if dietary lycopene intake can reduce the risk of prostate cancer. It was concluded that a high consumption of lycopene-rich foods can act as a preventive measure for prostate cancer, even reducing tumor size in early stages. However, there is insufficient evidence to confirm that a high lycopene diet has any effect in advanced cancer or metastasis. ^(22,23)

However, regarding a diet rich in antioxidants, several research studies support its benefits. For instance, Laura Castell's research in 2021, through a literature review, mentioned that oxidative stress is directly related to cancer. However, there is insufficient scientific evidence to demonstrate that antioxidant supplements can prevent or modify cancer, and even if consumed in doses higher than recommended, they can harm health. On the other hand, there is enough scientific evidence to assert that a rich and varied diet in fruits and vegetables has a protective capacity against cancer. Therefore, it is believed that the expected effect is achieved when multiple antioxidants act together. Similarly, Diaz and colleagues conducted a literature review aiming to identify the benefits of antioxidants in the treatment of oncology patients. The results showed that antioxidants during treatment have the ability to reduce the risk of neurotoxicity caused by cisplatin, a drug used in chemotherapy for various types of cancer.

Another extensively studied diet as a preventive measure against cancer is the Mediterranean diet. In this literature review study, evidence was presented that adopting this diet as a lifestyle accompanied by physical activity can protect against cancer. This is attributed to the diet's high quantities of fruits and vegetables, which are a source of antioxidants and anti-inflammatory properties. Furthermore, this diet prevents diseases such as overweight and obesity, which are considered triggers or risk factors for the development of neoplasms. This diet was also studied for its beneficial effect on intestinal microbiota, which can help prevent colon cancer. A literature review was conducted across scientific databases, resulting in findings that, being rich in fiber, antioxidant compounds, short-chain fatty acids, and nuts, specifically walnuts, it plays a protective role for colon cells, making it a good option for preventing this pathology in the short or long term. ^(4,5,7,24)

Through a literature review, all the latest advances in anticancer therapies specifically targeting oxidative stress generated by tumors were updated. It was identified that several agents can act as chemopreventive agents as they have the ability to eliminate ROS, the main precursor of cancer. Among these antioxidants are N-acetylcysteine, which was introduced in mice and showed a decrease in tumor growth. Similarly, the action of superoxide dismutase and catalase was studied, both of which also demonstrated their ability to reduce tumor size. However, in other studies where antioxidant supplements such as vitamin A, E, and β -carotene

were administered, they did not show any benefit in combating cancer. Additionally, another literature review investigated the effects of serum vitamin D levels and whether they are related to the subsistence of individuals with colorectal cancer. This study demonstrated that a diet high in vitamin D is related to the survival of patients with this type of cancer, as several articles showed that most patients who survived this pathology had high levels of vitamin D. However, a review study expressed interest in identifying which antioxidants can serve as chemotherapy and radiotherapy treatments and if it is possible to combine them. Several scientific articles were reviewed, and it was found that it cannot be asserted that antioxidants yield good or bad results, as this depends directly on the type of cancer being treated, the type of treatment, and the group of antioxidants being combined. This must always be supervised by a professional, as there is no standardization of safe consumption of these supplements, and if not monitored, they can have a negative effect by reducing the antineoplastic activity provided by chemotherapy treatment, harming the patient. ^(8,25,26)

Foods Rich in Antioxidant Properties

Several studies were conducted to identify what types of foods, plants, and seeds contain antioxidants and have a beneficial effect on pathologies such as cancer. Among these, a literature review was conducted to identify the pharmacological activity of various species of spirulina in relation to their antioxidant, anticancer, and hepatoprotective properties. The results suggested that spirulina could be used as a drug for prevention and, with further research, may have the potential to be used to combat this pathology, due to its anti-mutagenic, anticancer, anti-inflammatory, and antioxidant properties such as catalase, superoxide dismutase, and glutathione peroxidase. Among the various advancements, the antioxidant properties and function of a mixture of flaxseed, chia, sesame, and almond seeds were also investigated. The raw materials were collected, subjected to bleaching, each seed was ground separately, and then a homogeneous mixture was made. The properties of each seed were also investigated. The results indicated that this seed mixture provides significant nutritional benefits and may prevent diseases like cancer due to the abundance of antioxidants present in each. For example, flaxseed contains flavonoids, phenolic acids, and the lignan secoisolariciresinol diglucoside; chia contains a high amount of flavonoids; sesame is rich in zinc, selenium, and lignans; and almonds contain vitamin E. ^(27,28)

Several fruits were also evaluated, such as soursop, cherimoya, and pitahaya, with the aim of identifying their cytotoxic and nutraceutical characteristics. For this purpose, the fruits were carefully collected to ensure they were free from any damage or disease. Subsequently, they were disinfected, pulped, and the peel, seeds, leaves, and pulp were subjected to freezing, followed by lyophilization to analyze the content of each. The result obtained was that cherimoya is the fruit that contains the highest amount of antioxidants, primarily vitamin C, and a significant quantity of minerals such as calcium, phosphorus, magnesium, sodium, iron, zinc, and manganese, compared to soursop and pitahaya, which contain antioxidants in smaller amounts, mainly ascorbic acid and phenolic compounds. Therefore, these fruits could be considered as a means of preventing oxidative stress. However, the most studied fruit is soursop. In 2022, a literature review was conducted to highlight the benefits of consuming this fruit. The results of this search indicated that soursop contains acetogenin, one of the main components for the development of cancer drugs, as this component has the ability to prevent the development of cancerous cells and tumors. Additionally, this fruit exhibits anti-inflammatory and antioxidant properties, including vitamins C, E, phenolic compounds, anthocyanins, carotenoids, and phenolic compounds, which prevent oxidative stress. To corroborate the aforementioned information, another similar review yielded the same results, highlighting the presence of acetogenins mainly in stems, bark, roots, seeds, and leaves, as well as antioxidants that may serve as future cancer treatments. ^(29,30,31)

Another studied food was passion fruit due to its antioxidants, specifically the presence of protocatechuic acid. Here, the aim was to identify its antioxidant properties and its relationship with oxidative stress and consequently cancer. For this research, quantum chemistry was used, employing silicon experimentation through software and a SE-PM3 quantum model. Based on this, redox relationships were calculated, and the result obtained was that this acid present in passion fruit and the antioxidants in the same fruit, such as carotenoids and polyphenols, have the ability to protect against oxidative stress proliferation by eliminating the function of the SerpinB9-encoded protein, which is used as a prognostic and predictive cancer biomarker. Therefore, it can be asserted that it has good effects for combating and preventing the occurrence of cancerous tumors and is also related to diabetes treatment. ⁽³²⁾

Pomegranate is another fruit that was studied. In this case, a literature review was conducted on databases such as PubMed, Web of Science, Cochrane Library, with the objective of identifying antioxidants obtained from pomegranate. The result was that the antioxidant potential of pomegranate is due to its composition of ellagic and gallic acids, punicalagin, and urolithins. If ingested through the diet, these compounds have the ability to act on oxidative stress, suppress oxidative stress pathways, regulate gene expression, and protect cellular components, making it a good alternative for anticancer, anti-inflammatory, cardioprotective, and other health benefits. ⁽³³⁾

Research was also conducted on basil to identify its chemical composition and potential health benefits. For this, a literature review considering only *in vivo* and *in vitro* studies was conducted. The result identified that compounds in basil, including large quantities of polyphenols, eugenol, euclaptol, estragole, and linalool, specifically obtained from the oil extracted from the leaves and seeds of this plant, have health benefits associated with their antioxidant and anti-inflammatory effects, demonstrating its pharmacological potential for human health. ⁽³⁴⁾

DISCUSSION

Based on the results, it can be mentioned that there are several studies linking antioxidants to the prevention of ROS, which are precursors to cancer due to the damage they cause to DNA. However, there are different positions regarding their effect on cancer and whether they have the capacity to be used in its treatment.

Many studies refer to the possibility of preventing cancer through maintaining a healthy lifestyle, including a proper diet containing recommended amounts of fruits and vegetables, as evidenced by their provision of the most antioxidants to our diet, physical activity, and avoiding harmful habits. However, this may only serve as prevention rather than treatment. An important point to consider is that antioxidants have greater positive effects on oxidative stress when ingested through the diet, as the combination of various antioxidants present in foods provides the protective function that our body needs to combat or mitigate the harmful effects of oxidative stress, compared to the consumption of supplements, which have not yet shown any beneficial effects in combating cancer. On the contrary, without proper supervision, they can inhibit the function of anticancer treatment.

On the other hand, the role of antioxidants in cancer treatment still lacks a positive response because some studies mention that, while they may assist in certain oncological treatments, they can also interfere with such treatments, and improper consumption of them may lead to toxic effects.

However, there is a variety of foods and plants that have been studied and have shown their power to fight and prevent cancer. If further researched in depth, they could be a good alternative for combating this pathology. The question here is why more research has not been conducted on plants and foods that already have good scientific evidence to be used as an alternative treatment for cancer.

CONCLUSIONS

In conclusion, antioxidants have the capacity to prevent several diseases with inflammatory processes, such as cancer. Therefore, a proper diet rich in fruits and vegetables containing antioxidants will help reduce the risk of cancer, as endogenous antioxidants are not sufficient to counteract the effects of oxidative stress. However, regarding their relationship with anticancer treatment, there is still no concrete evidence of their function. Therefore, it is a topic that will need to be further investigated, paving the way for new natural options that are accessible to everyone.

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AUTHORSHIP CONTRIBUTION

Conceptualization: Camila Anahys Navas Bassante.

Research: Camila Anahys Navas Bassante.

Methodology: Camila Anahys Navas Bassante.

Project administration: Carmen Patricia Viteri Robayo.

Supervision: Carmen Patricia Viteri Robayo.

Writing - original draft: Camila Anahys Navas Bassante, Carmen Patricia Viteri Robayo.

Review and editing: Carmen Patricia Viteri Robayo.