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CLOVE (*SYZYGIUM AROMATICUM*): BENEFICIAL EFFECTS ON HUMAN HEALTH: A REVIEW

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ABSTRACT

Clove is an important ingredient of Indian kitchen and food as a spice. Researches have proved its various important and beneficial effects on human health. Looking into the history, Ayurveda has been using the cloves for medicinal purpose since several years. Clove is the native of Indonesia but now it has been produced in various countries all around the world. Clove is found to exhibit antimicrobial, larvicidal, anti-viral, anaesthetic, insecticidal, anti-oxidative and free radical scavenging activities. It is one of the richest sources of phenolic compounds. This review paper includes the benefits of clove in treating and protecting human health in various ways. This review paper particularly includes the anti- breast cancer activity of the clove. Breast cancer is the most common kind of cancer in females. Researchers have studied the properties of clove as a traditional spice, food preservative and medicinal effects and proved its importance in many ways.

Keywords : Cancer, Clove, Health benefits, Therapeutic plants.

Introduction

Clove is a dried flower bud and it is one of the important and useful spices that is being used in Indian food from centuries. It is used all over the world in different dishes to enhance the flavor and aroma of the food. It is widely used as a preservative in so many dishes and pickles. It is a good source of phenolic compounds such as eugenol, eugenol acetate, β -caryophyllene, α -humulene, gallic acid and these compounds have great potential in pharmaceutical, cosmetic, food and agricultural field. The main constituent of essential oil is eugenol and it can be obtained by the distillation process. The distillation of stem, flower and leaves can attribute to obtain clove oil. The molecular formula of eugenol is (C₁₀H₁₂O₂) and the IUPAC name of eugenol is 4-Allyl-2-methoxyphenol. Clove exhibits so many properties that can contribute to treat health related problems. Clove as a natural ingredient exhibits minimum negative effect on the human health and shows negligible resistance in human body. Clove oil is used by dentists because of its anti-inflammatory and anti-bacterial action. Clove oil (eugenol) acts as antioxidant agent to treat tumour in human body. Clove oil also acts against cardiovascular diseases by inhibiting the clotting. In some studies eugenol has been used with different chemotherapeutic drugs to induce better results against triple negative breast cancer that is the most aggressive type of breast cancer. Some experiments have been conducted to study the larvicidal action of the clove and the results conclude that clove oil is effective to a good extend. Clove oil is also used as an anaesthetic for fishes because it does not have any side effects. It also acts as stimulant in many activities. By looking into the benefits of eugenol and its results against many diseases, The Food and

Agriculture Organization (FAO) and World Health Organization (WHO) has allowed an acceptable daily intake of eugenol of 2.5 mg/kg body weight for human beings.

Breast cancer is one of the major health concerns of present time. It is the second biggest reason of death in women. The breast cancer can occur due to many reasons such as lifestyle, diet, alcohol consumption, smoking, family history and hormonal changes. Every year more than one million women are diagnosed with breast cancer all around the world (Shareef *et al.*, 2016). Breast cancer becomes life threatening disease because of its late detection and less awareness. The rate of death due to breast cancer can be decreased by spreading public awareness about how early detection can be done and thus one can get enough time to get proper treatment. Breast cancer is a fatal disease and there is a huge need to find different ways to minimize its effects on the body. In an adult woman, each breast contains 15-20 sections known as lobes and these lobes are further divided into lobules. Lobes and lobules are connected through ducts. The ducts are the main site of the tumour development which further leads to breast cancer. Breast cancer can be invasive and non-invasive based on the nature of the way it spreads further.

A lot of treatments such as removal of breast, chemotherapy, radiotherapy, allopathy treatments and ayurvedic treatments are getting explored from time to time. Most of the treatments possess huge side effects on the human body. All these things combine and conclude the need of finding other ways to treat this life-threatening disease that shows minimum side effects on body. Inspired from the ancient times, when people used to treat the diseases using different herbs, Scientists are working to find natural sources

such as herbs and different plants that can work in this situation and fulfil the need of time. Plants contain several types of aromatic compounds, flavonoids and essential oils that eventually are product of interest to treat the diseases like breast cancer. Plants like ginger, garlic, clove, green tea, cabbage, broccoli and many other plants have been tested for having antiproliferative properties and anti-carcinogenic effects.

Beneficial effects of clove

Clove and its components have huge number of beneficial effects on human body in so many different terms. It has a great influence in Ayurveda from ancient times and thus the research is also inspired from the Ayurveda to find out more prominent way to treat the diseases. The research that has been conducted so far, there are some findings that prove various benefits of clove on different health related issues of body.



Fig. 1 : Diagram showing health benefits of clove.

- **Anti-inflammatory activity:** Clove as a naturally available source of phytochemicals and free from any sort of side effects, the anti-inflammatory nature of clove has been studied widely and it has been found that clove and its components help to reduce the inflammation and swelling at different sites. The active component of clove is eugenol modulate the signalling pathway and immune response and that's how it reduces the inflammation (Widowati *et al.*, 2015). TNF- α is an important target of anti-inflammatory agent and by blocking one of the cytokines of TNF- α can get the work done. Clove oil attribute in treating the inflammation of dermal fibroblast (Han & Parker, 2017). In this way clove oil plays vital role in so many physiological and biological processes.
- **Antioxidant activity:** clove buds as aromatic plant possesses antioxidant properties and thus provide major benefit. Clove buds do possess antioxidant nature because they minimize the oxidation reaction in our body and thus number of free radicals reduce in our body (Gülçin *et al.*, 2012). Some of the oxygen taken by the living cells is converted into harmful reactive oxygen gases such as hydrogen peroxide and hydroxyl radical (Kasai *et al.*, 2015). These free radicals can damage the

tissues of body leading to the serious health related issues. Some of the antioxidants are produced by body itself and other we intake through our food. It is shown that major aroma chemicals named as eugenol and eugenyl acetate present in clove exhibit the antioxidant properties in clove.

- **Anticancer or chemo preventive activity:** Clove buds have been used to treat the cancer from the ancient times in Ayurveda. A lot of other techniques and mechanism such as chemotherapy, radiation therapy, bone marrow transplant and surgery; have been exploited to treat the cancer but they have so many side effects on human body and that is the reason we need to find the other ways to treat the cancer cells in other way. All these combined reasons lead the research to divert on natural resources that exhibit minimum side effects, resistance and effective results (Reddy *et al.*, 2003). Anticancer activity of clove is being studied from long time and several results shows that clove and its chemical components attribute as a good natural anticancer agent. The experiment conducted on HTh-7 (Thyroid cancer cell line) using nanoscale emulsion of the essential clove oil showed very effective results and the colony number were reduced up to a significant mark (Nirmala *et al.*, 2019).
- **Antitumour activity:** Antitumour nature of the clove has been studied on a broad level in in-vitro and in-vivo conditions and results are found to be quite significant and they prove the theory of antitumor or tumour suppressive nature of clove. A component of clove extract known as ethyl acetate possess in vitro antiproliferative and in vivo antitumor activity (Liu *et al.*, 2014). Another component of clove extract known as oleanolic acid (OA) that is present within the ethyl acetate plays vital role in cell cycle arrest that leads to apoptosis (Liu *et al.*, 2014). The research was conducted on various human cell lines such as lung cancer cell line and results demonstrated that clove exhibit activity on the tumour cells.
- **Larvicidal action:** The vector borne diseases such as dengue fever, malaria, yellow fever and chikungunya are caused by the mosquitos. Mosquitos act as vectors or vehicles for transmission of the disease. The dengue fever is very common in India as well as all around the world. At present, mosquitos show resistant against several insecticides and that's divert the attention to the natural resources that can act against these mosquitos. The experiments conducted on some larvae that belongs to different genus. Anopheles darlingi and Aedes aegypti larvae were taken to check the larvicidal action of some natural resources such as clove extract aqueous Eugenol and eugenol extract showed significant results after 48 hours of the bioassay on Aedes aegypti and the mortality rate was 76% (Medeiros. *et al.*, 2015). Thus, clove extract eugenol act as good larvicidal agent and thus helps to protect the human health from the mosquitos.
- **Triple negative breast cancer activity:** Triple negative breast cancer is a type of cancer in which the growth of cells does not depends on hormones such as human epidermal growth factor receptor 2 (HER2), estrogen and progesterone (Dent *et al.*, 2007). It is said that approximate 10-20% women do have this kind of breast cancer. The treatment of triple negative breast cancer is difficult than that of normal breast cancer because there

are very few targeted medicines that act in this situation. So, it is obvious that scientists have diverted their interest towards natural resources that give more promising result. As we know clove possess anticancer

activity and that's why scientists are exploring the activity of cloves on triple negative breast cancer. Besides all these therapeutic effects, cloves have so many health benefits that are yet to be found and classified.

Table 1 : Different plants exhibiting anticancer properties and their mode of action.

Sr. no.	Plant name	action	Working mechanism	References
1.	Basil (<i>Ocimum basilicum</i>)	Breast cancer, Skin cancer, lung cancer	Eugenol and methyl eugenol induce apoptosis	(Baliga <i>et al.</i> , 2013)
2.	Turmeric (<i>Curcuma longa</i>)	Prostate cancer, Breast cancer, lung cancer	Activity of COX-2 enzyme is restricted.	(Kuttan <i>et al.</i> , 1985)
3.	Chilli pepper	breast cancer, triple negative breast cancer	Protein expression of EGFR and HER2 get reduced by action of capsaicin	(Thoennissen <i>et al.</i> , 2009)
4.	Ginger (<i>Zingiber officinale</i>)	Skin cancer, gastrointestinal cancer	Gingerol a chemical compound present in ginger suppress cell growth and induces apoptosis	(Prasad & Tyagi, 2015)
5.	Garlic (<i>Allium sativum</i>)	Breast cancer	Oil soluble compounds such as diallyl disulfide (DADS), diallyl sulfide (DAS) induces cell cycle arrest at G2/M phase	(Tsubura <i>et al.</i> , 2011)
6.	Broccoli (<i>Brassica oleracea</i> var. <i>italica</i>)	Breast cancer, prostate cancer, lung cancer, colon cancer	Sulforaphane present in broccoli detoxify and remove carcinogens. Inhibit cell cycle progression, angiogenesis and induce apoptotic cell death	(Qazi <i>et al.</i> , 2010)
7.	Curry leaf (<i>Murraya koenigii</i>)	Breast cancer	Proteolytic activity leads to cancer cell death	(Noolu <i>et al.</i> , 2013)
8.	Roselle (<i>Hibiscus sabdariffa</i>)	Gastric cancer, leukemia	Hibiscus anthocyanins promotes cancer cell apoptosis and protocatechuic acid suppresses carcinogenic action	(Lin <i>et al.</i> , 2007)
9.	Parsley (<i>Petroselinum crispum</i>)	Lung cancer, colon cancer		
10.	<i>Catharanthus roseus</i>	Breast cancer, Hodgkin's lymphoma, ovary cancer, lung cancer	Alkaloids such as vincleukoblastine binds to tubulin in mitotic spindle and arrest cancer cell proliferation	(2009)
11.	Cabbage (<i>Brassica oleracea</i>)	Breast cancer, skin cancer	Brassinin and Cyclobrassinin extracted from cabbage exhibit chemo-preventive activity	(Mehta <i>et al.</i> , 1995)
12.	Grapes	Breast cancer	Grape skin extract inhibit the activity of Nox protein and undergoes programmed cell death	(Morré & Morré, 2006)
13.	Green tea (<i>Camellia sinensis</i>)	Prostate cancer, colon cancer	Epigallocatechin Gallate (EGCG) a polyphenolic compound of green tea exhibit antiproliferative activity and thus induces death of cancer cells.	(Du <i>et al.</i> , 2012)
14.	Honey	Colon cancer	Caffeic acid phenethyl ester is a component of manuka honey and digested manuka honey, leads to cell cycle arrest and cancer cell death	(Cianciosi <i>et al.</i> , 2020)
15.	<i>Cannabis sativa</i>	Breast cancer, cervical cancer, prostate cancer	A compound named as cannabidiol inhibit cell proliferation and induces apoptosis.	(Lukhele & Motadi, 2016)
16.	<i>Aloe vera</i>	Breast cancer, Liver cancer	Compound named aloin exhibit antiproliferative effect and cytotoxic activity by arresting the cell cycle at S phase.	(Kumar <i>et al.</i> , 2019)
17.	Goldenseal (<i>Hydrastis canadensis</i>)	Breast cancer, oral cancer	Exhibit antiproliferative effect on cancer cells	(Levitsky & Dembitsky, 2014)
18.	Ginseng (panax)	Breast cancer, gastric cancer	Active compound of ginseng exhibit free radical scavenging activity as well as antiproliferative activity	(Park <i>et al.</i> , 2014)
19.	Echinacea	Breast cancer, colon cancer	It induces apoptosis of cancer cells	(Tsai <i>et al.</i> , 2012)
20.	Burdock (<i>Arctium lappa</i>)	Breast cancer, lymphoma, pancreatic cancer	Compound tannin exhibit cytotoxic effect on cancer cells. It also reduces the metastasis	(Chan <i>et al.</i> , 2010)

Future prospects of clove as a therapeutic plant

As we have discussed a number of health benefits of clove and its mode of action at different sites and with time as the research work proceeds, we will get to know more about the plant and its benefits. The main future prospect lies to explore its anti-proliferative property and use it as a therapeutic agent against different types of cancer, with no side effects and higher tumoricidal potential. The treatment using natural compounds will be more cost effective and it will be available at a broad level. Successful research in in-vivo models will lead to minimize or replace the chemotherapy and radiotherapy treatment for various cancer diseases.

Conflict of Interest

There is no conflict of interest exists among the authors.

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