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Review

Functional food and dietary supplements for lung health



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ABSTRACT

Background: The World Health Organisation reported the global leading causes of death in the past decade were ischaemic heart disease (7.4 million), stroke (6.7 million), lower respiratory infections (3.1 million) and chronic obstructive lung disease (3.1 million). Lung cancers (along with trachea and bronchus cancers) caused 1.6 million (2.9%) deaths in 2012, up from 1.2 million (2.2%) deaths in 2000. Lung-related ailments (asthma, chronic obstructive pulmonary diseases, influenza and lung cancer) are common worldwide with high mortality rates. The major killer diseases in the world are related to the lungs (8 million) which statistically makes it the top cause of death.

Scope and approach: Various plants contain metabolites that help against lung ailments and have been demonstrated in *in vitro*, *in vivo* and clinical studies. This review compiles the scientific reports and findings resulting from the use of plant extracts as a complementary therapy or dietary supplement for lung health and their underlying mechanisms.

Key findings and conclusions: These plant metabolites benefit lung health by anti-inflammatory, immunomodulatory, and antioxidant effects. Many pungent flavor components in edible plants activate the mucous membranes of the respiratory tract to help fight microbes and remove undesirable agents. These flavor and aroma compounds can behave as expectorants, decongestant, antitussive, and antimicrobial agents. They enhance mucous membrane secretion, kill pathogens, reduce inflammation and decrease mucous viscosity by weakening the hydrogen bonds in the mucous. For lung cancer, certain plant metabolites help induce apoptosis, suppress angiogenesis (cancer-related new blood vessel growth) and suppress inflammatory pathways.

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1. Introduction

The World Health Organisation reported the 10 leading causes of death in the world on 2012, were ischaemic heart disease (7.4 million), stroke (6.7 million), lower respiratory infections (3.1 million) and chronic obstructive lung disease (3.1 million) during the past decade (Fig. 1) (WHO, 2014). Lung cancers (along with trachea and bronchus cancers) caused 1.6 million (2.9%) deaths in 2012, up from 1.2 million (2.2%) deaths in 2000. Nevertheless, the major killer diseases in the world are related to the lungs (8 million) which statistically makes it the top cause of death.

Natural herbal therapy as dietary supplement is getting popular again with increasing sales figures in some countries. The conventional drugs are perceived to have various undesirable side effects. Consequently, a generally regarded as safe, complementary therapy from natural edible plant sources is of interest (Ram,

Balachandar, Vijayananth, & Singh, 2011). The knowledge on the potential use of food or dietary supplement for the management of the top lung-related diseases is helpful. Many pungent flavor components in the edible plants activate the mucous membranes of the respiratory tract to help fight microbes and remove undesirable agents. These compounds that give flavor and aroma to the food can behave as expectorants, decongestant, antitussive, antimicrobial and good for respiratory ailments. They increase mucous membrane secretion, kill pathogens, reduce inflammation and reduce mucous viscosity by weakening the hydrogen bonds in the mucous. The compounds such as menthol (in mint) and thymol (in thyme) are powerful antimicrobial agents, anti-inflammatory and antioxidants besides their ability to weaken the hydrogen bonds of the mucous, to make it less viscous, less congested and facilitate air flow into the lungs. Limonoids in citrus peels protects the lung tissues and are often used in air fresheners. D-limonene, pinene and eucalyptol, that are commonly utilized in aroma therapy help clear congestive mucous from chronic obstructive pulmonary disease patients lungs (Mohamed, 1997).

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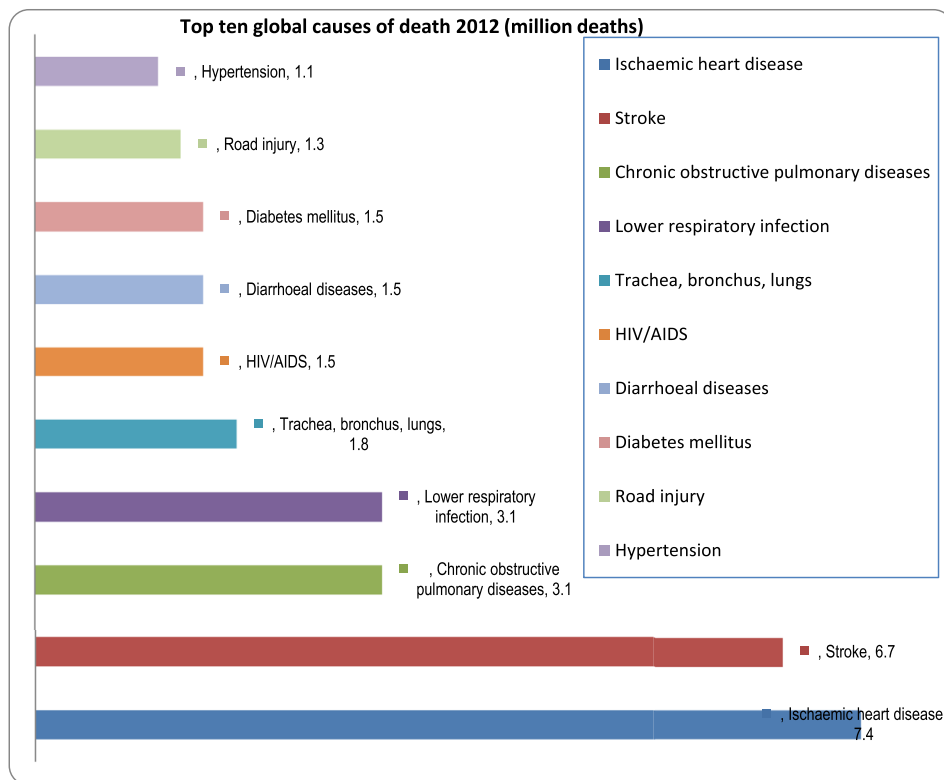


Fig. 1. Top ten global causes of death in 2012 (millions).

2. Asthma

Asthma is a chronic inflammatory airways disorder, associated with widespread air flow obstruction and increase in airway responsiveness to various stimuli. The asthma inflammation starts with CD4⁺ Thelper 2 (Th2) cells and dendritic cells, followed by eosinophilic lung infiltration and mast-cell sensitization, resulting in several inflammatory mediators release (Ram et al., 2011). Asthma attack is accompanied by wheezing, shortness of breath, chest tightness and coughing. The obstruction is often reversible either spontaneously or after treatment with various drugs. Asthma medications are mostly taken with an inhaler to effectively reach the lungs. The modern asthma therapy often use inhaled corticosteroids.

Clinical herbal studies showed significant improvements of sleep discomfort, cough frequency and cough intensity in addition to increased percentages of FEV1/FVC (Forced expiratory volume in 1 s/Forced vital capacity-) in patients suffering from allergic asthma, who used the herbal tea (chamomile, saffron, anise, fennel, caraway, licorice, cardamom and black seed) compared to those on the placebo tea (Haggag, Abou-Moustafa, Boucher, & Theoharides, 2003). The methodology for evaluation often use Pulmonary function tests (PFTs) including FEV1, peak expiratory flow (PEF), maximal mid expiratory flow (MMEF), maximal expiratory flow at 75, 50 and 25% of the FVC (MEF₇₅, MEF₅₀, and MEF₂₅, respectively) and specific airway conductance (sGaw) measured before administration and repeated, 30, 60, 90, 120, 150, and 180 min after administration of the oral extract and theophylline (as reference standard).

Diet and nutrition may affect the onset and course of chronic inflammatory airway diseases. Asthmatics have significantly lower serum lycopene and vitamin A levels compared to healthy control subjects (Riccioni et al., 2007), although the serum vitamin E and

beta carotene levels were not significantly different. Vitamin K₂ (menaquinone) administration, significantly relieved bronchial asthma in some patients (Ogunlesi, Okiei, Ofor, & Osibote, 2009).

Fish or high omega-3 fatty acids consumptions are also protective against allergic lung disease. The anti-inflammatory activity of oleic acid and hexadecaenoic acid can be therapeutic in the management of infections in asthma patients (Ruxton, Calder, Reed, & Simpson, 2005).

Fresh fruit consumption, particularly fruit high in vitamin C, has been related to a lower asthma symptoms prevalence and improved lung functions in children. Dietary supplementation or adequate intake of antioxidant lycopene, vitamin A, genistein, vitamin D and vitamin C rich foods may be beneficial for asthma patients (Gupta et al., 2011).

Euphorbia hirta L. containing phytol and its isomer 3,7,11,15-tetramethyl-2-hexadecen-1-ol (Ogunlesi et al., 2009), together with the volatile oils, alkaloids, tannins, saponins and steroids are regularly used in Nigeria, East and West Africa for asthma and various respiratory ailments. Traditionally, the plant is squeezed in water and the extract taken orally for asthma patients. The 2,6,10-trimethyl tetradecane present in the essential oil of *E. hirta* may relieve asthma (Hultqvist, Olofsson, Gelderman, Homberg, & Holmdahl, 2006). Phytols are produced from chlorophyll hydrolysis and forms part of the vitamin E and vitamin K molecules. Thus phytol may produce some vitamins E and K effects to relieve asthma.

Artemisia asiatica Nakai ethanol extract produced inhibitory effect on ovalbumin-induced airway inflammation in allergic asthma mouse model. The extract reduced ovalbumin-induced specific serum IgE levels, recruitment of inflammatory cells into the broncho-alveolar lavage (BAL) fluid and lung tissues, expressions of cluster of differentiation 40 (CD40), CD40 ligand and vascular cell adhesion molecule 1 (VCAM-1) molecules, goblet cell

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