NANO CURCUMIN: A REVIEW

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ABSTRACT

Background: Flavonoids' most important property is its antioxidant or radical scavenging ability, which protects cells from oxidative damage. Free radicals are rendered inactive due to the strong reactivity of the hydroxyl group of flavonoids; instead, flavonoids are converted by radicals to less reactive radicals. Turmeric (*Curcuma longa*), is a cooking spice used in Indian food and medicine, and encompasses cur cumin, which is a polyphenol and an active component. Cur cumin is a flavonoid found in the rhizome of the turmeric plant (*Curcuma longa* L.), and it has recently sparked interest of scientific researchers due to its wide range of biological and medicinal effects on chronic diseases including neurological disorders.

Aim: The goal of this review is to present a new current Nano biotechnological approach to disease treatment and the use of Nano cur cumin for disease management.

Methods: Cur cumin, a lipophilic polyphenol molecule produced from the rhizome of the turmeric plant, is currently widely regarded as one of the most promising anti-aging treatment and other diseases available such as cancer and cardiac disease. Relevant research on neurodegenerative disease were found by searching PubMed, Web of Science, Scopus, and the Cochrane Library databases.A total of 28 studies were included in the systematic review, which was based on a literature search.

Results: Cur cumin has antioxidant, immunomodulatory, anti-inflammatory, anti-microbial, cardio-protective, nephro-protective, hepato-protective, anti-neoplastic, anti-rheumatic, and hypoglycaemic properties. Meanwhile Poor bioavailability due to hydrophobic characteristics, limited solubility and stability, and fast systemic clearance due to extensive intestine-liver metabolism are all significant challenges in its therapeutic utilization, however modern technologies in the field of Nano biotechnology investigations have been proposed in order to overcome this limitation.

Conclusion: Innovative Nano biotechnology techniques, such as Nano delivery-based strategies, are now being investigated to address current cur cumin bioavailability limitations.

Key words: Rhizome, Nanoparticles, Cur cumin, Bioavailability.

INTRODUCTION

Nanotechnology is a rapidly developing field for the science and technology of manufacturing new materials at the nanometer level (Albrecht *et al,*. 2006). This is a multidisciplinary field, using methods from different disciplines. Nanotechnology has a wide range of applications, including electronics, biology, chemical engineering, and robotics electronics, (Wang *et al.*2012).the physical, chemical, optical and electronic properties of nanoparticles depend on their size, shape and surface morphology (Alivisatos, 1996: Anand *et al.,* 2007). The synthesis of nanoparticles is mainly carried out by two methods: bottom-up and top-down. In the bottom-up approach, nanoparticles are formed from molecular components that are chemically assembled by recognizing similar molecules, while in the top-down approach, nanoparticles are formed from larger objects (Bhawana *et al.,* 2011). The bottom-up approach is commonly used in the chemical and biosynthesis of nanoparticles.

Due to their applications in medicine, nanoparticles have been widely studied and used, such as for the transportation of active substances, the study of DNA structure, protein detection, tissue engineering, pathogen detection, the destruction of cancer cells and the study of phagocytosis kinetics (Bisht *et al,*. 2010). The main application of nanotechnology in medicine is the development of nanoparticles as drug delivery systems. The advantages of using nanoparticles are large surface area, controllable particle size, specific positioning, bioavailability, stability, biodegradability and controlled drug release. Metal nanoparticles such as silver, gold, platinum, and copper have been synthesized and used in clinical applications (Carey *et al.* 2010): (Chauhan *et al.,* 2012). However, these metal nanoparticles will stay and accumulate in the body, leading to harmful side effects (Cridge *et al.,* 2013). These limitations can be overcome by using biological sources to synthesize nanoparticles. Nano-biomaterials do not accumulate in the body and have been proven to be safe.

Since ancient times, humans have used natural botanicals for various purposes. As a natural defense mechanism, plants produce thousands of secondary metabolites. Most of these metabolites have pharmacological activities for drug design and development. Herbal preparations play an important role. Turmeric (Curcuma longa Linn) is a perennial herb of the ginger family and a traditional medicine in Asia. The typical yellow color of turmeric is due to the presence of cur cumin. Curcuminoids are polyphenols containing three main components: cur cumin (77%), desmethoxycurcumin (17%) and bisdemethoxycurcumin (3%), among them, the most biologically active ingredient is cur cumin (1, 7-bis (4-hydroxy-3-methoxyphenyl)hepta-1, 6-diene-3, 5-Dione). It has been widely studied as an antioxidant (Gandapu *et al.,* 2011). An anti-inflammatory agent (Ghalandarlaki *et al.,* 2014). And a variety of biological and pharmacological activities such as antibacterial agents, (Hempel1957):(Jayaprakasha *et al.,* 2006). And anti-tumor. Due to its poor water solubility, instability and low bioavailability, cur cumin's therapeutic use is limited. The main reasons for the low bioavailability of cur cumin are poor absorption, high metabolic rate and rapid systemic clearance (Kim *et al.,* 2003). Nanoparticle drug delivery system is used to improve its solubility, stability and bioavailability. In recent years, researchers have developed various Nano forms of cur cumin, such as Nano suspensions, Nano emulsions, solid lipid nanoparticles, hydrogel nanoparticles, etc. (Krausz *et al*., 2015). A number of studies have shown that cur cumin nanoparticles can be used as drugs for the treatment of various diseases (Mofazzal *et al.,* 2014).

Curcumin Bioavailability and Nano Biotechnology in Neurodegenerative Diseases

Alzheimer's and Parkinson's diseases are the leading causes of cognitive decline in populations, affecting the elderly and causing clinical symptoms such as progressive loss of memory, reasoning, and cognitive abilities. These diseases are caused by oxidative stress, which is caused by the production of reactive oxygen species such as superoxide ions (O2•), hydroxyl radical (•OH), singlet oxygen (O2), and others. As a result, antioxidants can help to prevent oxidative stress-induced neurotoxicity. The ultimate particle size and stability will affect cur cumin bioavailability, which can be increased using the newest nanoparticle technology. As a result, nanotechnology applications offer a new therapy platform for neurodegenerative diseases, and Nano cur cumin may be able to break through the blood-brain barrier, which is crucial in treating neurodegenerative diseases like Parkinson's and Alzheimer's, (Ghalandarlaki *et al.,* 2014). Developing a successful Nano medicine will result in the treatment of age-related neurodegenerative diseases like Alzheimer's and Parkinson's disease.

The Clinical Significance of Curcumin Nanoparticles Anticanceractivity

Cancer is the most commonly diagnosed devastating disease in the world, and traditional therapies such as chemotherapy, radiation therapy and surgery can cause undesirable side effects. Therefore, it is important to develop safer and alternative treatments for this malignant disease (Cridge *et al.,* 2013).they are used to discover new medicines. It is believed that plants contain several important non-toxic medicinal compounds that can be used to treat various types of cancer. Turmeric is herbal medication that is used to treat cancers of the mouth, breast, prostate, skin, and ovary, among others.

Breast Cancer

Breast cancer is a common disease that mainly affects women all over the world. In vitro studies of cur cumin micelles have shown that triple-negative breast cancer (TNBC) xenografts have increased bioavailability, cytotoxicity, and prolonged half-life (Onoue *et al*., 2011). They overexpress the receptors for estrogen, progesterone, or human epidermal growth factor 2, and are resistant to chemotherapy (Ruparelia *et al*., 2008**)**. Magnetic nanoparticles containing turmeric have shown effective anti-cancer activity on TNBC cells (MDAMB231 cell line) as well as magnetic targeting and imaging properties. The decrease of mitochondrial membrane potential is caused by cellular reactive oxygen species (Salata, 2004). In human MCF7 breast cancer cells, the combination of cur cumin-encapsulated nanoparticles and electroporation showed better anti-cancer activity (Shishodia *et al.,* 2007).

Ovarian Cancer

Ovarian cancer includes different types of cancers, depending on the cells they are made of. The main obstacle to the treatment of advanced ovarian cancer is resistance to radio chemotherapy, (Yallapuet al. 2013). Treatment of cisplatin-resistant ovarian cancer cells with nanoparticle conjugates A2780CP inhibits cell growth while promoting apoptosis. Consequently Adenocarcinoma cells that induce apoptosis. Turmeric Nano emulsion reduces the action of core factor B (NFB) and suppresses P-glycoprotein expression (Topp, 1982).

Pancreatic Cancer

According Bisht *et al*. (2010), used N-isopropylacrylamide, N-vinyl-2-pyrrolidone and poly (ethylene glycol) monoacrylate copolymer to synthesize cur cumin-loaded polymer nanoparticles. It acts as a potential tumor suppressor in a xenograft model of human pancreatic cancer. Gemcitabine also prevents tumor growth by inducing cell apoptosis, reducing NFκB activation, and the expression of matrix metalloproteinases MMP9 and cyclin D1, (Yallapu *et al.*2013). The therapeutic effect of Nano cur cumin has been confirmed by cell viability studies and clone formation methods (Wang *et al.*, 2012). In a mouse xenograft model, magnetic nanoparticles containing turmeric significantly inhibited the growth of human pancreatic cancer cells (HPAFII and Panc1). Compared with traditional cur cumin, this drug shows higher stability, higher bioavailability and biodistribution (Yallapu *et al.,* 2013).

Prostate Cancer

Prostate cancer is a disease that occurs in the prostate of the male reproductive system. It can gradually spread to other parts of the body, such as bones and lymph nodes, (Yallapuet al. 2014). Turmeric-rich poly (lactic-glycolic acid) (PLGA) nanoparticles made by Yallapu *et al.,* Prove the anti-cancer activity of cur cumin nanoparticles on prostate cancer. Cur cuminNanoparticles PLGA release the biologically active cur cumin into the cytoplasm and then incorporate them into cancer cells. Anti-apoptotic protein that causes apoptosis, (Yallapu *et al.,* 2014). In vitro studies on PLGA Nano spheres loaded with cur cumin in prostate cancer cell lines have shown that cur cumin can be released continuously for a long time, and the absorption of Nano spheres in cells is higher, (Yamada *et al*., 2014).

Antimicrobial Activity

Microorganisms play an important role in many human infections. Many natural and chemical compounds have been used as antibacterial agents to kill bacteria, fungi, protozoa and viruses. The turmeric nanoparticles are used in their natural state. Its antimicrobial activity is superior to regular cur cumin, (Ruparelia *et al.,* 2008). The antibacterial and antifungal activities of wet-milled Nano cur cumin are reported.

Nanoparticles enter the infected cell, destroy the cell wall, and eventually cause cell death. The composition of Nano cur cumin is more reactive to gram-positive bacteria than to gram-negative bacteria (Silva *et al*., 2016). In another study, cur cumin-coated nanoparticles inhibited the growth of methicillin-resistant Staphylococcus aureus and Pseudomonas aeruginosa, and increased the wound healing activity in mice in vivo wound models, (Krausz *et al.,* 2015). Similarly, in vitro studies of cur cumin-loaded chitosan tripolyphosphate nanoparticles inhibited the growth of Staphylococcus aureus and Pseudomonas aeruginosa in mouse skin, (Mirnejad *et al*., 2014).

Anti-HIV Activity

Human immunodeficiency virus (HIV) attacks the immune system by destroying CD4 + T cells. The gradual failure of immunity eventually leads to Acquired Immune Deficiency Syndrome (AIDS). CD4 + T cells are white blood cells that protect the body from infection. Antiretroviral drugs can suppress the virus, but the virus has not been completely eradicated, so alternatie therapies must be found to treat this deadly disease. (Gandapu *et al.,* 2011), reported that cur cumin-loaded apotransferrin nanoparticles prepared by the Soloil method are very effective in treating this deadly disease. They prevent HIV1 replication through transferrin-mediated endocytosis. Generally, HIV-infected cells express transferrin receptors. Apotransferrin nanoparticles loaded with turmeric specifically bind to receptors and transport the drug to infected cells. The drug is gradually released and the synthesis of viral cDNA is blocked, leading to the termination of HIV1 replication (Yallapu *et al*., 2010).

Antimalarial Activity

Malaria is caused by parasites and is transmitted by female Anopheles mosquitoes. In vivo study of cur cumin-loaded hydrogel nanoparticles by Dandekar et al. Toxicity studies have shown the oral safety and cytotoxicity of the Nano form (Gantaand Pharm, 2009). Chitosan nanoparticles containing turmeric cured mice infected with Plasmodium yoelii by preventing heme synthesis (Akhtar *et al.,* 2012).

Anti-Inflammatory Activity

In ancient Indian medicine, turmeric was used as an anti-inflammatory agent. Rocha et al. compared the anti-inflammatory activity of normal cur cumin and Nanocur cumin in rats. The inhibitory effect of Nanocur cumin at a dose of 50 mg/kg is similar to that of normal cur cumin. A dose of 400 mg/kg showed an increased anti-inflammatory effect of Nano cur cumin, (Rocha *et al.,* 2014). In a lipopolysaccharide-induced septic shock mouse model, the effectiveness of exosomes encapsulated in cur cumin was studied. The concentration in the blood is very high (Ruddon, 2007),

Alzheimer's Disease

Alzheimer's disease (AD) is a progressive neurodegenerative disease that occurs globally; it is a common dementia that is related to memory loss and the gradual death of brain cells. Due to the accumulation of β-amyloid plaques and the activation of caspase, neurons undergo apoptosis,(Cheng *et al.,* 2012). Studied the activity of Nano cur cumin on AD. In their study, the formulated Nano cur cumin was orally administered to Tg2576 mice for three months, and the mice's memory was measured. Mice treated with Nano cur cumin showed better signal memory related to fear-related conditioning.

Cur cumin nanoparticles coated with PLGA are combined with Tet1 peptide, which has anti-amyloid and antioxidant properties and can be used as a potential drug for the treatment of AD, (Mukerjeeand Vishwanatha, 2009). Proliferation and neurogenesis of stem cells in the hippocampus and subventricular zone of adult rats by activating the Wnt / β-catenin pathway. Therefore, the use of Nano cur cumin proved to be the best treatment for AD, (Bhawana *et al.,* 2011).

CONCLUSION

Nanotechnology-based drug delivery systems overcome the limitations of traditional therapies. In this review, the medical applications of cur cumin nanoparticles are discussed. Cur cumin nanoparticles show higher stability, bioavailability, targeting specificity, controllable particle size and sustained drug release. Nano-emulsion, polymer nanoparticles, polymer micelles and other nanometer forms. As potential active ingredients, these nanoparticles can fight various diseases, such as cancer, microbial infections, AIDS, malaria, AD and inflammatory diseases, the treatment of age-related neurodegenerative diseases will be possible if a successful Nano medication based on cur cumin is developed.

RECOMMENDATION

Future medication delivery systems will rely heavily on Nano biotechnology-based drug carrier, and therefore nanoparticles will be a way of fighting various diseases, such as cancer, microbial infections, AIDS, malaria, AD and inflammatory diseases. In order to improve the safety and effectiveness of the drug, the focus of research should be on fighting the infected cells and releasing the drug in a non-toxic and controlled manner.

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