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The Pharmacognosy and Therapeutic Efficacy of Turmeric (Curcuma Longa): A Systematic Review

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Introduction

Turmeric (also known as curcumin) is a natural product originating and prevalent in many southeast Asian cultures, and classified as a member of the ginger family. It is recognized by its vibrant yellow hue. It is considered sacred, traditionally incorporated into cultural and religious rituals in association with the Hindu lord Krishna. Today it is still incorporated often into cooking as a preservative and for its distinct flavor, but is also a dietary supplement often used for its anti-inflammatory and anti-oxidant properties.

Methods

Tertiary text and primary sources, such as journal articles and literature reviews, were used to investigate the chemistry and pharmacognosy of curcumin. Electronic and computerized literature also analyzed the translation of pharmacognosy to therapeutic efficacy. Preliminary searches for studies, trial data and journal articles were conducted through PubMed and EmBase, as well as by handsearching and reviewing references from previous sources. Articles identified as relevant to defining clinical efficacy were systematically reviewed by examining the study design, methods and desired outcomes. The pertinent clinical trial data and journal reviews resulted in a concise, detailed summary, listed in table 1.

Chemistry and Pharmacognosy

Curcuminoids are phenolic compounds which are the main active constituents responsible for the bioactivity of turmeric. Other constituents of turmeric include terpenes, steroids and fatty acids, which contribute to its aromatic taste and smell. The skeleton carbon structure illustrates a central seven-carbon chain with conjugated double bonds and methoxy groups which contribute to the activity of the molecule.[1]

INFLAMMATORY MECHANISMS: Inflammatory mediators, such as tumor necrosis factor alpha (TNFa), cyclooxygenase-2 (COX-2) and Nuclear Factor -kB (NF-kB) contribute to the pathological conditions of various inflammatory conditions. Curcumin works to downregulate the production of TNFa at a transcriptional level and by interrupting TNFa mediated cell signaling. Curcumin's ability to suppress COX-2 mRNA leads to a decreased production of COX-2 and contributes to its anti-inflammatory properties. The inflammatory process can also be disrupted by inhibiting NF-kB.

ANTI-OXIDANT MECHANISMS: Free radical molecules cause damage to cell DNA and result in a wide variety of chronic diseases. Anti-oxidant properties of curcumin work to decreased the damage caused by these molecules by scavenging the molecules before they can damage the cell DNA. The hydroxyl groups and the ethyl group located on the diketone moiety of the curcumin molecule are accepted targets for free radical scavenging.

ANTI-HYPERLIPIDEMIA: The oxidation of low density lipoproteins (LDL) leads to atherosclerosis and plaque build-up in the blood vessels via mechanisms related to both free radical and non-radical oxidation. Turmeric displays cardioprotective effects by reducing the susceptibility to oxidation of low density lipoproteins, leading to decreased production of foam cells and interrupting the process of atherosclerosis. It does so by interfering with the LDL receptors and downregulating proprotein convertase subtilisin/kexin type 9 (PCSK9) expression.

ANTI-PRURITIC: Pruritus is a symptom that typically arises due to an underlying disease state, making it difficult to determine the source of the itching and therefore making it difficult to treat. Mechanisms contributing to pruritus may be related to oxidative stress and inflammation. Considering the therapeutic mechanisms of curcumin as previously discussed, theoretically it can be applied to the treatment of the pruritus.

Clinical Evidence

Results of the trials reviewed are summarized in Table 1.

Consumer Considerations

Turmeric is available as dietary supplement as defined under the Dietary Supplement Health Education Act (DSHEA) of 1994, and manufacturers of these supplements are not required to receive Food and Drug Administration (FDA) approval before marketing. They must, however, meet the same safety standards as food in regards to adulteration. Therapeutic efficacy of supplements is not required before marketing. Organizations outside FDA analyze and critically evaluate the quality of formulations and brands of various supplements. Some recommendations from ConsumerLab.com, based on their testing and assessment can be found listed in Table 2. Turmeric is well tolerated; common adverse effects systemically include dyspepsia, diarrhea, distension, nausea and vomiting, and topically, causes contact dermatitis. During pregnancy, it is expected to be safe when used in cooking in amounts commonly found in food, but may be possibly unsafe in medicinal amounts because it may stimulate the uterus. Limited evidence exemplifies its ability to cross through breastmilk, though no harm to breastfeeding infants has been reported.

Limitations

The low aqueous solubility and poor bioavailability are major limitations to regular curcumin use. It is poorly absorbed and quickly metabolized, both hepatically and intestinally. Various formulations of curcumin have been developed to help increase the bioavailability including nanocurcumin, liposomal encapsulations and micelles. Administering the curcumin along with a more lipophilic substance, such as fatty milk, or with a potent inhibitor of glucoronidation, such as piperine, will also increase its bioavailability. Though the clinical evidence may provide promising data, there are many limitations to consider when translating the data to clinical efficacy. Many of the studies completed were for periods shorter than three months, with a very small number of subjects, who had very specific characteristics, such as being previously exposed to a certain substance or symptoms of a disease. The studies themselves cannot be compared to each other or combined for a meta-analysis because of the varying and inconsistent populations studied.

Conclusions

Turmeric has a wide variety of uses, both traditionally and medically. The many mechanisms of its bioactivity enable it to be an efficacious therapeutic agent. However, the bioavailability limitations present restrict clinical use. The heterogeneity of the studies analyzed and the inability to extrapolate results to the average population are limitations to consider when interpreting the data, despite any promising evidence suggesting turmeric may work as a therapeutic agent.

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