

## Monograph



### *Curcuma longa* (Turmeric)

#### Description

*Curcuma longa*, a perennial herb, is a member of the Zingiberaceae (ginger) family. The plant grows to a height of three to five feet, and is cultivated extensively in Asia, India, China, and other countries with a tropical climate. It has oblong, pointed leaves and bears funnel-shaped yellow flowers.<sup>1</sup> The rhizome is the portion of the plant used medicinally; it is usually boiled, cleaned, and dried, yielding a yellow powder.

Dried *Curcuma longa* is the source of the spice turmeric, the ingredient that gives curry powder its characteristic yellow color. Turmeric is used extensively in foods for both its flavor and color. Turmeric has a long tradition of use in the Chinese and Ayurvedic systems of medicine, particularly as an anti-inflammatory agent, and for the treatment of flatulence, jaundice, menstrual difficulties, hematuria, hemorrhage, and colic. Turmeric can also be applied topically in poultices to relieve pain and inflammation.<sup>2</sup> Current research has focused on turmeric's antioxidant, hepatoprotective, anti-inflammatory, anticarcinogenic, and antimicrobial properties, in addition to its use in cardiovascular disease and gastrointestinal disorders.

#### Active Constituents and Pharmacokinetics

The active constituents of turmeric are the flavonoid curcumin and volatile oils including tumerone, atlantone, and zingiberone. Other constituents include sugars, proteins, and resins. The best-researched active constituent is curcumin, which comprises 0.3 to 5.4 percent of raw turmeric.<sup>2</sup> Pharmacokinetic studies in animals demonstrate that 40-85 percent of an oral dose of curcumin passes through the gastrointestinal tract unchanged, with most of the absorbed flavonoid being metabolized in the intestinal mucosa and liver.<sup>3,4</sup> Due to its low rate of absorption, curcumin is often formulated with bromelain for increased absorption and enhanced anti-inflammatory effect.

#### Antioxidant Effects

Water- and fat-soluble extracts of turmeric and its curcumin component exhibit strong antioxidant activity, comparable to vitamins C and E.<sup>5</sup> A study of ischemia in the feline heart demonstrated that curcumin pretreatment decreased ischemia-induced changes in the heart.<sup>6</sup> An *in vitro* study measuring the effect of curcumin on endothelial heme oxygenase-1, an inducible stress protein, was conducted

utilizing bovine aortic endothelial cells. Incubation (18 hours) with curcumin resulted in enhanced cellular resistance to oxidative damage.<sup>7</sup> Another *in vitro* study demonstrated that low concentrations of curcumin incubated with activated macrophages resulted in a decrease in mRNA levels and nitric oxide synthase activity. This study demonstrates curcumin's antioxidant role in down-regulating nitric oxide formation, a key element in inflammation and possibly in the process of carcinogenesis.<sup>8</sup>

### Hepatoprotective Effects

Turmeric has been found to have a hepatoprotective characteristic similar to that of silymarin. Studies have shown its hepatoprotective effects in protecting animal livers from a variety of hepatotoxic insults, including carbon tetrachloride (CCL<sub>4</sub>),<sup>9,10</sup> galactosamine,<sup>11</sup> acetaminophen (paracetamol),<sup>12</sup> and *Aspergillus* aflatoxin.<sup>13</sup> Its hepatoprotective effect is mainly a result of turmeric's antioxidant properties. In rats with CCL<sub>4</sub>-induced acute and subacute liver injury, curcumin administration significantly decreased certain liver enzyme values, resulting in decreased liver injury in the test animals compared to controls.<sup>10</sup> Turmeric extract inhibited fungal aflatoxin production by 90 percent when given to ducklings infected with *Aspergillus parasiticus* at concentrations of 5-10 mg/mL. Turmeric and curcumin were also found to reverse biliary hyperplasia, fatty changes, and necrosis induced by aflatoxin production. Curcumin alone had no effect on aflatoxin production.<sup>13</sup> Sodium curcumin, a salt of curcumin, also exerts choleric effects by increasing biliary excretion of bile salts, cholesterol, and bilirubin, as well as increasing bile solubility, therefore possibly preventing and treating cholelithiasis.<sup>14</sup>

### Anti-inflammatory Effects

The volatile oils and curcumin of *Curcuma longa* exhibit potent anti-inflammatory effects.<sup>15-17</sup> Oral administration of curcumin in instances of acute inflammation was found to be as effective as cortisone or phenylbutazone, and one-half as effective in cases of chronic inflammation.<sup>17</sup> In rats with Freud's adjuvant-induced arthritis, oral administration of *Curcuma longa* significantly reduced inflammatory swelling compared to controls.<sup>16</sup> In monkeys, curcumin was shown to inhibit neutrophil aggregation associated with inflammation.<sup>18</sup> *C. longa*'s anti-inflammatory properties may be attributed to its ability to inhibit pro-inflammatory arachidonic acid, as well as neutrophil function during inflammatory states. Curcumin may also be applied topically to animal skin to counteract inflammation and irritation associated with inflammatory skin conditions and allergies.<sup>17</sup>

### Anticarcinogenic Effects

Animal studies involving rats and mice as well as *in vitro* studies utilizing human cell lines have demonstrated curcumin's ability to inhibit carcinogenesis at three stages: tumor promotion,<sup>19</sup> angiogenesis,<sup>20</sup> and tumor growth.<sup>21</sup> In two studies of colon and prostate cancer, curcumin was found to inhibit cell proliferation and tumor growth.<sup>22,23</sup> Turmeric and curcumin are also capable of suppressing the activity of several common mutagens and carcinogens in a variety of cell types in both *in vitro* and *in vivo* studies.<sup>24-27</sup> The anticarcinogenic effects of turmeric and curcumin are due in part to direct antioxidant and free-radical scavenging effect; but, they also enhance the body's natural antioxidant system, increasing glutathione levels, thereby aiding in hepatic detoxification of mutagens and carcinogens, and inhibiting nitrosamine formation.<sup>28</sup>

## Antimicrobial Effects

Turmeric extract and the essential oil of *Curcuma longa* inhibit the growth of a variety of bacteria, parasites, and pathogenic fungi. A study of chicks infected with the caecal parasite, *Eimera maxima*, demonstrated that diets supplemented with one-percent turmeric resulted in a reduction in small intestinal lesion scores and improved weight gain.<sup>29</sup> Another animal study, in which guinea pigs were infected with either dermatophytes, pathogenic molds, or yeast, found that topically applied turmeric oil inhibited the dermatophytes and pathogenic fungi, but neither curcumin nor turmeric oil affected the yeast isolates. An improvement in lesions was observed in the dermatophyte- and fungi-infected guinea pigs, and at seven days post-turmeric application the lesions disappeared.<sup>30</sup> Curcumin has also been found to have moderate activity against *Plasmodium falciparum* and *Leishmania major* organisms.<sup>31</sup>

## Cardiovascular Effects

Turmeric's protective effects on the cardiovascular system include lowering cholesterol and triglyceride levels, decreasing susceptibility of low density lipoprotein (LDL) to lipid peroxidation,<sup>32</sup> and inhibiting platelet aggregation.<sup>33</sup> These effects have been noted even with low doses of turmeric. A study of 18 atherosclerotic rabbits given low-dose (1.6-3.2 mg/kg body weight daily) turmeric extract demonstrated decreased susceptibility of LDL to lipid peroxidation, in addition to lower plasma cholesterol and triglyceride levels. The higher dose did not decrease lipid peroxidation of LDL, but cholesterol and triglyceride level decreases were noted, although to a lesser degree than with the lower dose.<sup>32</sup> Turmeric extract's effect on cholesterol levels may be due to decreased cholesterol uptake in the intestines and increased conversion of cholesterol to bile acids in the liver.<sup>14</sup> The inhibition of platelet aggregation by *C. longa* constituents is thought to be via its potentiation of prostacyclin synthesis and inhibition of thromboxane synthesis.<sup>33</sup>

## Gastrointestinal Effects

Constituents of *Curcuma longa* exert several protective effects on the gastrointestinal tract. A salt of curcumin, sodium curcumin, was found to inhibit intestinal spasm, and p-tolymethylcarbinol, a turmeric component, was found capable of increasing gastrin, secretin, bicarbonate, and pancreatic enzyme secretion.<sup>34</sup> Turmeric has also been shown in rats to inhibit ulcer formation caused by stress, alcohol, indomethacin, pyloric ligation, and reserpine. This study demonstrated turmeric extract significantly increased the gastric wall mucus in rats subjected to these gastrointestinal insults.<sup>35</sup>

## Safety and Dosage

No significant toxicity has been reported following either acute or chronic administration of turmeric extracts at standard doses. At very high doses (100 mg/kg body weight), curcumin may be ulcerogenic in animals, as evidenced by one rat study.<sup>34</sup> Because of its numerous protective benefits, regular addition of turmeric to animal feed may be beneficial. For a specific therapeutic effect, the typical canine dosage of curcumin is 50-250 mg three times daily, depending on the size of the animal.<sup>36</sup> If using whole turmeric, the average canine dosage is one-half teaspoon twice daily. Feline dosages are in the range of 50-100 mg daily of curcumin and approximately one-quarter teaspoon daily if using whole turmeric. Equine dosages of curcumin are much higher due to the size of the animal, and range between 1,200 and 2,400 mg daily. Curcumin and turmeric research in these animals is limited and the dosages stated above are estimates only.

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