BIOLOGICAL ACTIVITIES OF TURMERIC (Curcuma longa Linn.) - AN OVERVIEW

Suman Vikas Bhat¹, Tawheed Amin², Saima Nazir¹
¹Department of Food Technology, Islamic University of Science & Technology, Awantipora, J&K, 1921 22 INDIA
²Division of Post-Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences & Technology-Kashmir, Shalimar Campus, Srinagar, Jammu & Kashmir 191 121 INDIA

Correspondence should be addressed to Suman Vikas Bhat

Received February 10, 2015; Accepted March 15, 2015; Published March 28, 2015;

Copyright: © 2015 Suman Vikas Bhat et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Cite This Article: Bhat, S., Amin, T., Nazir, S. (2015). Biological Activities of Turmeric (Curcuma longa Linn.) - An Overview. BMR Microbiology, 2(1). 1-5

ABSTRACT

Now-a-days, economic and medicinal importance of turmeric (Curcuma longa Linn.) is an established fact, besides further research methodology is practiced to reach the extreme and extensive value of its diverse pharmacological and other uses. It has been appreciably used in traditional medicine as a household remedy for various diseases. Its anti-inflammatory, anticancer and anti-oxidant properties if exploited efficiently may benefit mankind in colorful ways. It has a low toxic effect on body hence large doses can be given without any fear of toxicity that reflects its broad therapeutic index. This plant has benefited us of its various medicinal values besides other utilities.

KEY WORDS: Turmeric, biological activities, anti-bacterial, anti-fungal, anti-inflammatory

INTRODUCTION

The continuous evolution of bacterial resistance to currently available antibiotics has necessitated the search for novel and effective antimicrobial compounds. Globally, plant extracts are being employed for their antimicrobial activities. It is known that more than 400000 species of tropical flowering plants have medicinal properties and this has made traditional medicine cheaper than modern medicine (Odugoemi et al., 2006). Curcuma longa is a medicinal plant belonging to Zingiberaceae family (Chattopadhyay et al., 2004). It is commonly used as a spice, food preservative and colouring agent (Aggarwal et al., 2007; Menon et al., 2007). It is native to tropical South Asia but is now widely cultivated in the tropical and subtropical regions of world (Shiyonli et al., 2011).

In Ayurvedic medicine, it is primarily used to treat inflammation and in traditional Chinese medicine; it is used as stimulant, aspirant, carminative and cordeal, emenagouge astringent, detergent, diuretic and martyrnet (Jurenka et al., 2009; Remadevi et al., 2007).

Turmeric extract is an oleoresin consisting of a volatile oil fraction (light) and a yellow-brown colored (heavy) fraction. It contains a number of cucuminoinds, monoterpenoids and sesquiterpenoids (Singh et al., 2012). The compounds showing yellow colour are three curcuminoid compounds- curcumin, demethoxycurcumin and dismethoxycurcumin. Curcumin, a yellow bioactive pigment, is the major component of turmeric (Menon et al., 2007; Hatcher et al., 2008). The chemical formula of curcumin is C₁₂H₂₀O₆₃.

Curcumin shows a wide spectrum of biological activities such as antifungal (Chattopadhyay et al., 2004), antibacterial (Di Mario et al., 2007; Rai et al., 2008), antidiabetic (Aggarwal et al., 2007), anti-oxidant (Menon et al., 2007; Mohammad et al., 2005), anti-allergic (Suzuki et al., 2005), anti-cancer (Lotempio et al., 2005), anti-
inflammatory (Punithavathi et al., 2000, Siddique et al., 2006) and anti-protozoal (Reddey et al., 2005) activities. It has been reported that the volatile oil of C. longa possess anti-inflammatory (Chandra et al., 1972), anti-bacterial (Lutomaski et al., 1974; Banerjee et al., 1978) and anti-fungal activities (Banerjee et al., 1978). These curcuminoids are responsible for the yellow color of root. For quite a long time, turmeric has been used as a potent anti-inflammatory agent in both Chinese and Indian systems of medicine (Gescher et al., 2005). It has a great ability for wound healing. C. longa is often cultivated to harvest rhizomes for ground turmeric powder as a spice and food colouring agent. The plant has also been recognized as a pharmaceutical crop for the production of standardized therapeutic extracts (STES) or small therapeutic molecules (STMS) (Yuan et al., 2010). India is the largest producer of turmeric supplying over 90% of worlds demand (OloJede et al., 2009). There are about 70 cultivars or varieties of C. longa cultivated in India, some important regional trade varieties of turmeric are RAJAPURI, DUGGIRALA, CUDDAPPAH, BERHAMPUR, ERODE, NIZAMABAD, KORAPUT, KASTURI, CHAYA, KODUR, SALEMI, WAGON, KARUR etc. (Sasikumar et al., 2005).

CHEMICAL COMPOSITION OF TURMERIC

The chemical composition of turmeric and its essential oil (5.8% obtained by steam distillation of rhizomes) is shown in Table 1 and Table 2, respectively.

Table 1: Chemical composition of turmeric

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>13.1</td>
</tr>
<tr>
<td>Protein</td>
<td>6.3</td>
</tr>
<tr>
<td>Fat</td>
<td>5.1</td>
</tr>
<tr>
<td>Minerals</td>
<td>3.5</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>69.4</td>
</tr>
</tbody>
</table>

Source: (Kapoor et al., 1990)

Table 2: Chemical composition of steam distilled essential oil of turmeric rhizome

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-phellandrene</td>
<td>1.0</td>
</tr>
<tr>
<td>Sabinene</td>
<td>0.6</td>
</tr>
<tr>
<td>Cineol</td>
<td>1.0</td>
</tr>
<tr>
<td>Borneol</td>
<td>0.5</td>
</tr>
<tr>
<td>Zingiberene</td>
<td>25</td>
</tr>
<tr>
<td>Sesquiterpines</td>
<td>53</td>
</tr>
</tbody>
</table>

Source: (Kapoor et al., 1990)

Curcumin (diferuloylmethane 3-4 %) is responsible for the yellow color and comprises curcumin 1 (94%), curcumin 2 (6%) and curcumin 3 (0.3%) (Ruby et al., 1995). Dimethoxy and dismethoxy derivatives of curcumin have also been isolated (Vopel et al., 1990). Curcumin was first isolated in 1815 (Vogel and Pelletier, 1815) and its chemical structure was given by Roughly and Whiting (1973).

PHARMACOLOGICAL ACTIVITIES

Antibacterial activity

In 1993, Sankaranarayanan and coworkers carried out a study to evaluate the antibacterial activity of chloroform-ethanol water and petroleum-ether extracts of dried rhizome of turmeric. They used the extracts at a concentration of 250 mg/ml on agar plates. The results of the study showed antibacterial activity against Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa and Staphylococcus aureus. Another study was carried out by Naovi et al., in 1991 in which antibacterial assaying was done for ethanol (95%) and water extracts of dried rhizome of turmeric, each at a concentration of 10.0 mg/ml. It was found from the results that the ethanol (95%) extract did not show any activity on Corynebacterium diptheriae, Diplococcus pneumonia, Staphylococcus viridians and Streptococcus pyogenes. Water extract was also found to be ineffectve against Corynebacterium diptherie and Diplococcus pneumonia and produced weak activity against Staphylococcus aureus, Streptococcus viridians and Streptococcus pyogenes (Naovi et al., 1991). Several other researchers have studied different fractions of dried turmeric rhizome for their antibacterial activity. For example, Elkeltawi et al. (1980) studied the antibacterial activity of essential oil of turmeric rhizome on agar plate, the results of which showed no antibacterial activity against Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa and Staphylococcus aureus. Another researcher, Dhar et al. (1968) evaluated the ethanol extract of rhizome against Lactobacillus acidophilus, Staphylococcus aureus, Escherichia coli and Salmonella typhosa. It was contended from the results that the extracts were effective against the first three bacterial species, equivocal on Escherichia coli and inactive on Salmonella typhosa. In a study by Ross et al. (1980), undiluted essential oil on agar plate did not show any effect on Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa and Staphylococcus aureus.

Anti-fungal activity

A study was carried out by Acharait and co-workers in which the anti-fungal activity of chloroform, ethanol and water extracts was evaluated against Epidermophyton floccosum, Microsporum gypseum and Trichophyton rubrum. The results showed that chloroform and ethanol extracts of dried rhizome of turmeric on agar plate exhibited a good anti-fungal activity but water extract produced weak activity. Banerjee et al. (1978) evaluated the antimicrobial activity of essential oil of dried rhizome of C. longa on agar plate at a concentration of 1:100. It was found from the results that the extract was active on Trichoderma viride, Aspergillus flavus, Microsporum gypseum and Trichophyton mentagrophytes. Naovi et al. (1991) also carried out a study to evaluate the antimicrobial activity of water extract of dried rhizome. Naovi and his co-workers used the extract at a concentration of 10.0
An anti-inflammatory activity

Ethanol extract of dried rhizome administered intraperitoneally to male rats at a dose of 100 mg/kg was active vs. granuloma pouch model. Doses of 200 mg/kg, 400 mg/kg and 800 mg/kg were active vs. carrageen in induced pedal edema but on lowering the dose to 50.0 mg/kg, the extract was found to be inactive vs. granuloma pouch model. Water extract at doses of 5 mg/kg, 10 mg/kg, 20 mg/kg, 40 mg/kg and 80 mg/kg were active against carrageen in induced rat pedal edema. A dose of 10 mg/kg was inactive vs. granuloma pouch model but a dose of 20 mg/kg was active. Petroleum ether extract at a dose of 12.5 mg/kg was inactive against granuloma pouch model, 25 mg/kg was active vs. granuloma pouch model but inactive vs. carrageen in induced rat pedal edema. A dose of 50 mg/kg was active vs. carrageen in induced rat pedal oedema. A dose of 0.1 g/kg was equivocal. The water extract at a dose of 0.1 ml/kg was active vs. carrageen in induced pedal oedema (Gupta et al., 1972).

Anti-oxidant activity

Reactive oxygen species (ROS) are associated with many biological phenomena such as inflammation, carcinogenesis and aging (Amin et al., 2012). Todd et al. (1985), has reported the antioxidant effect of hexane and methanol extracts of rhizome at a concentration of 0.1%. They found that hexane extract of dried rhizome at a concentration of 0.06% was inactive when tested on lard however, the methanol extract was active (Lee et al., 1982). According to a study by Shalimn et al. (1987), hot water extract of a commercial sample of tuber was active vs. protection of DNA against per oxidative injury. Water extract of rhizome was active on rat brain vs. Fe$^{2+}$/ascorbate Fe$^{2+}$/TBH induced lipid per oxidation. The biological activity was highly dose dependent, IC$_{50}$ (median inhibitory concentration) 100 mcg/ml. The extract was also active vs. lipid per oxidation induced by TBARS, IC$_{50}$ 50 mcg/ml which means that the activity depends on the doses and varies with dose variation (Selvam et al., 1995).

Anti-coagulant activity

Kosuge et al. (1984), evaluated the anti-coagulant activity of ethyl acetate extract of dried rhizome. They fed the mice intraperitoneally at a dose of 0.1 g/kg which showed strong anti-coagulant activity. Ethyl acetate extract was found to have very strong anticoagulant activity. Results were found to be significant at $p < 0.01$ level. The water extract at a dose of 0.1 g/kg was equivocal.

Anti-implantation effect

Garg et al. (1974) studied the anti-implantation effect of petroleum ether extract and water extract of turmeric rhizome. Garg and co-workers fed the rats at a dose of 100 mg/kg and 200 mg/kg and contended from the results that there was 80% and 100% reduction in implantation effect respectively.

Embryo toxic effect

A study was carried out by Garg and coworkers in 1978 in which ethanol (95%) extract of rhizome after administering orally to rats at a dose of 100 mg/kg and 200 mg/kg produced 70% and 80% inhibition of pregnancy, respectively. Water extract produced 80% and 100% inhibition respectively (Garg et al., 1978).

Anti-viral activity

Cai et al. (1988), showed in a study that hot water extract of dried rhizome in cell culture was active on vesicular stomatitis virus. The prescription included 10g each of Curcuma longa rhizome, Rheum officinale root, Cinchonae foetida rhizome, Anemarrhena asaphodeloides rhizome, Areca catechu seed, Magnolia officinalis bark and Scutellaria baicalensis root along with 5g Amomum tsaooko fruit, together with insects Bombyx mori and Cryptotympana pustulata. May et al. (1978), reported that...
Formation of labeled benzo[a]pyrene-DNA adducts was inactive on rat liver microsomes. A concentration of 0.033 mg/ml was active on Salmonella typhimurium TA100 vs Aflatoxin B1 induced mutagenesis. Metabolic activation had no effect on the results. Dried rhizome extract on agar plate at a concentration of 50 mg/ml was inactive on rat liver microsomes and the formation of labeled benzo[a]pyrene-DNA adducts was inhibited. Infusion at a concentration of 2 mcg/plate on agar plate was active on Salmonella typhimurium TA100. 1-methyl-3 nitro-1-nitroguanidine-induced mutagenesis was inhibited by 25%. There was a 38% inhibition of 4-nitro-D-phenylenediamine-induced mutagenesis of S. typhimurium TA98. Infusion of rhizome administered intra-gastric to mice at a dose of 3mg/animal was active. The incidence of benzo[a]pyrene induced bone marrow micro nucleated cells was decreased 40% by pre-treatment with the extract (Azuine et al., 1992). Powdered rhizome at a concentration of 0.033 mg/ml was active on rat liver microsomes. Formation of labeled benzo[a]pyrene-DNA adducts was inhibited (Deshpande et al., 1995). Powdered rhizome administered intra-gastric to rats at a dose of 0.5% of the diet was active. Animals fed the diet for one month before being given 3-methylcholanthrene intraperitoneally, produced urine with reduced mutagenicity on S. typhimurium strains TA100 and TA98, with or without activation with S9, as assessed by Ames test (Polasa et al., 1991).

Anti-diabetic effect
Curcumin has been found to possess anti-diabetic effect and helps in the prevention of galactose-induced cataract at very low doses (Suryanarayana et al., 2003). Both turmeric and curcumin decrease blood sugar level in alloxan-induced diabetes in rats (Arun et al., 2002). Curcumin also decreases advanced glycation end products induced complications in diabetes mellitus (Sajithhal et al., 1998).

Anti-protozoan activity
The ethanol extract of turmeric rhizome has anti-Entamoeba histolytica activity. Curcumin has anti-Leishmania activity in vitro (Koide et al., 2002). Several synthetic derivatives of curcumin have anti-L. amazonensis effect (Gomes et al., 2002). Anti-Plasmodium falciparum and anti-L. major effects of curcumin have also been reported (Rasmussen et al., 2000).

Antispasmodic activity
Turmeric has been found to show antispasmodic activity. Ethanol/water (1:1) extract of rhizome is found to be active on the ileum of guinea pigs (Dhar et al., 1968).

Anti-venomous activity
Araujo et al. (2001), has reported that Ar-turmerone isolated from C. longa, neutralizers both haemorrhagic activity of Bothrops venom and 70% lethal effect of Crotalus venom in mice. It acts as an enzymatic inhibitor of venom enzymes with proteolytic activities (Ferreira et al., 1992).

CONCLUSION
Keeping in view the above mentioned biological properties of Curcuma longa, it is quite clear that turmeric being available in pure form, it would be easier to develop new drugs which can be more effective with less side effects. In recent years, it has been seen that there is a continuous enthusiasm in treating various diseases with natural products. Due to being nontoxic with a wide spectrum of biological functions, turmeric may find its application in the formation of various medicinal products which can help in the treatment of various diseases in coming future.

REFERENCES