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A Touch of Turmeric: Examining an Ayurvedic Treasure

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Turmeric, or *Curcuma longa*, is a perennial root plant of the ginger family. This plant originates from Asia and is widely grown and used in India. South Asians have used turmeric for its medicinal purposes for centuries and it has become integrated into spiritual life as a symbol of protection and purity (Ravindran et al. 2007). Turmeric acts as a powerful healing tool because of the phytochemicals it contains. The main phytochemical in turmeric is curcumin. Research shows that curcumin provides anti-cancerous, anti-inflammatory, and anti-microbial health effects, among others. Curcumin may not be as beneficial as turmeric in its entirety due to variation in bioavailability (Martin et al., 2011). This extrapolation should be taken into consideration when attempting to reap the benefits of turmeric in the West.

Keywords: Alternative; Medicine; Ayurveda; Ayurvedic; *Curcuma longa*; Curcumin; Phytochemical; Turmeric

Introduction

From afar, human-plant interactions serve the mere purpose of sustenance; the ability to provide the body with necessary amounts of caloric energy to produce adequate levels of ATP for daily functions. This attitude towards diet is a prevalent one in modern society. Moreover, the West is further detached from nutrition in that the purpose of eating is centered on enjoyment and palatable satisfaction. Meat is available, cut, cleaned, and packaged in plastic, ready for cooking. Produce is grown miles away from home and covered in pesticides to increase shelf life. Most consumers in the US have never set foot onto a farm, never seen the animal that their meat comes from, and never touched the soil where their vegetables and fruits were once rooted. The cognitive disconnect between food and sociocultural aspects of life are ever growing. The idea of nourishment in its most holistic form is diminishing.

But upon closer examination of the importance of food, it becomes apparent that sustenance is just one facet of human-plant co-evolution. These interactions are steeped in cultural significance and medicinal value that enrich health when used with well-informed knowledge. For example, turmeric is a plant that is integrated into a myriad of aspects within South Asian culture, but also contains many phytochemicals that serve a variety of medicinal purposes. It is no coincidence that this plant has simultaneously been revered in this region of the world and provided wondrous health benefits to users. Through human-plant co-evolution, turmeric has become a revered societal staple, but it also comprises of many biochemical properties that are beneficial to human health.

Methods and Materials

This paper was written in order to understand the human-plant interactions of turmeric, a spice of South Asian origin. The University of North Carolina—Chapel Hill Library system was utilized to search for journal articles on turmeric and its history, chemical composition, and health effects and conduct a meta-analysis of these data. Key search terms included turmeric, curcumin, curcuminoids, anticarcinogen, antimicrobial, and anti-inflammatory. The comprehensive book, *Turmeric*: *The Genus Curcuma*, by Ravindran et al. (2007) was used for a review of historical and cultural related information. Several studies were reviewed that provided analysis of research showing the benefits of curcumin in various forms and tests. Lastly, the benefit and use of this plant was put into context of use in Western Society.

Background

The Turmeric is known as the "golden spice" and has strong sociocultural ties to the people of India and its surrounding sister countries. Many South Asian cultures have been using this earthy spice for thousands of years for medicinal purposes as well as cultural uses (Rathaur et al., 2012). The ancient Vedic societies of India regarded it as "the herb of the sun" because of its yellow-orange rhizome. In fact, there is at least 6000 years of documented use of the spice (Ravindran et al., 2007).

Also known by its Latin classification, *Curcuma longa*, turmeric is part of the Zingiberaceae or ginger family (Majeed et al., 1996). Its geographic origin is not agreed upon; though, the plant most likely originated in Cochin, China and was brought to the Indian subcontinent through either Chinese migration to the Northeast Indian region or by Buddhist monks traveling through the region. Once introduced into the subcontinent, *Curcuma longa* most likely replaced most of the indigenous variants of the species (Ravindran et al., 2007). Ravindran et al. (2007) document 53 synonyms for turmeric, all referring to its

various benefits and characteristics in Sanskrit. Today, there is a word for turmeric in various languages across the globe from Burmese to Portuguese. Even though many cultures from different world regions knew of turmeric, only recently has it come into the lime light of research and American marketing.

Turmeric is currently grown in several Asian countries and parts of South America. However, India remains the largest producer, producing over 500,000 metric tons annually and exporting nearly half (Bengmark et al., 2009). Major importers of Indian turmeric include the United Arab Emirates, followed by US, Japan, United Kingdom, Iran, Singapore, Sri Lanka, and South Africa (Ravindran et al., 2007).

Religious Significance

Turmeric is used in countless aspects of Hindu culture. These sacred implications are likely related to the health benefits of turmeric. Ancient inhabitants may have been attracted to the vibrant saffron color of the root; subsequently, the health benefits that followed the use of the root led to the belief that the plant was sent from the heavens (Ravindran et al., 2007).

In Hindu weddings the women wear a *mangalasutra*, or nuptial necklace. This necklace is usually made of black and gold beads. However, in several regions of India, including Andhra Pradesh and Tamil Nadu, a raw piece of turmeric can be threaded and worn around the neck to symbolize the *mangalasutra.* Both the wealthy and poor use the turmeric, differing only in the material of the chain, i.e. gold or thread. When worn as an amulet or charm, turmeric is believed to ward off evil spirits (Ranvindran et al., 2007). Newlyweds perform many rituals to deter the evil eye of jealous onlookers.

Another use of turmeric in marriage rituals is from the Punjabi tribe of the *Dandasis*. Here, the elder most patriarchal figure of the community places a nut cutter and areca nut (*Areca catechu*) into the hands of the bride and groom and ties the nut seven times with a thread that has been dyed with turmeric. The parents then proceed to pour turmeric from either a conch shell or leaf over their hands, signifying the end of the ceremony (Ravindran et al., 2007). In the Tamil tribe of *Tareya*, the front door of every household invited to the wedding is painted with fresh turmeric paste.

At almost every Hindu ritual a yellow and deep-red powder are present at the altar. These two powders are used for holy rites. The yellow powder is turmeric in its basic ground form, and the red is the alkalized for of turmeric, which turns a vibrant red after reacting with acid (Aggarwal et al., 2007).

Diet

In India, particularly in the southern regions, turmeric is incorporated into the daily diet through cooking. Bengmark et al. (2009), estimates, "that adult Indians consume daily 80 - 200 mg curcumin per day". Many staple dishes like lentils are prepared using a sautéed seasoning of spices. Of this seasoning, turmeric is a common ingredient. The spice adds flavor and also gives the food a pleasing golden color (Ranvindran et al., 2007).

According to Aggarwal et al. (2007), curcumin, the active component in turmeric, is hydrophobic but soluble in ethanol, dimethylsulfoxide, acetone, and oil. This solubility in oil would make turmeric easier to digest in a cooked form. Furthermore, Bengmark et al. (2009) explains, "It is also reported to be dramatically elevated by co-ingestion of peperine (a component of pepper (*Piper longum*)), demonstrated both in experimental animals and humans." (p: 275). Thus the effectiveness of turmeric is amplified due to its use in cuisine as shown by the benefits of co-ingestions with pepper.

Traditional Medicine

The Many different traditional healing systems, such as Ayurveda, Sidha, Unani, and Tibetan, have incorporated the use of turmeric in their practices (Ravindran et al., 2007). Ayurveda is still heavily practiced in modern India, and turmeric is still used to treat "biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism, and sinusitis" (Shishodia et al., 2007).

Commercial Use

Turmeric is used in other industries beyond traditional household and medicinal purposes. In India, for centuries, turmeric was used to dye cloth yellow. In fact, the yellow color of the cloth was considered sacred and purifying, as it was yellow/orange like fire, an element symbolic of eradicating impurities (Ravindran et al., 2007). The British tried to use the dye for non-clothing purposes but had no luck in that the dye was too dull and not permanent enough for heavy commercial use. Indian calico painters later developed a paint that was a mixture of turmeric, pomegranate, and aluminum. Currently, use of turmeric for commercial dyeing has ceased but it is still used as a common food additive to reach the desired yellow tinge in many dishes (Ravindran et al., 2007). In America, the food industry uses curcumin as a coloring agent in "cheese, spices, mustard, cereals, pickles, potato flakes, soups, ice cream, and yogurt" (Shishodia et al., 2007).

Chemical Composition

The chemical composition of turmeric is vital to fully comprehending turmeric's benefits. According to Rathaur et al. (2012), the structure of turmeric is comprised of protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (23.1%). The essential oil (5% - 8%) obtained by steam distillation of rhizomes has α-phellanderene (1%), sabiene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%) (p: 1988). One study in India conducted by Nayak et al. (2011) that examined the properties of extracted oil of turmeric rhizomes found the chemical composition of the oil through gas chromatography mass spectrum analysis. The oil examined was predominantly composed of r-tumerone (49.1%) followed by curlone (16.8%), a-phellandrene (5.3%), ar-curcumene (3.5%), eucalyptol (2.6%), b-sesquiphellandrene (1.8%), b-caryophyllene (0.8%), b-bisabolene (0.6%) and d-3-carene (0.3%) (Nayak et al., 2011). The complexity of the chemical composition of turmeric, as with many other foods, is essential to the health benefits it provides.

Of the ingredients listed above, the group to be cogitated is curcuminoids. Curcuminoids (see **Figure 1**) are a group of polyphenols found in turmeric that have been shown to provide numerous health effects. Polyphenols are a group of phytochemicals found in various plants, such as cabbage (*Brassica oleracea*), tea leaves (*Camellia sinensis*), chili peppers (*Capsicum annuum*), and turmeric (*Curcuma longa*). These phyto

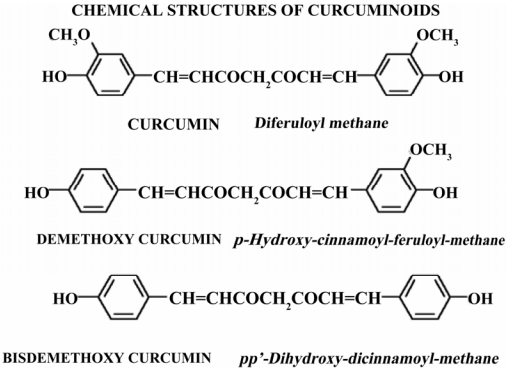

Figure 1[*].
Chemical structure of curcuminoids.

chemicals reduce inflammation and therefore reduce susceptibility to a multitude of diseases (Bengmark et al., 2009).

Curcuminoids have many different mechanisms within the body that prevent and aid in the treatment of several diseases. Some of these include, a reduction in LDL oxidation, cell membrane stabilization, and an increase in antioxidant plasma concentrations, which aid in the treatment of atherosclerosis (Bengmark et al., 2009). Another disease that has seen promising benefits from curcumin use is cancer. Cancer is also positively affected by curcuminoids through induced apoptosis of harmful cells and inhibited metastasis (Bengmark et al., 2009).

Several curcuminoids are found in turmeric, but of these polyphenols, the most isolated and studied compound is curcumin. The presence of curcumin in turmeric has been known for some time, however only recently has interest spiked in exploring its benefits through extensive studies (Bengmark et al., 2009).

In its isolated form, curcumin has a low bioavailability due to the fact that it is highly stable in acidic solutions and is poorly soluble within water (Martin et al., 2011). Normally, foods are digested in gastric acid within the stomach but curcumin stays stable throughout this process.

These chemical properties give turmeric the ability to heal many different types of diseases and are the reason that ancient societies venerated turmeric as a holy substance. There are many studies proving the anti-disease properties South Asian societies have known for thousands of generations. The studies reviewed in this paper look at anti-cancerous, anti-inflammatory, and anti-microbial properties.

Results

Anti-Carcinogenic Effects of Turmeric

As mentioned, curcumin has been shown to be a powerful natural agent in cancer treatment. Carcinogenesis occurs by means of several biological pathways and through the deregulation of hundreds of molecules. Curcumin reduces cancer growth by targeting several of these pathways and preventing deregulation of molecules (Shishodia et al., 2007). One example of a biological pathway that curcumin protects is the transcription factor, NF-kB. NF-kB translocates to the nucleus from the cytoplasm on contact with free radicals, cytokines, tumor promoters, and other harmful stimuli. Here, at the nucleus, NF-kB is thought to induce the expression of over 200 genes that suppress apoptosis and induce cell proliferation and chemoresistance. These changes are extremely harmful for both early and late stages of cancer. Research by Shishodia et al. (2007) shows that curcumin suppresses the activation of this transcription factor.

Another biological pathway that is aided by curcumin use is the p. 53 tumor suppressor. p. 53 regulates many biological processes including cell signal transduction, cellular response to DNA damage, genomic stability, cell cycle control, and apoptosis (Shishodia et al., 2007). This tumor suppressor also induces the p. 21 gene, which regulates apoptosis of cells with damages DNA and cancer cells. The mutant p. 53 protein loses its ability to induce action of the p. 21 gene and therefore increases the risk of cancer. Curcumin, however, induces apoptosis independent of the mutant p. 53 gene, therefore making up for any loss from silencing of the p. 21 gene (Shishodia et al., 2007). These examples illustrate how curcumin fights cancerous cells through mediation of various biological malfunctions.

Anti-Inflammatory Effects

Inflammation is an underlying issue in an array of diseases, from heart disease to Alzheimer's disease (Berkeley, 2008). Gingivitis is a form of periodontal disease that stems directly from inflammation of the gums. When plaque and tartar are not removed from teeth, they irritate gums and cause inflammation (PubMed Health, 2012). A study conducted by Behal et al., (2012) observed 60 subjects of ages 15 and up for 21 days. Half the study population rinsed their mouths with a turmeric mouth wash, while the other half used a chlorohexidine wash. Chlorohexidine is a standard wash used in dentistry offices. The subjects were instructed to rinse for approximately one minute, 30 minutes after brushing their teeth.

Both rinses showed significant reduction in plaque on the 14th day and further reduction on the 21st day. Behal et al. (2012) explains, "anti-inflammatory action of turmeric was evaluated on clinical parameters using the gingival index, which showed significant reduction. This suggests that turmeric has an anti-inflammatory property." Furthermore, there were minimal side effects like staining and bitter taste with use of turmeric mouthwash, but chlorohexidine also showed these side effects in users. Both the turmeric wash and chlorohexidine wash showed anti-inflammatory, anti-plaque and anti-microbial properties, but the turmeric wash had fewer adverse side-effects, therefore further research should be conducted to implement the use of turmeric wash.

Anti-Microbial Effects

Turmeric is believed to have anti-microbial properties. For centuries it has been used to help heal open wounds and infections (Aggarwal et al., 2007). A study performed at Siksha O Anusandhan University in Orissa, India by Nayak et al. tested the anti-microbial properties of turmeric oil. The study strived to evaluate the effects of turmeric rhizome oil on eye infections, in hopes that the essential oil could replace the use of conventional antibiotics (Nayak et al., 2011). The experimental method started by harvesting the leaves and rhizomes of the turmeric plant from a medicinal plant garden in the Centre of Biotechnology, Bhubaneswar, Orissa. These harvests were then immediately put through a distillation process for oil extraction.

[*]**Figure 1**: http://www.sabinsa.com/newsroom/paper_curcumin.html.

The plant material was cleaned and cut into slices and mixed with distilled water. This mixture went through hydro-distillation using Clevenger's apparatus. The extracted oil was then put through gas chromatography testing for initial analysis and then was tested with test microbes. The microbes being monitored were *Staphylococcus aureus* (MTCC-3160), *Pseudomonas aeruginosa* (MTCC-424), *Candida albicans* (MTCC-183) and *Aspergillus niger* (MTCC-281). The four microbes were chosen, as they are indicator microbes for common human infections. These microbes were plated and turmeric rhizome oil was loaded on the plates in volumes of 2, 5, and 10 microliters. These plates were then incubated at 37˚C overnight (Nayak et al., 2011).

The GC-MS analysis showed that the primary component of the essential oil to be r-tumerone (49.1%). The ratios of the various components in the rhizome oil differed from study to study because various studies use turmeric cultivated from different regions. This study predicts that turmeric roots from the high altitude regions of Orissa will be very sought-after in national and international health markets due to the high content of r-tumerone which increases the medicinal value of the oil.

Of the indicator microbes *S. aureus* saw the most reduction. *P. aeruginosa*, *C. albicans*, and *A. niger* saw lower levels of reduction in decreasing order. The results of this study show that turmeric essential oil may hold significant bactericidal properties but weaker fungicidal properties (Nayak et al., 2011). When attempting to market essential oil for ocular infections, bacterial infections should be targeted over fungal infections.

This is the first study that showed curcumin as a potential anti-microbial agent for pathogens of ocular infections. In recent times, the public has become concerned over synthetic antibiotic use. Additionally, conventional antibiotics for sensitive organs such as ears and nose are having serious side effects, even at low concentrations (Nayak et al., 2011). Therefore, this may be the perfect time to introduce turmeric oil as a potential medication.

Discussion

Consequences of Curcumin Extraction

The discovery of curcumin is promising to so many medical fields. Therefore, in recent years, the health industry of the West has marketed supplements of curcumin extract. According to Bengmark et al. (2009), the standard dosage of curcumin is 400 - 600 mg of curcumin a day. This is the equivalent of 60 mg of fresh turmeric root.

Martin et al. 2011 of the University of Louisville School of Medicine performed a study aimed to "compare and contrast the bioavailable distribution of curcumin and turmeric as well as to look at the molecular effects these compounds have on pro- and anti-inflammatory markers" (p: 228). The study observed 35 rats that were put on a control, curcumin, and turmeric diet. The curcumin group was fed 700 pmm or 0.7 g/kg diet of curcumin, and the turmeric group was fed 14,000 ppm or 14 g/kg diet of turmeric for a total of 3 months. It is important to note that the dosages of curcumin and turmeric given to rats in the experiment are much higher than the recommended dosages for human intake.

Throughout the study, all rats showed a stable weight relative to the other groups. Both curcumin-fed and turmeric-fed rats saw a steady increase for the first half of the trial and a steady decrease for the second half. Analysis suggested that turmeric has a higher bioavailability. The turmeric group saw a significant increase in the degree of fold change of key molecular markers. Specifically, the turmeric diet increases the levels of IL-6 (1.9-fold, $p = 0.05$), iNOS (4.39-fold, $p = 0.02$), IL-8 (3.11-fold, $p = 0.04$), and COX-2 (2.02-fold, $p = 0.05$). However, the curcumin group saw no significant change in the degree of fold change in any molecular markers (Martin et al., 2011). The results from this study show that the turmeric diet was more bioavailable than the curcumin diet and therefore had more of an effect on pro-inflammatory genes (Martin et al., 2011).

Further deduction from this study suggests that prescribed use of turmeric incorporated into the regular diet or supplement of whole turmeric may demonstrate more positive results than curcumin alone. As opposed to recommending the standard 400 mg of curcumin supplementation a day, health specialists could recommend using the 60 mg of fresh turmeric. The issue with incorporating turmeric into the diet is a lack of knowledge in the U.S. on how to cook with the spice and a matter of lifestyle. With less time to prepare food, Americans are more likely to take the easy route and use curcumin. However, the best option in this case may be to promote turmeric powder supplements as opposed to curcumin capsules.

Integrating Ayurvedic Knowledge into Western Treatment

As the West becomes more acquainted with Eastern culture through the proliferation of inter-continental exchanges in a modern global economy, the realization that Western medicine in its current form is not meeting all the needs of its patients is becoming increasingly apparent. According to Francis C. Assisi (2007), a writer for *India Currents* magazine, Americans have been questioning the fundamentals of traditional allopathic medicine for over thirty years. Ayurvedic advocates like Dr. Vasant Lad and Maharishi Mahesh Yogi have initiated an interest in discovering better ways to prevent and treat disease which align with the pillars of Ayurveda. In other words, treating the individual from a perspective of amalgamating the body, mind, and spirit. More frequently, patients turn to alternative forms of therapy like acupuncture, diet-based treatments, and even meditation for chronic and non-chronic illnesses alike. In fact, in 2003, California passed the Health Freedom Act (SB 577), which allows for non-traditional medicine practitioners to consult with patients without fear of violating the Medical Practice Act, which prohibits non-physicians to provide medical services (Assisi, 2007).

Many physicians are becoming aware that a combination of allopathic and alternative medicine is the most effective way to treat patients. In regards to a nationwide clinical trial of curcumin supplementation for 30 days in patients showing levels of pre-cancerous biomarkers, Dr. Frank Meyskens of UC Irvine (2007) remarks, "Though it has been used for centuries in traditional medicine, we're very early in the clinical development of curcumin as a chemopreventive agent" (Assisi, 2007). One of the foremost cancer researchers in the United States, Dr. Bharat B. Aggarwal of the University of Texas M.D. Anderson Cancer Center in Houston believes that expanding knowledge of alternative medicine is the only thing that will decrease cancer rates. He explains, "Recent statistics indicate that the overall cancer incidence in the United States, in spite of billions of dollars

spent on research each year, has not changed significantly in the last half-century... Ayurveda can be used in combination with modern medicine to provide better treatment of cancer." (Assisi, 2007). This realization put into practice could potentially decrease cancer rates that have remained stagnant.

An issue that arises in bringing Ayurveda to America and other western societies is striking the right balance between making the art marketable to a new audience as well as staying true to the colors of an ancient teaching. Ayurveda is rooted in a holistic treatment of body, mind, and soul, and this spiritual approach cannot be totally eliminated to reach an American audience, or the art will chance degradation. Americanizing the teachings of Ayurveda may risk losing essential elements of prescription that require a holistic, complete understanding. For example, turmeric shows a propensity to cure many different ailments, but Ayurveda may prescribe that turmeric be consumed with different foods for different health problems.

However, forcing a completely untouched version of Ayurveda in a foreign, modern culture may only repel potential beneficiaries. Alakananda Devi is a British-borne physician earning her medical degree in London and currently directing the Alandi Ayurvedic Clinic and its *gurukula* in Boulder, Colorado. She comments, "In offering Ayurveda to the West, there is no need to bring about conversion to either Hinduism or Buddhism. However, we must always walk in the spirit of *sanatana dharma* (Universal righteousness), honoring its essential teachings of truth and ahimsa (non-violence), of reverence for the indwelling mystery within all things animate and inanimate, and of striving for *loka sangraha*, the welfare of the Whole" (Assisi, 2007).

In essence, Ayurvedic treatments, including that of turmeric use, are very valuable to Western societies. They may even fill some of the many holes that allopathic medicine has not been able to. While this ancient practice is being introduced into the West, using it with a cultured understanding for its roots is imperative. Nevertheless, Ayurveda will have to adapt to the likings of American to make its way into our practices.

Conclusion

Many studies show promising results for the efficacy of turmeric and its active ingredient curcumin against many important diseases. Bacterial and carcinogenic diseases alike can be treated with this plant-based compound with apparently minimal adverse side-effects.

Use of curcumin as compared to the use of turmeric should be further studied to determine whether there is a loss of benefit when extrapolating and using key ingredients in isolation.

The integration of turmeric into society started thousands of years ago and the evolution is continuing today. Integration of the plant into modern Western society will undoubtedly reveal new understandings and uses for an age old plant.

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