

Potential of Curcumin in Turmeric as a Preventive Modality from Covid-19 in Pregnant Women

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ABSTRACT

Coronavirus disease 2019 (Covid-19) is a state of health emergency and global concern. Unfortunately, there is no effective therapeutic strategy available in dealing with Covid-19 infection. This can endanger risk groups, especially pregnant women. Various studies are competing to develop the therapeutic potential of Covid-19 from herbal compounds, one of which is curcumin. This study aims to determine the potential of curcumin in turmeric as a preventive modality from Covid-19 in pregnant women. This paper uses literature study. Based on the results obtained, the anti-viral, anti-inflammatory, anti-oxidant and anti-coagulant effects in curcumin play an important role in preventing the development of the SARS-CoV-2 virus in humans based on various mechanisms. Low doses of curcumin have also been proven safe for consumption by pregnant women. Therefore, routine and low-dose curcumin supplementation can prevent Covid-19 infection in pregnant women.

INTRODUCTION

Coronavirus disease 2019 (Covid-19) is a health emergency and global concern, caused by a coronavirus belonging to the family Coronaviridae which has a single and sensitive RNA of 26 to 32 kb (Weiss and Leibowitz, 2011; Tay *et al.*, 2020). A new member of this virus family, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) which can cause Covid-19, emerged in late 2019 in Wuhan, China and has become a pandemic and ongoing health problem until now (Cascella *et al.*, 2020).

Individuals susceptible to the virus have been reported to be elderly (>65 years), individuals with compromised immune systems, meaning those with chronic or other underlying infections, and include pregnant women (Haung *et al.*, 2020). Reports indicate that women are more susceptible to respiratory infections during pregnancy (Rothan and Byrareddy, 2020). However, there are currently no reports of mother-to-child transmission of the coronavirus, due to the protective effect of the placenta against the virus (Mor and Cardenas, 2010). In another study, the placenta has been shown to have ACE2 receptors on villous cytotrophoblasts and syncytiotrophoblasts and findings suggest that

coronavirus enters host cells via these ACE2 receptors (Li *et al.*, 2020). This allows an increased risk of mother-to-child transmission of the virus and has the potential to threaten the health of the mother and fetus.

Both normal pregnancy and COVID-19 are characterized by decreased lymphocytes, NKG2A inhibitory receptors, and increases in ACE2, IL-8, IL-10, and IP-10. Although the exact mechanism of the pathogenesis of Covid-19 is not fully understood, it appears that aberrant immune responses play an important role in disease progression (Ghaebi *et al.*, 2020). According to recent studies, increased secretion of cytokines and pro-inflammatory mediators, such as interleukin (IL)-1 β , IL-6, IL-7, IL-8, IL-18, interferon (IFN)- γ , tumor necrosis factor (TNF)- α , monocyte chemoattractant peptide (MCP)-1, and granulocyte-colony stimulating factor (GCSF), in Covid-19 patients trigger acute inflammation and hyper-immune response, causing lung tissue damage and sometimes even ARDS (Conti *et al.*, 2020). On the other hand, there is a pro-inflammatory phase in first and third trimester pregnant women. These conditions create a suitable environment for Covid-19.

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Curcumin (also known as diferuloylmethane), as a herb from turmeric which comes from a plant called "curcuma longa". Curcumin is a polyphenol of diacyl heptanoids with the chemical formula 1,7-bis (4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione (Gupta *et al.*, 2013). For many years, curcumin has been used in health problems because of its anti-inflammatory, antioxidant and anti-cancer effects, which are related to the activity of the methoxy group (Valizadeh *et al.*, 2020). In addition, curcumin, as an immunomodulatory agent, is able to prevent the development of tissue damage and inflammatory diseases. According to different studies, curcumin can affect the immune system by inhibiting the production of reactive oxygen species (ROS) in macrophages, increasing the expression of CD80 and CD86 in dendritic cells (DC), modulating T cell proliferation and function (Bose *et al.*, 2015), regulating secretion of proinflammatory cytokines and adhesion molecules, and ultimately regulate immune response patterns (Afolayan *et al.*, 2018; Trivedi *et al.*, 2017). Considering that inflammation is the epicenter of the etiopathogenesis of Covid-19, curcumin is thought to have the potential to modulate the inflammatory response and prevent the occurrence of this disease in pregnant women.

Although there is ample evidence of the effects of curcumin on the prevention of Covid-19 in the general population, studies discussing its effects on pregnant women are limited. Therefore, this study aimed to determine the potential of curcumin in turmeric as a preventive modality of Covid-19 in pregnant women. This study will also discuss the properties of curcumin that play a role in preventing Covid-19, the mechanisms involved and its safety for consumption in pregnant women.

Covid-19

SARS-CoV-2 is a member of the Coronaviridae family and the order Nidovirales. SARS-CoV-2 includes Betacoronavirus along with two highly pathogenic viruses, SARS-CoV and MERS-CoV. SARS-CoV-2 is an enveloped and positive-sense single-stranded RNA (+ssRNA) virus (Chen *et al.*, 2020; Master, 2019). The virus was originally transmitted from animals to humans, but is now rapidly spreading from humans to humans. Person-to-person transmission is thought to occur between close contact, mainly through respiratory droplets from an infected person coughing or sneezing. Vomiting may be a major source of transmission, as SARS-CoV has been found to persist on surfaces for up to 96 hours and other coronaviruses for up to 9 days (Kampf *et al.*, 2020; Ralph *et al.*, 2020).

Host-virus activity is regulated by several molecular interactions, including receptor binding. Further extensive structural analysis strongly suggested that SARS-CoV-2 could use the host receptor angiotensin-converting enzyme 2 (ACE2) to enter cells, the same receptor facilitating SARS-CoV to infect airway epithelium and alveolar type 2 (AT2) pneumocytes, lung cells that synthesize pulmonary surfactant (Wan *et al.*, 2020). Immediately upon binding to their receptive receptors, SARS-CoV-2 enters the host cell where they encounter the host's immune response. Given that Covid-19 and SARS have similar clinical features, SARS-CoV-2 may have a similar pathogenesis mechanism to SARSCoV. In response to SARS-CoV infection, the type I interferon (IFN) system induces the expression of IFN-stimulated genes (ISGs) to inhibit viral replication. To counter this antiviral activity, SARSCoV encodes at least 8 viral antagonists that modulate IFN and cytokine induction and evade ISG effector functions (Huang *et al.*, 2020)

The immune system's response to viral infection by mediating inflammation and cellular antiviral activity is critical for inhibiting viral replication and spread. However, it is the exaggerated immune response accompanied by the lytic effect of the virus on the host cell that leads to pathogenesis. Studies have shown that Covid-19 patients generally have symptoms of fever, dry cough, dyspnea, chest pain, fatigue, and myalgia. Less common symptoms include headache, dizziness, abdominal pain, diarrhea, nausea, and vomiting (Huang *et al.*, 2020; Wang *et al.*, 2020). Acute Respiratory Stress Syndrome (ARDS) and septic shock develop rapidly in some patients, which is eventually followed by multiple organ failure and approximately 10% of patients will die (Chen *et al.*, 2020).

As the development of this disease is very fast, WHO has issued guidelines for the diagnosis of this disease. Suspected cases of Covid-19 are persons (a) with a severe acute respiratory infection (history of fever and cough requiring admission to hospital) and without any other etiology that fully explains the clinical presentation and history of travel to or living in China for 14 years. the previous day for the onset of symptoms; or (b) patients with acute respiratory illness and at least one of the following during the 14 days prior to the onset of symptoms: contact with a confirmed or probable case of SARS-CoV-2 infection or working in or visiting a health care facility where the patient with SARS-CoV-2 acute respiratory illness confirmed or likely being treated. Possible cases are those for whom testing for SARS-CoV-2 was inconclusive or who tested positive using the pan-coronavirus test and without laboratory evidence of other respiratory pathogens. A confirmed case is a case

with laboratory confirmation of SARS-CoV-2 infection, regardless of clinical signs and symptoms (WHO, 2020). For patients who meet the diagnostic criteria for testing for SARS-CoV-2, the CDC recommends collecting specimens from the upper respiratory tract (nasopharyngeal and oropharyngeal swabs) and, where possible, the lower respiratory tract (phlegm, tracheal aspiration, or bronchoalveolar lavage) (Patel *et al.*, 2020).

Like MERS-CoV and SARS-CoV, there is still no specific antiviral treatment for Covid-19. Isolation and supportive care including oxygen therapy, fluid management, and antibiotic treatment for secondary bacterial infections are recommended. Symptoms of some Covid-19 patients progress rapidly to ARDS and septic shock, which is eventually followed by multiple organ failure. Therefore, the initial handling of Covid-19 must be directed at early identification of suspects and transmission of the disease by immediately isolating and controlling infection (Tang *et al.*, 2020; Habibzadeh and Stoneman 2020).

Controlling the chain of transmission is the key to stopping the spread of the disease. Several measures should be taken such as timely dissemination of pandemic information to eliminate the source of infection, rapid diagnosis of infected persons, reporting, isolation of infected persons, physical and psychological support and protection to reduce stress and mental problems during the Covid-19 pandemic (Sahin *et al.*, 2020). The CDC recommends basic actions such as washing hands, using disinfectants, avoiding contact with patients to prevent the spread of the virus. For example, the Chinese government has taken many effective measures, including closing public transport, reducing migration and promoting personal protection with masks, hygiene, and so on (Wang *et al.*, 2020).

Turmeric

Turmeric is a product of *Curcuma longa*, a rhizomatous herbaceous perennial plant belonging to the ginger family Zingiberaceae, native to tropical South Asia. A total of 133 species of ginger have been identified worldwide. Most of them have common local names and are used for various drug formulations. Turmeric plants need temperatures between 20°C and 30°C and a fairly high annual rainfall to thrive. This plant grows to a height of 1 m with long, oval leaves. Plants are collected annually for their rhizomes, and replanted from some of these rhizomes the following season (Benzie and Wachtel, 2011). The rhizome of turmeric origin is tuberous, with rough and segmented skin. The rhizomes ripen under the leaves on the ground. It is yellowish brown in color

with a dull orange interior. The main rhizome is tapered or tapered at the distal end and measures 2.5–7.0 cm (1–3 in) long and 2.5 cm (1 in) in diameter, with the smaller tubers branching. If the turmeric rhizome is dried, it can be ground into a yellow powder with a bitter, slightly spicy, but sweet taste (Kant *et al.*, 2014).

Turmeric consists of three groups of curcuminoids: curcumin (diferuloylmethane), demethoxycurcumin, and bisdemethoxycurcumin, as well as essential oils (tumerone, atlantone, and zingiberone), sugars, proteins, and resins. Curcumin is a lipophilic polyphenol that is almost insoluble in water but is quite stable in the pH of gastric acid. The phenolic groups in the structure of curcumin explain the ability of curcumin to scavenge oxygen-derived free radicals. Free radicals that can be removed by curcumin are hydroxyl radicals, singlet oxygen, superoxide radicals, nitrogen dioxide and NO (Labban, 2014; Rathore *et al.*, 2020).

Turmeric is often used in both Asian cuisines, both for its flavor for curries and for its distinctive yellow color. This plant is also used as a coloring agent in cheese, butter, and other foods. Turmeric has been used in Ayurvedic medicine primarily as an anti-inflammatory and for the treatment of jaundice, menstrual difficulties, hematuria, bleeding, and colic. It has been recognized in the Chinese pharmacopoeia as well as in other Asian countries such as Japan and Korea and its uses cover a wide range of health indications. In China, turmeric can be eaten directly and applied topically for urticaria and skin allergies, viral hepatitis, inflammatory joint conditions, sore throats and sores (Labban, 2014; Benzie and Wachtel, 2011).

Curcumin

Curcumin (1,7-bis (4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione), also known as diferuloylmethane, is the main natural polyphenol found in the rhizome of *Curcuma longa* (turmeric) and elsewhere. Other *Curcuma* spp. (Hewlings and Kalmna, 2017). *Curcuma longa* has been used traditionally in Asian countries as a medical herb due to its antioxidant, anti-inflammatory, antiviral, antimutagenic, antimicrobial, and anticancer properties (Vera-Ramirez *et al.*, 2013; Wright *et al.*, 2013).

a. Anti-viral activity

Curcumin has been demonstrated as a compound with various antiviral activities against various types of viruses: papillomavirus, influenza virus, Hepatitis B and C viruses, adenovirus, coxsackie virus, Human norovirus, Respiratory syncytial virus and Herpes simplex 1 (Yang *et al.*, 2017; Gupta *et al.*, 2017). This antiviral effect

is dose dependent. Curcumin can inhibit the activity of the enzyme inosine-mono phosphate dehydrogenase (IMPDH) both non-competitively and competitively. This inhibition leads to a decrease in the intracellular level of the guanine nucleotide required for the synthesis of viral RNA and DNA. The mechanism of curcumin involves viral entry or other stages of the life cycle rather than viral RNA replication. Therefore, with IMPDH inhibition curcumin has potential anti-proliferative, antiviral and antiparasitic effects (Rathore *et al.*, 2020).

b. Anti-inflammatory Activity

Curcumin has significant anti-inflammatory activity in both acute and chronic inflammatory models. Oral administration of curcumin in cases of acute inflammation was found to be as effective as cortisone or phenylbutazone. Oral administration of *Curcuma longa* significantly reduces inflammatory swelling. The anti-inflammatory properties of *C. longa* are related to its ability to inhibit the biosynthesis of inflammatory prostaglandins from arachidonic acid, and the function of neutrophils during inflammatory conditions. Curcuminoids also inhibit LOX, COX, phospholipase, leukotrienes, prostaglandins, thromboxane, nitric oxide elastase, hyaluronidase, collagenase, monocyte chemoattractant protein-1, interferon-induced protein, TNF and interleukin-12. In addition, this compound also reduces the formation of prostaglandins and inhibits leukotriene biosynthesis through the lipooxygenase pathway (Bundy *et al.*, 2004; Labban, 2014).

c. Anti-Oxidant Activity

Curcumin has been shown to increase systemic markers of oxidative stress, it can modulate the activity of GSH, catalase, and SOD enzymes which are active in neutralizing free radicals. A recent systematic review and meta-analysis of randomized control data related to the efficacy of supplementation with purified curcuminoids on oxidative stress parameters—showing a significant effect of curcuminoid supplementation on all investigated oxidative stress parameters including plasma SOD and catalase activity, as well as serum glutathione peroxidase concentrations. (GSH) and lipid peroxide (Sahebkar *et al.*, 2015). The effect of curcumin on free radicals involves several different mechanisms. These compounds can scavenge various forms of free radicals, ROS and RNS which can modulate the activity of GSH, catalase, and SOD enzymes which are active in neutralizing free radicals, can also inhibit ROS-producing enzymes such as lipooxygenase /

cyclooxygenase and xanthine hydrogenase / oxidase. In addition, curcumin is a lipophilic compound, which makes it an efficient peroxy radical scavenger and is considered a chain-breaking antioxidant such as vitamin E (Marchiani *et al.*, 2014; Lin *et al.*, 2007).

d. Anti-Microbial Activity

Turmeric extract and curcumin essential oil can inhibit the growth of various bacteria, parasites, and pathogenic fungi. In addition, curcumin suppresses the biofilm formation of *P. gingivitis* homotypic and *Streptococcus gordonii* in a dose-dependent manner (Tsekova *et al.*, 2017). Curcumin was also found to have moderate activity against the main organisms *Plasmodium falciparum* and *Leishmania*. The extract showed antifungal activity against *Trichophyton longifusus* and *Microsporum canis* and weak antibacterial activity against *Staphylococcus aureus*. Toxic activity was also observed in *Lemna minor* (No *et al.*, 2017).

e. Anti-Cancer Activity

Curcumin is able to suppress the activity of several common mutagens and carcinogens in various cell types in both in vitro and in vivo studies. Studies involving mice, as well as in vitro studies utilizing human cell lines, have demonstrated the ability of curcumin to inhibit carcinogenesis at three stages: tumor promotion, angiogenesis, and tumor growth (Garg *et al.*, 2008). The anticancer properties of turmeric and curcumin are due to their ability to induce cancer cell apoptosis and inhibit angiogenesis. In addition, indirectly, curcumin can increase glutathione levels which play a role in liver detoxification from mutagens and carcinogens. The active antioxidant properties and good free radical scavenging ability are certainly one of the reasons for the anticancer properties of curcumin (Bayomi *et al.*, 2008).

Curcumin Intake for Pregnant Mothers

Covid-19 is generally a respiratory disease, but manifests in severe cases with symptoms of systemic inflammation leading to complications such as ARDS, AKI, and myocardial injury. Currently, there is no effective therapeutic strategy for treating Covid-19 infection. Currently, there is increasing evidence of the antiviral potential of several herbal compounds (Saber-Moghaddam *et al.*, 2021). These phytochemical indications have attracted attention because of their proven efficacy and safety based on ethnomedicinal reports. Curcumin, the bioactive ingredient of turmeric, is a good example of a phytochemical with a multi-mechanistic mode of action. The ability

of curcumin to affect the viral replication cycle systemically, inhibit proinflammatory pathways and scavenge free radicals makes this compound a candidate for the prevention and treatment of Covid-19 and other viruses (Robert *et al.*, 2020).

As an anti-viral, curcumin uses its pleiotropic effect as a regulator of the viral replication cycle. Some of the effects of curcumin, such as inhibiting viral infection by targeting viral penetration and attacking components required for viral replication. Recently a molecular study showed that curcumin has a very good receptor binding ability so that it can inhibit the entry of the Covid-19 virus. ACE2 is a receptor that binds to the SARS-CoV-2 glycoprotein spine that facilitates membrane fusion and viral infection via endocytosis. Therefore, spine glycoproteins are potential drug target candidates to suppress the entry of COVID19 into cells while preventing the attachment and internalization of the virus in various organs, such as the liver, cardiovascular system, and kidneys (Zahedipour *et al.*, 2020). In the treatment of Covid-19, curcumin has shown binding affinity for the protein S receptor binding domain (RBDS), the ACE2 protease domain, and the main protease SARS-CoV-2 (6LU7) (Khaerunnisa *et al.*, 2020). Thus, it can prevent adhesion to the host cell and prevent the cleavage of early viral polyproteins to make functional proteins for further viral replication. In addition, Ting Du *et al.* studied the effect of curcumin on the synthesis of negative strand RNA by using PEDV or cell membranes as coronavirus models. They demonstrated that curcumin could inhibit PEDV at the replication stage. The amount of plaque was reduced when exposed to curcumin which indicates that curcumin can inhibit viral replication (Ting *et al.*, 2018). This evidence supports the potential role of curcumin as a promising antiviral agent.

As the results of various studies, curcumin is one of the strongest anti-inflammatory agents. Curcumin, also a prominent immune modulating factor, suppresses the expression of several pro-inflammatory cytokines, such as IL-6, IL10, TNF-, COX-2, IL-1 β , IL-12, and chemokines by suppressing NF- signaling. B (Robert *et al.*, 2020). According to several studies, curcumin is able to reduce mRNA expression and secretion levels of IL-1, IL-6 and TNF- α in inflammatory diseases (Yetkin *et al.*, 2020; Mouzaoui *et al.*, 2012). A meta-analysis also revealed that curcumin was able to decrease the amount of circulating IL-6 in patients with systemic inflammation (Derosa *et al.*, 2016), whereas a similar effect of curcumin on TNF- was observed in another meta-analysis. (Sahebkar *et al.*, 2016). This proves that curcumin acts as an anti-inflammatory and immunomodulatory agent and is

able to decrease the proliferation and differentiation of inflammatory cells and related cytokines.

The anti-inflammatory effect on the expression of these pro-inflammatory cytokines can also prevent inflammation, fibrosis, and edema in the pulmonary and cardiovascular systems. Curcumin has anti-inflammatory and anti-fibrotic effects by decreasing the expression of various pro-inflammatory cytokines involved in lung infections including factor- κ B and MAPK pathways (Ferreira *et al.*, 2015). Furthermore, curcumin has been shown to reduce collagen in an experimental model of pulmonary fibrosis induced by whole-body irradiation, bleomycin and cyclophosphamide (Zahedipour *et al.*, 2020). Downregulation of NF-B activity and stabilization of hypoxia-inducible factor 1-alpha (HIF1- α) leading to downregulation of angiogenic molecules such as VEGF followed by reduction of pulmonary edema and albumin extravasation in rat bronchoalveolar lavage fluid studies (Titto *et al.*, 2020).

Covid-19 is also known to activate the coagulation cascade secondary to ARDS, hypoxia, and the subsequent production of tissue factors that trigger a hypercoagulable state that sometimes leads to DIC. In many cases, the main side effect of curcumin consumption is increased bleeding (Robert *et al.*, 2020). However, in the treatment of Covid-19, this effect is positive. An in vivo study found curcumin and BDMC significantly increased aPTT and PT times, and inhibited the formation of thrombin and factor Xa (Kim *et al.*, 2012). These blood coagulation-inhibiting properties of curcumin also include inhibiting platelet aggregation, the cyclooxygenase pathway, and blocking calcium signaling (Roy *et al.*, 2020). It was concluded that daily consumption of turmeric or curcumin may help maintain anticoagulant status, and thus represent another beneficial effect of curcumin in the treatment of Covid-19.

Curcumin is a powerful antioxidant that has the electron transfer ability to scavenge various intracellular small oxidative molecules. Curcumin can regulate glutathione (GSH) expression, and inhibit the formation of reactive oxygen species (ROS) and malondialdehyde (MDA) (Abrahams, *et al.*, 2019; Farzaei *et al.*, 2018). Curcumin (200 mg/kg) reduced malondialdehyde (MDA) levels and restored xanthine oxidase (XO) and total antioxidant capacity (TAOC) levels in ventilator-induced lung injury in rats (Wang *et al.*, 2018). Similarly, curcumin (200 mg/kg) increased SOD activity and decreased MDA content in the lungs in acute injury caused by sepsis (Xiao *et al.*, 2012). Therefore, curcumin has the potential to have antioxidant properties that are beneficial in the treatment of SARS-COV-2-mediated oxidative stress in the lungs.

The protective properties against Covid-19 given by curcumin can be used in groups at risk of Covid-19,

one of which is pregnant women. However, the use of curcumin in pregnant women is still lacking. A study stated that giving pegylated curcumin to rats had negative effects on reproductive function, such as uterine contractions and bleeding that led to miscarriage or early delivery. (Murphy *et al.*, 2012). Meanwhile, in vitro studies have shown that curcumin is safe for the development of mouse embryos. A recent study showed that curcumin did not affect maternal blood pressure and proteinuria, or interfere with fetal development, which supports the view that curcumin is safe for pregnancy (Zhou *et al.*, 2016).

Importantly, curcumin is recommended in pregnant women in low doses to prevent adverse effects on kidney and liver function. Intake of curcumin 0–3 mg/kg daily has been recommended by the World Health Organization (WHO) (Ghaneifar *et al.*, 2020). However, oral doses of up to 12 g/day for 3 months are well tolerated in human subjects, and the United States Food and Drug Administration (US FDA) has declared curcumin to be a GRAS compound (generally recognized as safe) (Mahendra *et al.*, 2016). In a two-generation reproductive toxicity study in Wistar rats, there was no proven detrimental effect on pregnancy outcome in two successive generations, even at high doses of curcumin 850 mg/kg. Curcumin was also shown to suppress methylglyoxal-induced apoptosis in mouse ESC-B5 cells and blastocysts by blocking ROS production, indicating its safety for the fetus (Ganiger *et al.*, 2007).

Curcumin has low bioavailability, but many data from clinical trials show high efficacy of curcumin or turmeric against several diseases (Kunnumakkara *et al.*, 2019). Various strategies including curcumin analogues and formulations such as adjuvants, nanoparticles, liposomes, micelles, and phospholipid complexes have been developed to enhance this biopotential (Kunnumakkara *et al.*, 2017). Recently, studies have shown that encapsulation of curcumin into specific nanocarriers can enhance its therapeutic efficacy (Moballegh Nasery *et al.*, 2020). The most interesting is black pepper (Piperine). This plant can increase the bioavailability of curcumin up to 2000% by inhibiting the curcumin metabolic pathway (Panahi *et al.*, 2015).

Routine low-dose curcumin supplements are best recommended as a preventive measure against Covid-19 in pregnancy because it blocks the entry of the virus and provides antiviral effects. In its prophylactic use, curcumin may decrease viral load, potentially causing depression and preventing clinical manifestations in certain patients. As a treatment option, it should not be overlooked as an adjunct

therapy in developed and developing countries where medical supply chains are not as robust and access to modern medicines may be limited. Curcumin is a non-toxic, cost-effective, over-the-counter, and readily available drug for prevention and treatment in pregnant women.

CONCLUSION

Curcumin as one of the ingredients of turmeric has a preventive as well as therapeutic potential against Covid-19 infection in pregnant women. The anti-viral, anti-inflammatory, anti-oxidant and anti-coagulant effects of curcumin play an important role in preventing the development of the SARS-CoV-2 virus in humans. Various mechanisms are also involved as the basis for each of these effects. Curcumin has also been shown to be safe for consumption during pregnancy when used in low doses. Therefore, low-dose and routine curcumin supplementation can prevent the occurrence of Covid-19 infection in pregnant women.

This study shows that low-dose and routine curcumin supplementation can prevent the occurrence of Covid-19 infection in pregnant women. This can be the basis for further research to develop the effectiveness, strength and safety of this therapeutic opportunity, especially in pregnant women. Curcumin can also be a non-toxic, cost-effective and easy-to-obtain Covid-19 preventive effort. If this potential continues to be developed to increase demand in the market, this will certainly open up agribusiness opportunities from turmeric. This condition is also supported by the increasing number of pregnancies. This agribusiness opportunity must be supported by various related parties, such as the government, health workers and the community so that there is an increase in the quantity and quality of cultural products as well as improving the quality of curcumin farmers.

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