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FORMULATION AND EVALUATION OF HERBAL TABLET OF CURCUMIN FOR ANTICANCER ACTIVITY

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Abstract:

This thesis examines the effectiveness of curcumin against breast cancer and provides a compelling case for their value as cancer preventatives.Given that free radicals are primary factor behind the occurrence of cancer, phytochemical analysis of the chosen plant reveals the presence of flavonoids, which have strong antioxidant activity and are also known to be useful in treating malignant development. Curcumin and its analogous compounds, such as eugenol, eugenol orthodimer (also known as bis-eugenol or 3,3'-dimethoxy-5,5'-di-2-propenyl-1,1'-biphenyl-2,2'-diol), and isoeugenol, were examined to assess their impact on cell toxicity, ability to generate reactive oxygen species (ROS), and capacity to scavenge radicals. This article discusses the properties of curcumin, a yellow pigment present in the rhizome of the Curcuma longa plant. Curcumin has been extensively researched due to its various biological impacts, such as anti-inflammatory and antioxidant properties. The article delves into the underlying biological mechanisms and potential therapeutic benefits of utilizing curcumin as a treatment in cancer therapy. A natural substance with excellent therapeutic potential is curcumin. Numerous studies have demonstrated the wide range of biological activities of curcumin, one of which is its potent anti-inflammatory properties. A physiological and pathological process that is both complex and widespread is inflammation. A tablet is a unit solid dose form that includes the active drug, together with any necessary excipients. These dose forms are the most often utilized.

Keywords: Curcumin, Cytotoxicity, ROS (reactive oxygen species), Cancer, Curcuma Longa, Tablet.

INTRODUCTION

CURCUMIN:

The primary component within turmeric, referred to as curcumin (scientifically known as diferuloylmethane), originates from the underground stem of the East Indian plant Curcuma longa. Curcuma longa, a perennial plant belonging to the ginger family (Zingiberaceae), is native to Southeast Asia. Within turmeric, there exist curcuminoids, a group of substances which encompass curcumin, desmethoxycurcumin, and bisdemethoxycurcumin.[1] Among these, curcumin, the principal curcuminoid, constitutes approximately 2-5% of turmeric, responsible for both the spice's distinct yellow hue and a substantial portion of its medicinal properties. Beyond its role as a food enhancer and colorant, turmeric has a rich history of use in Ayurvedic medicine due to its recognized antioxidant, antibacterial, pain-relieving, antimalarial, and anti-inflammatory characteristics. Curcumin has been employed as a dietary supplement since ancient times, and it is widely regarded as having a favorable safety profile from a pharmacological perspective.[1] Plants or biometabolites include a number of substances similar to curcumin. The unprocessed drug "Turmeric" contains curcuminoids like curcumin, monodemethoxycurcumin, and bisdemethoxycurcumin. It is well known that the active metabolite of curcumin is tetrahydrocurcumin (THC).[2][3]

Anti-Cancer plants:

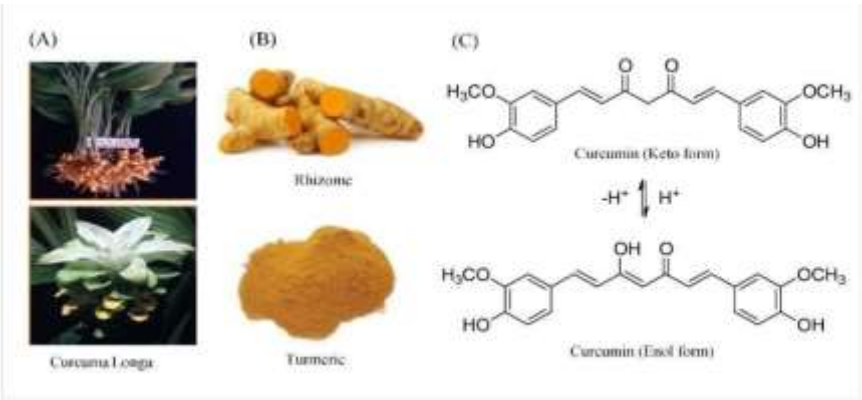
The use of natural products, particularly plants, for medicinal purposes has a rich history that spans across different cultures and civilizations. For thousands of years, terrestrial plants have been employed as remedies in various societies, including ancient Egypt, China, India, and Greece. Many modern pharmaceuticals have their origins in plant-based compounds. The earliest documented evidence of the therapeutic use of plants dates back to around 2600 BC. In India, Ayurvedic medicine has a long tradition of using herbal remedies. Knowledge of Ayurvedic formulations and principles has been recorded in texts like those from the Susruta and Charaka periods, dating back to about 1000 BC. The ancient Greeks also made significant contributions to the field of herbal medicine. Dioscorides, a Greek physician who lived around 100 A.D., authored a work titled "De Materia Medica," which detailed the uses of more than 600 medicinal plants. The use of plants as a source of therapeutic agents continues to be an area of interest and research, with many natural products forming the basis for new drugs and treatments.[4][5]

Turmeric (Curcuma longa) is a flowering plant belonging to the Zingiberaceae family, which is also known as the ginger family. It is primarily cultivated for its rhizomes, which are used for various purposes, including culinary and medicinal applications. The plant is native to the Indian subcontinent and Southeast Asia. Turmeric is a perennial herbaceous plant that grows from rhizomes, which are underground stem structures.[6] These rhizomes are the part of the plant that is harvested and used. Turmeric requires specific climatic conditions to grow well. It thrives in temperatures ranging from 20 to 30 °C (68 to 86 °F) and requires a substantial amount of annual rainfall to support its growth. The bright yellow or orange pigment of turmeric is due to a compound called curcumin, which also contributes to its various health benefits. The rhizomes of the turmeric plant are typically harvested, dried, and ground to produce the vibrant yellow powder that is commonly used in cooking to add flavor and color to dishes. Beyond its culinary uses, turmeric has gained attention for its potential medicinal properties, including anti-inflammatory and antioxidant effects.[7][8]

TAXONOMY:[9]

Scientific Name: Curcuma Longa
Family: Zingiberaceae
Kingdom: Plantae
Sub-Kingdom: Tracheobionta-Vascular plants
Order: Zingiberals
Super-division: Spermatophyta
Division: Magnoliophyta– Flowering plants
Class: Lilliopsida- monocotyledons
Sub-class: Zingiberidae
Genus: Curcuma L. curcuma
Species: Curcuma longa L
Synonym: Diferuloymethane

Used: Leaf, Root and Bark Flower.[10]



(1E, 6E)-1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5 dione

Figure: Chemical Structure of Curcumin

Synonyms:[11]

Common Name: Curcuma Longa

English: Turmeric

Hindi: Haldi

Marathi: Halad

Sanskrit: Ameshta

Bengali: Halud

Telugu: Haridra

Tamil: Ameshta

French: Curcuma

Indonesian: Kunyit

Malay: Kunyitbasah

Chemical Information:

Chemical Formula: C21H20O6

Molecular Mass: 368.385 g/mol

Pharmacokinetic Data: -

Bioavailability 100 %

Solubility Poor in Soluble

Half-life 6 to 7 hours

Appearance: Vibrant yellow-orange powder

Melting Point: 183°C (361°F; 456 K)

Description:

Curcumin, a vibrant yellow compound, is synthesized by plants belonging to the Curcuma longa species. It serves as the primary curcuminoid found in turmeric (Curcuma longa), a member of the ginger family known as Zingiberaceae. This substance is marketed as an herbal supplement, an ingredient in cosmetics, a food enhancer, and a food dye. From a chemical standpoint, curcumin falls within the category of diarylheptanoids, specifically among curcuminoids.[12] These are phenolic pigments responsible for imparting the characteristic yellow hue to turmeric. Despite its various applications, neither laboratory experimentation nor clinical research have substantiated any medical utility for curcumin. The compound is challenging to study due to its inherent instability and limited bioavailability. As a result, it is improbable to yield valuable insights for pharmaceutical development.[13]

Structure Activity Relationship of Curcumin:

The Structure-Activity Relationship (SAR) of curcumin and its derivatives refers to the correlation between the chemical structure of these compounds and their biological activities. In the case of curcumin and its various derivatives, researchers study how specific modifications to the molecular structure affect their efficacy, potency, and interactions with biological targets.[14]

Some key points in the SAR of curcumin and its derivatives include:

Functional Groups: Modifications or substitutions of functional groups in curcumin's structure can lead to changes in its activity. For instance, altering the phenolic groups may affect antioxidant or anti-inflammatory properties.

Substituents: Adding or changing substituents on the curcumin molecule can influence its bioactivity. Different substitutions can enhance solubility, stability, and binding to target proteins.[15]

Conjugation and Ring Modifications: Changing the conjugation pattern or modifying the aromatic rings can impact biological activity. These alterations might affect the compound's ability to interact with enzymes, receptors, or other biomolecules.

Stereochemistry: Isomeric forms of curcumin may have varying effects due to differences in spatial arrangement. Stereochemistry

can influence how a molecule interacts with enzymes or receptors.[16]

Bioavailability Enhancements: Many studies focus on modifying curcumin's structure to improve its bioavailability, as the native form has limited absorption. Derivatives might include delivery systems, nanoparticles, or prodrugs.[17]

Target Specificity: Structural modifications can lead to derivatives with improved selectivity for specific molecular targets, potentially reducing off-target effects.[18]

Toxicity and Safety: Altering the structure of curcumin can impact its toxicity profile. Some modifications might enhance safety or reduce potential adverse effects.[19]

Pharmacokinetics: Changes in the structure can influence the compound's absorption, distribution, metabolism, and excretion, affecting its overall pharmacokinetic profile.[20]

Synergistic Effects: Combining curcumin derivatives with other compounds might lead to synergistic effects, enhancing therapeutic outcomes.[21]

Research in this field aims to optimize curcumin derivatives for various applications, such as drug development, nutraceuticals, and medical treatments. By understanding how structural changes influence biological activities, scientists can design derivatives with improved properties and potentially unlock new therapeutic avenues.[22][23]

Uses[24]:

a) Natural antioxidant curcumin has anti-inflammatory properties.

b) A number of cancers can be treated and prevented with its help.

c) It is a long-term therapeutic choice for osteoarthritis patients that is secure andproductive.

d) Curcumin has been found to increase the levels of brain-derived neurotrophic factor (BDNF). BDNF is a crucial protein that supports the growth, survival, and function of neurons in the brain.

e) Curcumin has demonstrated positive effects on several factors that are associated with heart disease. It is known to have anti-inflammatory, antioxidant, and anti-thrombotic properties.

f) Joint inflammation is a typical feature of the condition known as arthritis. there is a growing body of research that suggests the potential effectiveness of curcumin in treating the signs and symptoms of arthritis.

g) The most popular uses for turmeric are as a cosmetic ingredient, in dietary supplements, as afood flavoring (such as in the South and Southeast Asian beverages with turmeric flavoring), and as a food colouring (such as in curry powders, mustards, butters, and cheeses).

h) the active compound found in turmeric, is indeed used as a food additive to provide an orange-yellow coloring to prepared foods. In the European Union, it is assigned the E number E100, which is a classification for food additives permitted for use in the EU.

i) Additionally, it has FDA approval to be used as food colouring in the US.

General Information and History:

Cancer, the second most life-threatening condition, stands as a significant global public health challenge. In 2018 alone, approximately 1.73 million new cancer cases were diagnosed, leading to over 609,000 cancer-related deaths in the United States. Despite notable advancements in cancer treatment, both the reported incidence and mortality rates have not shown improvement over the past three decades.[25] Curcumin's distinctive anticancer effectiveness is predominantly achieved through two main mechanisms: inducing apoptosis and hindering tumor growth and invasion via the inhibition of several cellular signaling pathways. Various studies have demonstrated curcumin's anticancer potential across an array of cancer cell lines, including those associated with breast cancer, lung cancer, head and neck squamous cell carcinoma, prostate cancer, and brain tumors. However, despite its numerous advantages, curcumin faces limitations.[26] The natural substance curcumin, which belongs to the diarylheptanoid class of

substances known ascurcuminoids, is derived from the underground stem of the East Indian plant Curcuma longa L., commonly referred to as turmeric. Desmethoxycurcumin, bisdemethoxycurcumin, and cyclocurcumin are the other three main curcuminoids found in turmeric; collectively, they are referred to as the curcuminoid complex.[27]In traditional Asian medicine, the turmeric plant and the remedies derived from it boast an extensive history of therapeutic utilization. The unprocessed, frequently dried plant material is commonly used as a food component in curry spices, which frequently also include a variety of additional substances. Additionally, Turmeric and its derivatives hold a prolonged legacy of being employed as dietary supplements and herbal remedies, chiefly to address a range of inflammatory conditions.[28][29] Although a significant portion of studies have concentrated on its biological attributes, a handful of others have been drawn to the crucial chemistry of curcumin that underlies its distinct biological action. For chemists working in span various domains of chemistry, encompassing organic, inorganic, physical, and analytical chemistry, curcumin research has emerged as one of their most popular topics. The primary focus of research in organic chemistry revolved around the extraction and synthesis of curcumin, as well as the creation of innovative synthetic compounds. In the realm of inorganic chemistry, emphasis was placed on the exploration of the -diketo group, which have harnessed its metal chelating properties to create novel structural entities with altered biological functions.[30][31]

As a nutritional supplement, curcumin is offered by numerous businesses. Dietary supplements are controlled as foods, not pharmaceuticals, in the United States.[32] Therefore, In cases where explicit claims for disease prevention or treatment are not asserted, premarket evaluation and approval from the U.S. Food and Drug Administration (FDA) are not required. Dietary supplements that are judged dangerous by the FDA may be taken off the market. Ingredients in dietary supplements may differ significantly from lot to lot because manufacturing consistency is not regularly reviewed for them. Furthermore, there is no assurance that the components listed On product labels, it is indeed necessary to ensure that the claims or stated quantities are accurate and truthful. Curcumin use as a cancer or other medical condition treatment has not received FDA approval.[33]

Anti-cancer Activity: Inhibition of Carcinogenesis

Curcumin has been investigated for its impact on various human carcinomas, such as melanoma, head and neck, breast, colon, pancreatic, prostate, and ovarian cancers. Epidemiological studies explain India's low prevalence of colon cancer by the curcumin-rich foods' chemo preventive and antioxidant effects. Curcumin's anti-cancer properties are multifaceted, targeting multiple levels of regulation in cellular development and apoptosis processes.[34] It operates across various stages of carcinogenesis, spanning from the initial events triggering DNA mutations to tumorigenesis, growth, and metastasis. Apart from its vertical impact on transcription factors, oncogenes, and signaling proteins, curcumin also exerts influence across these different temporal stages of carcinogenesis. With its diverse array of actions and impacts on cellular development control mechanisms, curcumin stands as a promising contender for potential use as a chemotherapeutic agent against a wide range of human malignancies.[35]

Curcumin's impact on cancer-related processes is extensive and involves multiple mechanisms: NF-κB Pathway Suppression: Curcumin targets the NF-κB pathway, reducing the expression of NF-κB-regulated genes like TNF, COX-2, cyclin D1, c-myc, MMP-9, and interleukins. This inhibits key factors involved in carcinogenesis. IKB Activity Inhibition: Curcumin obstructs IKB (inhibitor of NF-κB) activity, disrupting the NF-κB signaling cascade and subsequently hindering the expression of pro-cancer genes. Cell Cycle and Apoptosis Control: Curcumin's effects on p16 and p53 overexpression contribute to controlling the cell cycle and promoting apoptosis, preventing uncontrolled cell growth. Angiogenesis and Metastasis Inhibition: Curcumin modulates autophagy and suppresses various growth factors, including VEGF, COX-2, MMPs, and ICAMs. This dual action impedes tumor angiogenesis (formation of new blood vessels) and metastasis (cancer spread). Overall Anti-Inflammatory and Anti-Growth Effects: By targeting multiple factors and pathways, curcumin creates an environment that discourages cancer development, growth, and spread. It's important to recognize that while these actions have been observed in various studies, the translation of curcumin's effects from the lab to clinical applications involves complexities and challenges. Clinical trials are essential to determine its efficacy and safety in treating cancer in humans displays inhibitory effects during the early stages of carcinogenesis. Curcumin has been demonstrated to have the capacity to inhibit DNA mutagenesis brought on by UV radiation and to promote cellular SOS functions. Curcumin also affects the Phase I and Phase II enzymes within the hepatic cytochrome P450 enzyme system, which play roles in oxidizing and detoxifying harmful substances. These effects are in addition to curcumin's capability to inhibit nitric oxide (NO) production and its scavenging ability for DNA-damaging superoxide radicals. Phase I enzymes, including

cytochrome P450 isoforms and p450 reductase, which become active in response to toxin exposure and generate various carcinogenic metabolites during the oxidation of such substances, have been discovered to be inhibited by curcumin during the early stages of carcinogenesis. Curcumin activates Phase II enzymes (such as glutathione S-transferase, glutathione peroxidase, and glutathione reductase) that play a role in the detoxification of hazardous compounds. In numerous animal models representing diverse tumor types, including oral cancer, mammary carcinoma, and intestinal tumors, curcumin's inhibitory effects on carcinogenesis have been demonstrated.[36][37][38]

Curcumin's effects on cancer:

Multiple studies have substantiated that curcumin exerts potent anti-cancer effects by restraining the development of new blood vessels from existing ones, a process known as angiogenesis. Angiogenesis involvesa number of processes, including endothelial cell activation, proliferation, invasion, and migration. Multiple inhibition of these stages by curcumin has been demonstrated to inhibit angiogenesis in many malignancies.[39] Additionally, research revealed that curcumin suppressed VEGF Receptor signaling in vivo to prevent lymph Angiogenesis encompasses the growth of new lymphatic vessels, a pivotal process that holds a significant role in the metastatic spread of cancer. Many fried foods are used in Indian diets, which may also contributeto gastrointestinal tract malignancies as a result of the cooking process, which produces heterocyclic amines (HA) that are potentially carcinogenic or mutagenic. According to certain animal research, giving mice traditional Indian foods like deep-fried veggies caused a 20% increase in stomach cancer. Contrary to other nations, India's stomach tumour incidence rates are considered to be moderate tolow. Since stomach tumours are frequently caused by the cancer-causing bacterium Helicobacter pylori, The substantial utilization of natural substances like turmeric might contribute to elucidating their protective effects against cancer. Anticancer mechanism of bioavailable curcumin along with a few examples of tumours that curcumin or curcumin composites increased.[40][41]

Colon Cancer

The challenge of achieving effective dosages of phytochemicals through oral administration, particularly from dietary sources, is a notable issue in harnessing the anti-cancer benefits of these bioactive compounds found in foods and plants. In a study by Aromokeye and Si, the combination of two phytochemicals, curcumin and luteolin, both present in food, demonstrated a stronger inhibitory effect on colon cancer growth. The research delved into potential molecular mechanisms underlying this anti-colon cancer action. The combined treatment of curcumin (Cur) at 15 M and luteolin (LUT) at 30 M (C15L30) effectively suppressed the proliferation of human colon cancer CL-188 cells. This synergistic effect was also observed in additional colon cancer DLD-1 cells, showcasing the potency of C15L30 across various colon cancer cell types. The combined treatment showed a synergistic reduction in wound healing in CL-188 cells. In mice harboring xenografts of CL-188 cell-derived tumors, the synergistic impact continued as the combination of Cur and LUT (administered at 20 mg/kg/day and 10 mg/kg/day, respectively, through IP injection for 5 days over 2 weeks) significantly reduced tumor growth. Western blot analysis revealed that the combination of Cur and LUT led to a synergistic decrease in Notch1 and TGF-β protein levels, both in CL-188 cells and xenograft tumors. Interestingly, individual treatments with Cur and LUT had limited effects on tumor necrosis. However, the combined Cur and LUT treatment resulted in a synergistic promotion of necrosis, as confirmed through tumor pathological investigation. These findings highlight the potential synergy between curcumin and luteolin in inhibiting colon cancer growth and suggest their combined use as a promising approach for combating this type of cancer.[42][43]

Lung Cancer

Conventional chemotherapy drugs have certain limitations when employed for lung cancer treatment, such as adverse side effects, inconsistent drug release, poor absorption, and the emergence of drug resistance. To overcome these issues, a new approach involving modified nanoparticles named T7-CMCS-BAPE (CBT) was developed. These nanoparticles, created using carboxymethyl chitosan (CMCS), aimed to mitigate the shortcomings of free drugs and improve therapeutic outcomes. CMCS allowed precise control of drug release based on pH and ROS levels, and it could also target the transferrin receptor (TfR) found on lung cancer cells. The study revealed that docetaxel (DTX) and curcumin were loaded into the nanoparticles with drug-loading contents of 7.82% and 6.48%, respectively. These nanoparticles maintained good biosafety even at high concentrations of 500 g/mL. Remarkably, in comparison to other nanocarriers carrying DTX and curcumin separately, as well as DTX alone, the T7-

CMCS-BAPE-DTX/CUR (CBT-DC) complexes exhibited superior in vitro and in vivo anti-tumor effects. Furthermore, CBT-DC improved the immune-suppressed microenvironment, aiding in inhibiting tumor growth.[44][45]

Prostate Cancer

Prostate cancer stands as the most prevalent tumor in the United States. Its propensity to advance into a hormone-resistant stage contributes to its aggressive nature. Effectively halting tumor growth and preventing the dissemination of metastatic disease poses a significant challenge in the clinical management of prostate cancer (PC). Recent years have witnessed concerted efforts to discover novel compounds for PC therapy, yielding promising advancements in this domain. Many drugs utilized in PC therapy lead to resistance, leading to the emergence of metastatic castration-resistant forms (mCRPC), which renders the cancer almost incurable. Among those grappling with mCRPC, the readily available dietary supplement curcumin emerges as an appealing therapeutic avenue. The results revealed that curcumin administration, akin to chemotherapy drugs like paclitaxel, cisplatin, and docetaxel, exhibited dose-dependent reductions in the viability of DU145 and PC-3 cells. The study also delved into the impact of EGFR-mediated signaling on ERK activation within DU145 and PC-3 cells. The findings indicated elevated EGFR expression in these cell lines, with both curcumin and chemotherapy drugs leading to lowered EGFR levels and diminished ERK activation. Ultimately, both curcumin and chemotherapy agents demonstrated the capacity to induce apoptosis and shrink the size of DU145 and PC-3 spheroids, both in regular conditions and Matrigel environments.[46]

Pancreatic Cancer

The increasing resistance of pancreatic cancer to chemotherapy has become a formidable challenge in the realm of clinical practice. Pancreatic carcinoma stands as a malignancy with a notably high mortality rate, necessitating the development of a potent therapeutic approach. Sestrins, a cluster of stress-associated proteins, wield influence over metabolism and cell growth by serving as antioxidants. Turmeric, rich in curcumin, a natural pigment, exhibits a range of pharmacological actions including anti-inflammatory, antioxidant, and potential anticancer properties, as supported by various studies. The specific mechanism and potential synergy between curcumin and the sestrin family in inhibiting tumor growth have yet to be fully explored. An investigation sought to uncover the molecular processes potentially responsible for the combined anticancer effects of curcumin and sestrin family members on pancreatic malignancy. The findings demonstrated that sestrin2 and curcumin collaboratively produced a profound reduction in pancreatic cancer. Notably, through precise targeting of the Nrf2/Keap1/HO-1/NQO-1 pathway, sestrin2, in tandem with curcumin, exhibited a suppressive effect on pancreatic cancer. The strategic targeting of sestrin2 by curcumin could hold promise as a valuable therapeutic strategy for combating pancreatic cancer. In a separate study, a robust solid-phase method was proposed for the combined synthesis of a compact library of curcumin analogs, resulting in high yields and purity. Previously ineffectual outcomes in pancreatic cancer cells were transformed into substantial growth inhibition and effective cell death in PC3 prostate cancer cells.[47]

Breast Cancer:

Breast cancer, the leading cause of mortality among women, presents a significant challenge. Despite treatments like lumpectomy, radiation therapy, chemotherapy, and endocrine therapy, a meta-analysis of 21 retrospective studies has shown that breast cancer recurrence rates remain high. This underscores the persistent need for novel and effective therapeutic strategies. In a study involving MCF10A human mammary epithelial cells and MCF7 breast cancer cells, curcumin treatment exhibited a concentration-dependent reduction in telomerase activity. This outcome correlated with the downregulation of hTERT by curcumin, though not through the c-Myc mRNA pathway. Another examination involving MDA-MB-231 and BT-483 breast cancer cell lines investigated curcumin's impact on NF-B, matrix metalloproteinases (MMPs), and cell-cycle regulatory proteins. This study confirmed previous findings across different breast cancer cell lines by validating curcumin's ability to inhibit NF-B, resulting in an antiproliferative effect. Moreover, cyclic D1 in MDA-MB-231 cells and CDK4 in BT-483 were reduced following curcumin treatment. In the MDA-MB-231 cell line, the combination of arabinogalactan and curcumin intensified apoptosis induction by elevating ROS levels, disrupting the mitochondrial membrane, and reducing glutathione. Curcumin's influence on breast tumor growth was multifaceted. It upregulated the p53 gene and lowered the levels of the ki-67 antigen, leading to the inhibition of breast

tumor growth. Another study on MDA-MB-231 cells highlighted curcumin's inhibition of inflammatory cytokines CXCL1/2. Additionally, curcumin impeded the expression of genes that promote metastasis, including the chemotactic receptor CXCR4, by blocking CXCL1 and CXCL2.[48]

Pharmacological Effects of Curcumin:

Antimicrobial and Antiviral Effects: Penicillium notatum, and Aspergillus niger, nanocurcumin (discussed above) demonstrated significantly higher aqueous dispersion than curcumin. According to transmission electron microscope research, Nanocurcumin particles exhibited effective disruption of bacterial cell walls, resulting in a bactericidal effect. The antibacterial action of nanocurcumin was particularly potent. In a study involving mice with Helicobacter pylori infection, curcumin demonstrated antibacterial properties by suppressing the production of matrix metalloproteinase-3 (MMP-3) and MMP-9. Furthermore, when tested against 14 different Candida strains, curcumin displayed antifungal activity. Specifically, it notably reduced ergosterol content in the fungal cell membrane, proteinase secretion from fungal cells, and H+ extrusion from Candida albicans and Candida glabrata. However, these effects were not as pronounced as those observed with the antifungal drug fluconazole (azole).

Curcumin exhibited inhibition of HIV-1 replication pathways by preventing Tat-induced long terminal region (LTR) transactivation. It achieved this by specifically halting Tat-mediated downregulation of HDAC1 expression, inhibiting Tat-mediated dissociation of HDAC1 from LTR, and blocking Tat-mediated binding of p65/NF-B to LTR promoters.[49]

Inflammation and Immunity: Recent investigations have provided strong support for the well-established claims that curcumin possesses potent immunomodulatory and anti-inflammatory properties. Under physiological sheer stress conditions, curcumin-treated HIMEC (human intestinal microvascular endothelial cells) exhibited reduced leukocyte adhesion to TNF-α/LPS-activated HIMEC monolayers. Additionally, curcumin suppressed the expression of vascular cell adhesion molecule-1 (VCAM-1) induced by TNF-α/LPS. In human umbilical vein endothelial cells stimulated by TNF, curcumin effectively hindered the transcriptional and translational expression of intracellular cell adhesion molecule-1 (ICAM-1), monocyte chemoattractant protein-1 (MCP-1), and interleukin-8 (IL-8), leading to decreased monocyte adhesion. In an Indian study, dietary curcumin offered protection against endotoxin shock in mice by impeding neutrophil transmigration and infiltration into the liver after LPS injections. This effect was associated with a substantial reduction in ICAM-1 and VCAM-1 expression in the liver and lungs.[50]

Cardiovascular System: The potential pharmacological effects of curcumin on the cardiovascular system, particularly its protective attributes, have gained significant attention in recent times. A Romanian study revealed that curcumin possesses the ability to counteract the pro-inflammatory effects of the cytokine resistin in human endothelial cells. Curcumin exhibited several positive outcomes, including inhibiting the expression of P-selectin and fractalkine, reducing the activation of nicotinamide adenine dinucleotide phosphate (NADPH), decreasing monocyte adherence to human endothelial cells, and preventing an increase in intracellular ROS (reactive oxygen species) levels.[51]

Metabolism and Bioavailability of Curcumin: Absolutely, you've provided accurate information about curcumin, the main active compound found in turmeric. Curcumin's chemical structure, insolubility in water, solubility in organic solvents, and stability in acidic environments are key characteristics that contribute to its bioavailability and potential therapeutic applications. Its unique properties have made it a focus of extensive research and exploration for various health benefits. Chemically speaking, molecule is symmetric, has two aromatic rings that are identical to one another, and has conjugate double bonds that are used as efficient electron donors to prevent the generation of ROS. Indeed, you're correct. Curcumin's presence in turmeric, a common spice used in many Asian cuisines, has led to its widespread use in food preparations. The vibrant yellow color of turmeric is attributed to curcumin, making it a popular natural coloring agent. The dosage and length of the treatment were factors in the decrease of oxidative stress caused by curcumin administration. a comprehensive overview of curcumin's potential benefits and challenges related to its bioavailability and metabolism. Indeed, curcumin holds promise for the treatment of various human illnesses, and its safety has been recognized by regulatory bodies such as the US Food and Drug Administration (FDA). However, its limited bioavailability due to poor absorption, rapid metabolism, and excretion rate presents a challenge for its effective

therapeutic use.Curcumin's metabolism involves both phase I and phase II reactions, which lead to the formation of various metabolites, including glucuronide and sulfate conjugates.[52]

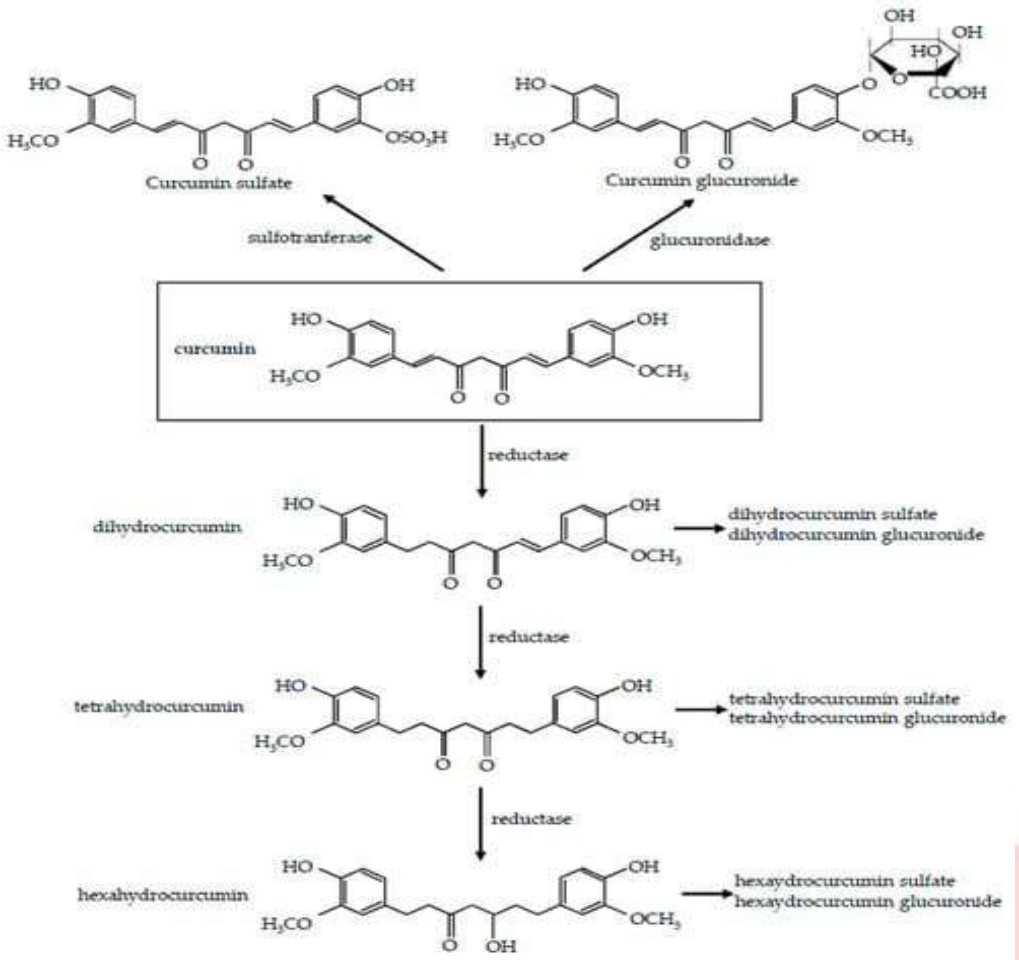


Figure depicting the metabolism of curcumin and its reduction pathway, as well as the two conjugation pathways: glucuronidation and sulfatation.

Extraction of Curcumin from Turmeric and Detection:

A comprehensive overview of the extraction and detection methods used for curcumin, highlighting the various techniques and instruments employed to isolate and quantify this compound from turmeric. This information sheds light on the complexity and sophistication of the processes involved in studying and utilizing curcumin for various purposes. The extraction of curcumin from turmeric is a crucial step in obtaining this bioactive compound for research and commercial applications. Different solvents and extraction techniques are employed to achieve high yields of curcumin while maintaining its purity and minimizing the use of organic solvents, especially in food applications. The use of supercritical carbon dioxide extraction and enzyme pretreatment are examples of innovative approaches to enhance curcumin yield while ensuring environmentally friendly and economically viable processes. The analysis and detection of curcumin are equally important to ensure accurate quantification and quality control. Various methods, such as absorption detectors, liquid chromatography (HPLC and UPLC), mass spectrometry (LC/MS), and capillary electrophoresis, are employed to detect and quantify curcumin in different matrices. The sensitivity of fluorescence detection, particularly in the 400–450 nm range, makes it a preferred method for detecting low concentrations of curcumin. The integration of chromatographic and spectroscopic techniques allows researchers to effectively separate and detect curcumin, determine its concentrations in various samples, study its pharmacokinetics, metabolism, and distribution, and ensure the quality and authenticity of curcumin-containing products. Overall, the detailed extraction and detection methods you've described showcase the multidisciplinary nature of curcumin research and its applications, as well as the continuous efforts to optimize and refine these techniques for both scientific and industrial purposes.[53][54]

Materials and Methods:

Materials Used: The Materials employed in the formulations and evaluations and the corresponding suppliers were

listed in the following Table.

List of Materials Used

Sr. No.	MATERIALSUSED	SUPPLIER	ROLE OF MATERIALS
1.	Curcumin	Noida, Uttar Pradesh, India	Rhizome Active Content
3.	Turmerine	K Patel Phyto Extractions Pvt. Ltd.	Enhancing Agent
4.	piperin	Shaanxi Honghao Bio-tech Co, Ltd.	Anti-inflammatory Agent
5.	Peptides	Core Peptides	inhibit tumour cell proliferation or migration, orsuppress the formation of tumour blood vessels
6.	Lactose	Shreeji PharmaInternational	Diluent, Binder
7.	Starch	Natural Ingredient	Binding Agent
8.	MagnesiumStearate	Global Calcium	Lubricant
9.	Gum Acasia	Sunrise Agriland Development and ResearchPvt.Ltd.	Stabilizer, Emulsifier,Thickener

Equipments Used:

List of Equipment Used

Sr.No.	Equipment's/ Instruments	Manufacturer/Company Name
1.	Electronic Weighing Balance	Electronic balance, Shimandzu, Japan
2.	Sieves	Hicon sieves
3.	Hot air oven	Hicon
4.	Vernier caliper	Mutitoyo, Japan
5.	Hardness tester	Monsanto hardness tester
6.	Friability apparatus	Model-EF-2W, Electrolab
7.	Tablet compression Machine	Fluid pack
8.	Dissolution Apparatus	Electro lab, DT (UST)

Selection of the Plant: Drawing upon an analysis of existing literature, extensive consultation with medical professionals, and under the guidance of Assistant Professor Mr. Bhupendra V. Madhavi, the plant Curcuma longa is chosen for analysis of the anticancer activities.

Authentification of the Plant: The Curcuma longa plant material was collected in April to July from the Botanical Garden of Balaghat, and verified by Assistant Professor Mr. Bhupendra V. Madhavi, Kalode College, Omkar Nagar, Nagpur. Each plant has a voucher specimen that has been kept for future reference.

Preparation of Crude Drug for Extraction: Selected plant rhizomes and roots were used to prepare the extract. Selected plant rhizomes and roots were collected and dehydrated in the shade. Rhizomes and roots were dried and then crushed mechanically into a coarse powder. Then sieve No. 16 was used to sift this coarse powder of chosen plant Rhizomes and Roots. And after passing, that was kept for extraction in an airtight container.

Physico-chemical Evaluation: Plant Rhizomes and Roots that had been dried and stored as a powder underwent a standard procedure to determine various types of physicochemical parameters.

Determination of Ash Values:

Ash values recognition is designed to identify inexpensive goods, expired medications, and sand or other earthy materials. By utilizing water-soluble ash and acid insoluble ash, it can also be employed as a method of differentiating the chemical components (Ministry of Health and Family Welfare, 1999).

Total Ash Value: Using a silica crucible that has been weighed beforehand, 5 grams of meticulously measured air-dried powder extracted from selected plant rhizomes and roots were incinerated until all carbon content was eliminated. To determine the percentage of total ash concerning the air-dried powdered plant materials, the mixture's weight was taken after it cooled down, following the guidelines outlined by the Ministry of Health and Family Welfare in 1999.

Acid Insoluble Ash: Utilizing 25ml of hydrogen chloride (HCl) that has been diluted, the ashes obtained from the chosen plants were subjected to a 5-minute heating process. The residual waste was collected onto filter paper that is devoid of ash particles. This collected material was then rinsed with hot water, ignited, and subsequently weighed. By comparing this weight against the weight of the air-dried medicinal substance, the percentage of acid-soluble ash was calculated following the guidelines provided by the Ministry of Health and Family Welfare in 1999.

Water Soluble Ash: The ash derived from the plant material was subjected to heating in 25 cubic centimeters of water for a duration of 5 minutes. The resulting waste was collected onto filter paper that is free from ash content. Subsequently, this collected residue was rinsed with hot water that had been heated to the point of ignition. To determine the quantity of water-soluble ash contained within the air-dried medicinal substance, follow the procedures outlined by the Ministry of Health and Family Welfare in 1999.

Determination of Extractive Values:

Soluble Extractive: The procedure involved utilizing 100 milliliters of various solvents, including petroleum ether, ethanol, hydroalcohol, and distilled water. In a secure flask, 5 grams of roughly powdered, air-dried medicinal material was subjected to maceration using these solvents for a duration of 20 hours. Following this, the mixture was allowed to stand undisturbed for an additional 15 hours after having been shaken for 5 hours. From the resulting mixture, 25 milliliters of filtrate were placed in a shallow, flat-bottomed dish and subjected to evaporation until it reached dryness. The dried material was then heated to 105 degrees Celsius and weighed. By comparing this weight to the weight of the air-dried medicinal substance, the percentage of soluble extractive was determined. These steps were carried out in accordance with the guidelines provided by the Ministry of Health and Family Welfare in 1999.

Extraction of dried Rhizomes and Roots by using various solvents of increasing polarity:

The extraction process used Curcuma longa's gathered, orderly, and ground Rhizomes and Roots. The Soxhlet apparatus has 500 g of powder placed into it equally. Following that, it was extracted using a range of non-polar to polar solvents, including petroleum ether, ethanol, hydroalcoholic, and distilled water. Prior to usage, these solvents were refined. Consistent hot percolation with various solvents was used as the extraction method for 72 hours. By vacuum distillation, the extracts were concentrated to a volume of 1/10, which was then transferred to a 100ml beaker and evaporated with a water bath. It was cooled and then put in a desiccator to draw out the excess moisture. Further research was conducted using the dried extracts, which were stored in airtight containers.

Preliminary phytochemical studies:

Tests for Flavonoid:

1. When **sodium hydroxide** solution to a small quantity of extracts resulted in the appearance of a yellow to orange coloration, indicating the presence of flavonoids.

2. A small portion of the extracts was treated with **concentrated sulfuric acid,** and the emergence of a yellow-orange color indicated the presence of flavonoids.

3. Shinoda's Test: alcohol was introduced to a small amount of extracts, and after allowing it to dissolve, a fragment of magnesium was introduced. Subsequently, concentrated hydrochloric acid was added drop by drop, and the mixture was subjected to heating. The presence of flavonoids was signified by the manifestation of a bright yellow color.

Determination of total flavonoid content:

The total flavonoid content of the sample was assessed using the colorimetric technique involving aluminum chloride. Quercetin was employed to establish a standard calibration curve for quantifying the total flavonoid concentration. Serial dilutions of quercetin with methanol (ranging from 5 to 250 µg/mL) were used to create standard solutions, starting from a stock solution containing 5.0 mg of quercetin in 1.0 mL of methanol. For each sample, 0.6 mL of a 2% aluminum chloride solution was mixed with 0.6 mL of the extracts (100 µg/mL). This mixture was then left at room temperature for 60 minutes. The absorbance of the reaction mixtures was measured at 420 nm, compared against a blank. Utilizing the calibration curve, the total flavonoid content in the samples was calculated, expressed as milligrams of quercetin equivalent (QE) per gram of dry plant material. The readings were averaged after being recorded three times.

RESEARCH METHODOLOGY

Preformulation of Herbal Tablet:

Angle of Repose Determination: The angle of repose was determined using the funnel method. Precisely weighed granules were introduced into a funnel, allowing them to flow freely onto a surface. The diameter and height of the resulting powder cone were measured, and the angle of repose was calculated using the following formula:

$$\tan \theta = h/r$$

Where: θ represents the angle of repose,

h stands for the height of the formed powder cone, and

r signifies the radius of the formed powder cone.

Loose Bulk Density Measurement: The loose bulk density (LBD) was determined by introducing a precisely weighed quantity of granules into a graduated cylinder and measuring both the volume and mass. The loose bulk density was calculated using the formula:

LBD= Weight of the Powder / Volume Occupied in the Cylinder

Tapped Bulk Density Measurement: The tapped bulk density (TBD) was determined by introducing a known quantity of granules into a graduated cylinder. The cylinder was subjected to tapping using a mechanical tapping apparatus. Tapping was continued until there was no further change in volume observed. The tapped bulk density was then calculated using the formula:

TBD = Weight of the Powder / Volume of the Powder after Tapping

Hausner Ratio Calculation: The Hausner ratio provides insight into the frictional resistance of the drug. It is calculated using the following formula:

Hausner Ratio =TBD/LBD

Carr's Compressibility Index Calculation: The Carr's compressibility index is a parameter that helps assess the compressibility of the material. It is calculated using the formula:

Compressibility Index (%)=(TBD−LBD)×100/TBD

Loss on Drying Determination: To assess the loss on drying (LOD), a glass stoppered bottle was employed. Precisely 1 gram of granules was weighed and added to the bottle. These bottles were then positioned within a drying chamber. The stopper was

removed from the bottle, and the contents were dried for a specified duration until a constant weight was achieved. The calculation of loss on drying was carried out using the formula:

Loss on Drying (%)=[Initial Weight−Final Weight]×100

This methodology is in accordance with the approach described by Lachman in 1987.

Synthesis of Curcumin:

In 1918, Lampe released the initial study regarding the creation of curcumin, one hundred years after its extraction from turmeric. Lampe's process involved five steps and began with the utilization of carbomethoxy feruloyl chloride and ethyl acetoacetate. Subsequently, Pabon introduced a simplified technique to produce substantial amounts of curcumin. This method involved combining acetyl acetone with substituted aromatic aldehydes in the presence of boron trioxide (B2O3), trialkyl borate, and n-butylamine. Several research groups have since employed this procedure with slight modifications for subsequent curcumin production. In attempts to enhance yields, certain patents propose the use of unreactive organic amide solvents, B2O3, trialkylborate, and n-butylamine. Efforts to substitute boron oxide with boric acid proved unsuccessful. Rao and Sudheer suggested trifluoroboronite, leading to the creation of stable curcuminoid trifluorboronites that could be converted into curcumin through hydrolysis in aqueous methanol with a pH of 5.8. The pivotal step in each of these processes is the interaction between 2,4-diketones and appropriate aromatic aldehydes. Complexing it with boron prevents the diketone from participating in Knoevenagel condensations. Optimal conditions for these reactions involve anhydrous settings and polar aprotic solvents, facilitating the separation of curcumin from the reaction mixtures. Primary and secondary amines serve as catalysts to provide the necessary basicity for deprotonating the diketone's alkyl groups. Scavengers like alkyl borates are employed to eliminate the water formed during the condensation reaction, which could hinder curcumin production. Under slightly acidic conditions, the boron complex disassembles into curcumin. The curcumin from this reaction mixture can be extracted through column chromatography after repetitive precipitation and washing, illustrates the comprehensive reaction scheme employing the Pabon approach.[55]

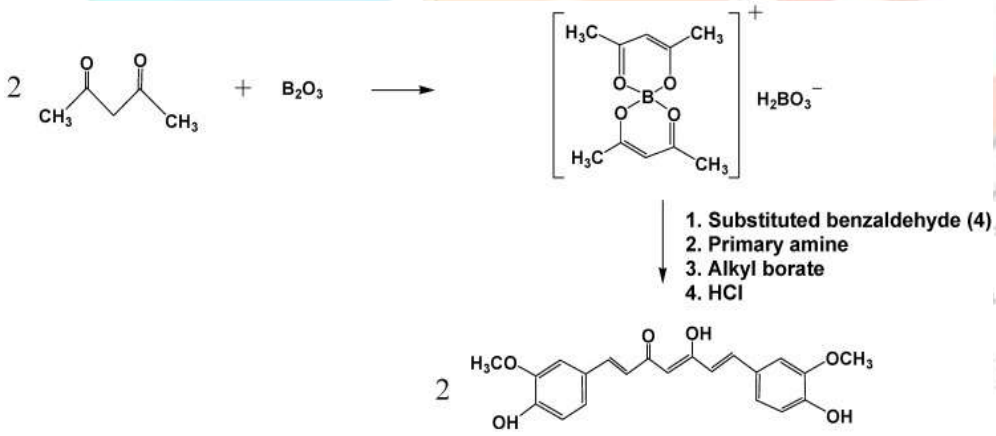


Figure: Production of curcumin using the general technique presented by Pabon

Characterization of Pure Drug (Curcumin):

The pure drug has been extensively characterized based on a range of parameters, showcasing robust attributes such as potent antioxidant, anti-carcinogenic, anti-inflammatory, anti-angiogenic, antispasmodic, antimicrobial, anti-parasitic, and various other beneficial activities.

Sample Preparation:

Formulation Development:

The wet granulation method was chosen for tablet formulation due to its suitability for small-scale formulations. This method offers ease of implementation and is well-suited for creating consistent and uniform tablet formulations on a smaller scale.

Process:

- Curcumin extract and other excipient was weighed, ground, and separately runthrough an 80-number sieve.
- All materials other than talc and magnesium stearate were combined and ground in a pestle and mortar before being once again put through sieve number 80.
- After combining the extract with the starch/acacia solution, the lump was created.
- Lump was screened over sieve number 18 to obtain granules, which were then dried in ahoover dryer at 35°C.
- Add talc and granulated magnesium stearate.
- To eliminate larger granules, the granules were once again processed through sievenumber 18 before being placed in desiccators.
- After that Compressed that granules into desired punching machine to give proper shape and size to the tablet.

Formulation of tablet

Sr.No.	Ingredients(mg)	F1	F2	F3	F4	F5	F6
1	CurcuminExtract	450	450	450	450	450	450
2	Lactose	5	5	5	5	5	5
3	starch	2	4	6	8	10	12
4	Gum acasia	10	10	10	10	10	10
5	Magnesiumstearate	5	5	5	-	-	-
6	talc	-	-	-	5	5	5
7	Piperine	5	5	5	5	5	5
8	Peptides	5	5	5	5	5	5
Tablet weight 500 mg							

Evaluation of herbal tablet:

Uniformity of Weight: 20 pills from each formulation were chosen at random, and each one was weighed separately. The average weight of each tablet was determinedand compared to it.

General appearance: During the evaluation process, the overall appearance of the tablet was assessed, including factors such as its color, odor, and texture.

Hardness test: To endure the mechanical stresses encountered during various handling operations, tablets must possess a specific level of strength or hardness, as well as resistance to friability. The Monsanto hardness tester measured the hardness of 20 randomly chosen tablets of eachformulation.

Percentage friability test: The Roche Friabilator was employed to evaluate the friability of tablets. This involved determining the percentage of weight loss from a selection of 20 randomly chosen tablets from each batch. These tablets were subjected to tumbling within the friability machine. After rotating at a speed of 25 revolutions per minute for 4 minutes, the dust produced from the tablets was collected, and the percentage of weight loss was calculated.

Disintegration test: The disintegration time of the tablets was determined using a digital microprocessor-based disintegration test device (basket rack assembly, Lab India). Each individual tube was loaded with a single tablet, along with an accompanying disc. This assembly was then submerged in a 1000 mL beaker filled with water. The water level in the beaker was adjusted to ensure that the wire mesh was at least 25 mm above and below the water's surface at its highest and lowest points, respectively.

The equipment was maintained at a temperature of 37°C throughout the process. It was observed that all tablets uniformly underwent disintegration and passed through the wire mesh in an equal amount of time.

Stability Studies: Environmental conditions like temperature, light, air, and humidity, along with packaging elements, can significantly influence the stability of a pharmacological dosage form. These factors can impact various stability parameters of the formulation. To assess the impact of these factors, all formulations underwent stability testing for a duration of 12 months. Long-term testing was conducted at temperatures of 25°C with a relative humidity of 60%, and at 40°C with a relative humidity of 75% for six months. During accelerated stability testing under elevated temperature conditions, several metrics were evaluated, including the tablets' color, odor, and texture, as well as average weight, hardness, friability, and disintegration time. These evaluations were performed to gauge the formulation's ability to withstand adverse conditions and maintain its intended properties over time.

RESULTS AND DISCUSSION

Results of Descriptive Statics of Study Variables

Physicochemical analysis of crude drug:

Determination of Ash Values of selected plant

Plant Name	Type of Ash	Percentage of Ash (w/w)
Curcuma Longa	Total Ash	8.3
	Acid Insoluble	3.7
	Water Insoluble	1.5

Determination of extractive value of selected plant:

Extractive Values are determined and reported in Table.

Determination of extractive value of selected plant

Solvent	% Yield
	Curcuma Longa
Petroleum Ether	34.2
Ethanol	38.9
Hydro Alcohol	42.6
Distilled Water	41.0

Preliminary Phytochemical Evaluation of Selected Plant: Chemical analysis of the phytoconstituents identified the presence of different phytoconstituents in diverse extracts. The results, which are presented in Table, shown that the extract of Curcuma longa's roots and rhizomes includes flavonoids.

Preliminary Phytochemical Evaluation of Curcumin Extract

Constituent	Tests	Curcuma Longa			
		Petroleum Ether	Ethanol	Acetone	Aqueous
Flavonoids	Lead Acetate test	–	+	+	+
	Con.H2So4 test	–	+	+	+

	FeCl3 test	**–**	**+**	**+**	**+**

Preformulation Studies of Curcumin: Different granules' angles of repose reveal outstanding flow characteristics between 25 and 29 degrees. The outcomes derived from the loose bulk density, tapped bulk density, Hausner ratio, and compressibility index values presented in Table. demonstrate favorable flow properties.

Preformulation Parameters of Tablet of Curcumin

Parameters	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
Angle of repose	27.1	29.1	25.5	27.02	30.9	26.9
Loose bulk density (g/cm3)	0.78	0.78	0.77	0.75	0.77	0.76
Tapped bulk density (g/cm3)	0.9	0.9	0.89	0.88	0.9	0.89
Hausner ratio	1.15	1.15	1.15	1.17	1.16	1.16
Compressibility index (%)	13.04	13.1	13.6	14.3	14.3	14.1
Loss on drying (%)	0.98	0.98	0.98	0.98	0.98	0.98

Evaluation of Herbal Tablet:

The tablets containing various extracts underwent testing across a range of parameters, and the results fell within the tolerance limits outlined by the Pharmacopoeia. The tablets demonstrated weight uniformity well within the acceptable 5% range. Notably, their hardness, varying from 6.98 to 7.02, indicates a considerable degree of solidity, suggesting they will be easy to dissolve. The mechanical stability of tablets is demonstrated by their low friability, which was determined to be between 0.36 and 0.47. The time it took for tablets to dissolve was 12–13 minutes, which was within Pharmacopoeia's acceptable limit. Table. displayed all of the evaluation parameter results.

Evaluation parameters of tablets of Curcumin

Parameters	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
Uniformity of weight	1.03	1.45	1.49	1.79	1.50	1.60
Colour	Bright Yellow	Bright Yellow	Bright Yellow	Bright Yellow	Bright Yellow	Bright Yellow
Odour	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic
Texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Hardness (kg/cm2)	7.05	6.98	6.99	7.02	6.94	7.01
Friability (%)	0.68	0.71	0.75	0.68	0.72	0.75
Disintegration time (minutes)	14.09	11.51	13.09	13.54	12.00	13.44

Physicochemical analysis of crude drug: Physicochemical analysis was conducted on the powdered rhizomes and roots of the chosen plant. The assessment included the determination of ash values, encompassing total ash, acid-insoluble ash, and water-soluble ash. For the rhizomes and roots of Curcuma Longa, the findings revealed the following ash values:

Total Ash: 8.3% w/w

Acid Insoluble Ash: 3.7% w/w

Water-Soluble Ash: 1.5% w/w

These values indicate the presence of a notable amount of inorganic matter in the samples, highlighting the mineral content within the plant material.

Determination of extractive value of selected plant:

Extractive Values of Curcumin are determined and reported.

Preliminary Phytochemical Evaluation of Selected Plant:

Chemical analysis of the phytoconstituents identified the presence of different phytoconstituents in diverse extracts. The results, which are presented and shown that the extract of Curcuma longa's roots and rhizomes includes flavonoids.

Preformulation Studies of Curcumin:

The angles of repose for different granules demonstrated excellent flow characteristics, ranging between 25 and 29 degrees. Additionally, the results from measurements of loose bulk density, tapped bulk density, Hausner ratio, and compressibility index collectively suggest favorable flow properties for the granules.

Evaluation of Herbal Tablet:

The tablets containing a range of extracts underwent comprehensive testing across various parameters, and all results fell within the tolerance limits specified by the Pharmacopoeia. The tablets exhibited weight uniformity well within the acceptable 5% range. Notably, their hardness, spanning from 6.98 to 7.02, signifies a considerable level of solidity, indicating that they are likely to dissolve easily. The mechanical stability of tablets is demonstrated by their low friability, which was determined to be between 0.36 and 0.47. The time it took for tablets to dissolve was 12–13 minutes, which was within Pharmacopoeia's acceptable limit. Table No. 6 displayed all of the evaluation parameter results.

In this study, curcumin was employed to assess anticancer activity; in the future, herbal tablets will also be used to assess their anticancer potency. The powerful active components from plant extract that are responsible for anticancer activity will be identified and isolated. To research the spectrum against various forms of carcinomas, the anticancer efficacy of active ingredients against various cell lines will be examined. Since all three of the researched plants have significant anticancer activity, a polyherbal formulation may be made to assess their synergistic effect. Comparative analysis can be done by comparing efficacy and potency in various formulations.

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