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A comprehensive Colorectal Cancer Medicinal Plants and Metabolites Database: CRCMMDB

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Abstract
Colorectal cancer (CRC) represents a significant health challenge due to the complexities of treatment, which often result in low efficacy and adverse side effects. Medicinal plants, rich in bioactive compounds, offer promising alternatives but the relevant data is scattered across various sources. Our Colorectal Cancer Medicinal Plants and Metabolites Database (CRCMMDB), consolidates this information into an accessible platform, facilitating the integration of genomic data, natural drugs, and medicinal plant metabolites that show promise in treating CRC. This resource aims to support more focused and effective research on natural therapies for CRC. The database integrates genome information, specific natural drugs for CRC, details on medicinal plants and their metabolites, along with associated pathways and activity in carcinoma, and FDA drug target genes for CRC. Employing one-to-many relationships throughout the data frame facilitates unrestricted connections. We utilized Django v4.3.2 and integrated SQLite3 for web development. The study reveals that CRCMMDB provides extensive data on genomics, CRC-specific natural drugs, medicinal plants, bioactive compounds, and FDA drug target genes. The 'natural drug' section includes curated therapeutic substances with details like PMID, drug ID, chemical structure, source plant, and mechanism of action. It also offers comprehensive coverage of CRC's stages, risk factors, preventive measures, symptoms, and related conditions. Users can explore plant-derived compounds like alkaloids and polyphenols, known to modulate oncogenic pathways like PI3K and Akt. Each plant entry is cross-referenced with NCBI, serving as a valuable resource for natural treatment research. CRCMMDB stands as a vital resource in CRC investigation, addressing the need for centralized data on natural medications. With increasing CRC prevalence globally, there's a critical demand for readily available information. CRCMMDB (http://crcmmdb.in) offers an easily navigable interface promoting the discovery of natural compounds for CRC treatment.

Keywords: Medicinal plant metabolites, Phytochemical compounds, Natural Drugs, Colorectal Cancer, Genome.

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Introduction

In the contemporary era, elevated living standards and enhanced accessibility to quality healthcare have significantly augmented diagnosis and treatment capabilities. This approach has globally impacted various regions and their respective average life expectancies. In Western nations, the prevalence of colorectal cancer has transitioned from a rarity in the 1950s to constituting 10% of all cancer cases [1].Colorectal cancer (CRC) stands as the third most prevalent form of cancer and the second leading cause of cancer-related mortality in the United States for both genders [2][3]. While merely 10% of CRC instances involve germ-line mutations resulting in syndromes such as Lynch syndrome and Familial Adenomatous Polyposis, the metabolic pathways of CRC, including glycolysis and tricarboxylic cycle pathways, play a pivotal role in the uncontrolled growth of cancer cells [4][5][6]. The current therapeutic approaches, primarily involving surgery and chemotherapy, lack a less harmful alternative for normal cells. This research investigates the viability of utilizing bioactive compounds sourced from medicinal plants as a substitute for existing methods in colorectal cancer management.

Phytochemicals such as terpenes, alkaloids, flavonoids, glycosides, and polyphenols, employed by plants for medicinal purposes, are under scrutiny

Ethno-pharmacological studies advocate for optimizing plant selection, extraction techniques, and dosages to maximize medicinal advantages. Plants exhibiting potential anti-cancer properties, including hibiscus, bananas, cruciferous vegetables, pomegranates, Cordyceps (mushroom), and Cassia fistula, are identified [7]. Tumour suppressor genes (P53, APC, TGF-β) and oncogenic pathways (RAS, BRAF, PI3K) are associated with colorectal cancer and are classified as sporadic (60%), congenital/ familial (30%), transmitted/ hereditary/ inherited (10%) instances. Worldwide, 70% of people use medicinal plants, which may contain chemicals with carcinogenic properties. Vinca alkaloids were discovered as a result of the discovery of anti-cancer drugs in the plant in the 1950s. Plant substances are the basis or inspiration for many new anti-cancer drugs, including taxol, vinblastine, vincristine, irinotecan, and camptothecin [8].

Various chemotherapeutic agents and dietary plans are proposed based on the cancer stage and individual patient characteristics. Noteworthy medications, such as 5-fluorouracil (5-FU), form the foundation of neo-adjuvant therapies like folfox and folfiri, often combined with cetuximab, panitumumab, or bevacizumab. Chemotherapy targets rapidly dividing cells, including cancerous ones, but it also affects healthy cells found in the blood, gastrointestinal system, and hair follicles, leading to side effects such as insomnia, headaches, muscle and stomach pain, vomiting, diarrhoea, sore throat, blood abnormalities, constipation, neurological impairment, memory issues, appetite loss, and hair loss [9].

Timely cancer detection and treatment significantly enhance global patient outcomes. Unfortunately, many individuals in developing countries, particularly those in rural areas, face limited access to modern diagnostic facilities. The World Health Organization (WHO) estimates that approximately 80% of the population in these regions relies on traditional healthcare. Phytotherapy, also known as phytomedicine, presents an alternative treatment approach involving the use of plant extracts or combinations thereof[10]. Medicinal plants, through their diverse therapeutic effects, contribute to the physical, mental, and emotional well-being of individuals by restoring the body's defences, regulation, and healing mechanisms. Extensive research supports the efficacy of medicinal plants in various conditions, including hormonal imbalance, hyperlipidaemia, kidney and liver disorders, neurological and mental disorders, anaemia, and infertility. The manifold benefits identified underscore the potential of medicinal plants for cancer prevention and treatment [11,12].

Therapeutic intervention is imperative to address the substantial global health impact of colorectal diseases, ranging from inflammatory bowel disorders to colorectal cancer. The exploration of natural chemicals derived from medicinal plants has emerged as a promising avenue for drug development and discovery within the spectrum of various methodologies. This study introduces a pioneering project a meticulously curated database designed to systematically document information on colorectal medicinal plants, their bioactive compounds, and natural medications[13]. The intersection of modern scientific research and traditional knowledge has created novel prospects for addressing the intricate challenges associated with colorectal health by identifying medicinal plants as reservoirs of pharmacologically active compounds. This manuscript elucidates the rationale behind establishing this database and underscores its significance in collecting and disseminating crucial data essential for advancing research, supporting evidence-based treatments, and expediting the exploration of non-pharmacological interventions for colorectal disorders. Subsequent sections will delve into the methodologies employed in constructing this database, its structural components, and the potential benefits it offers to physicians, researchers, and pharmaceutical scientists engaged in the pursuit of innovative and effective treatments for colorectal diseases[14].

The research delineates key constituents present in plant extracts and furnishes a comprehensive overview of the empirical evidence supporting the efficacy of medicinal plants in both the prophylaxis and therapeutic intervention of colorectal cancer[15]. Furthermore, it delves into insights derived from the amalgamation of plant-based biochemical therapies with conventional chemotherapy regimens for the management of colorectal cancer and the mitigation of drug resistance [16]. Emphasis is also placed on elucidating the potential of medicinal plants harbouring bioactive compounds with anti-colorectal cancer properties, positing a transformative impact on colorectal cancer treatment paradigms [17]. The study underscores the advantages and intricacies associated with the utilization of plant-derived biochemicals in colorectal cancer treatment, thereby contributing to the expansion of research endeavours in this domain [18].

The emergence of advanced genomic technologies such as microarrays, proteomics and gene sequencing has generated vast amounts of data. The primary challenge in handling this multi-omics cancer data lies in the design and utilization of repositories. These repositories function as databases, consolidating and managing extensive knowledge by integrating it into a singular database [19]. Notable databases like the Cancer Genome Atlas (TCGA), RespCanDB, cBioPortal, Co-19PDB, and ICGC have been established in the field of CRC (colorectal carcinoma) research, offering comprehensive information on carcinoma studies [19]. These databases have undergone thorough research, review, and visualization using diverse genomics data. To facilitate seamless research within the scientific community, there is a need for a user-friendly and well-organized platform. This platform should enable easy access to all cancer research data with a single click. In pursuit of simplifying data retrieval, we have compiled almost all cancer databases and categorized them into five groups based on the types of data they encompass genomics, natural drugs for colorectal carcinoma, medicinal plants and their metabolites with pathways involved in carcinoma, and the family of medicinal plants. While existing databases for CRC primarily focus on chemical treatments and conventional therapies, they often overlook the potential of medicinal plants and their metabolites. The CRCMMDB database fills this critical gap by specifically highlighting natural drug alternatives and their therapeutic applications in colorectal cancer treatment. The study underscores the significance of exploring natural alternatives to synthetic treatments for CRC, offering affordable, cost-effective options, and leveraging integrated data from the CRCMMDB database. Users can effortlessly access all relevant databases with just one click by entering the name of the required medicinal plant into the search bar. A comprehensive overview of the database is depicted in Figure 1.

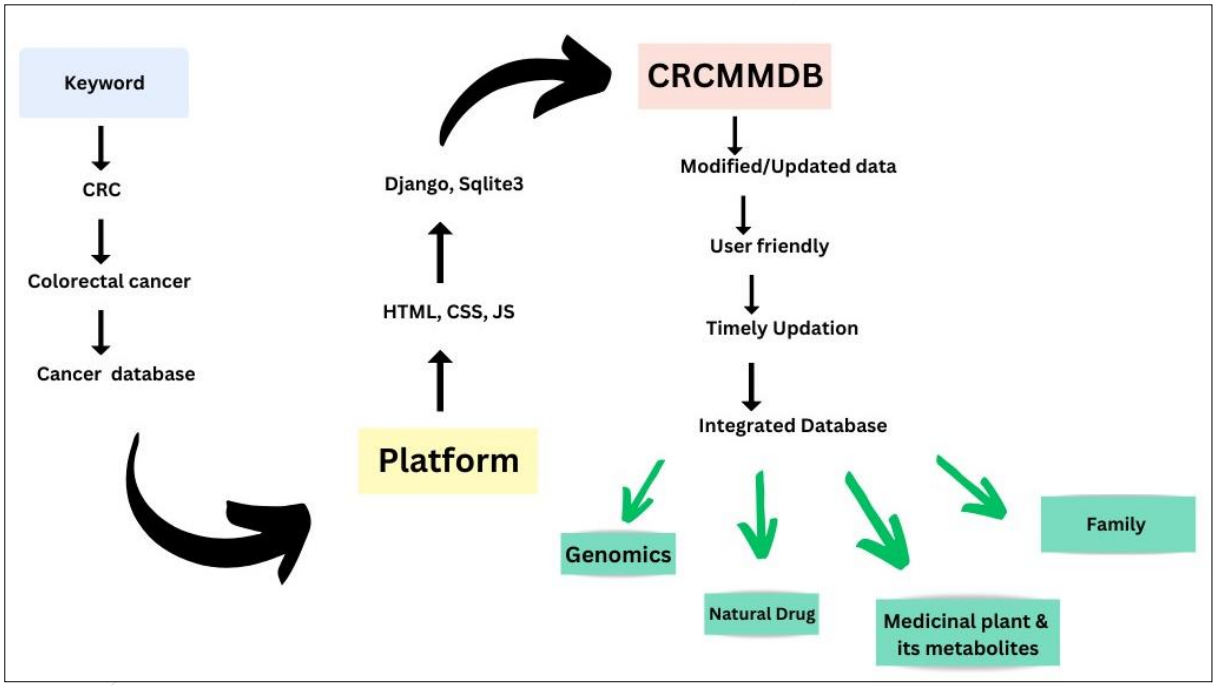

Figure 1 – Overview of CRCMMDB Database

Medicinal plants and colorectal cancer

The subsequent review concentrated on 190 articles, which were published between 2000 and 2017 and pertained to 190 distinct plant species. The comprehensive analysis incorporated both in vitro and in vivo experiments, as indicated by reference [20]. In the realm of in vitro studies, which encompassed 172 experiments, the emphasis was on elucidating the influence of diverse plant extracts on specific colon cancer cell lines. For instance, grape extracts demonstrated a notable impact on the PI3K/Akt pathway, green tea induced apoptosis, and garlic inhibited cancer cell growth via the phosphoinositide 3-kinase/Akt pathway [21]. In animal models, primarily murine, analogous effects were observed, including the induction of apoptosis, inhibition of proliferation, and antiangiogenic effects[22].

The anticancer effects of the mentioned plants primarily operate through the initiation of apoptosis via caspase activation, control of cell cycle phases, and modulation of pivotal proteins, including p53, p21, and nuclear factor-κB (NF-κB) [23][24][25]. Notably, specific bioactive compounds within these plants, such as flavonoids, polyphenols, and saponins, have been identified for their anticancer properties[26]. The collated studies present a comprehensive elucidation of the multifaceted mechanisms through which these plants counteract colon cancer, thereby suggesting promising avenues for subsequent research and therapeutic advancements [27].

Mechanism of action of medicinal plants in colorectal cancer

The induction of distinctive oncogenic traits in colon epithelial cells through a combination of genetic and environmental influences constitutes a mechanism contributing to the pathogenesis of colorectal cancer[28]. The acquisition of these traits results from a stepwise accumulation of genetic and epigenetic modifications that trigger the activation of oncogenes and the inactivation of tumour suppressor genes. Typically, the advancement of colorectal cancer follows a foreseeable pattern, encompassing histological, genetic, and epigenetic changes as normal epithelial cells transition into adenocarcinoma[29][30]. It has been recognized that sessile serrated polyps, in contrast to conventional adenomatous polyps, exhibit potential as indicators for colorectal cancer[29][31]. In molecular categorization, subgroups with discernible genetic traits are delineated, elucidating considerable mutational diversity within tumours. The onset of colorectal cancer is shaped by the interplay of genetic anomalies, epigenetic modifications, and the tumour microenvironment, encompassing the gut microbiota [32].

The treatment of colon cancer involving medicinal plants encompasses various processes. It includes the inhibition of apoptosis, suppression of cell cycle expansion, reduction in anti-apoptotic protein expression, regulation of signalling pathways, and the identification of antioxidant and anti-inflammatory properties in these plants. Certain medicinal plants possess the capability to modulate sex hormone levels, specifically androgens and estrogens, impacting the proliferation rate of colon cancer cells[33]. Furthermore, medicinal plants contribute to reinforcing the body's defences against cancer cells and enhancing immunity. Specific bioactive compounds in medicinal plants, such as berberine, curcumin, and resveratrol, have demonstrated their ability to induce apoptosis in colon cancer cells. These substances also facilitate the expression of cell cycle inhibitors (e.g., p53, p27, p21) while diminishing the expression of proteins like P-Akt, MMP, and PI3K. Chemicals stimulate the up-regulation of proapoptotic proteins such as BAD, Bax, caspase 3, caspase 7, caspase 8, and caspase 9[34]. Notably, garlic, olives, pomegranate, green tea, beans, and grapes are identified as the most effective medicinal plants in preventing colon cancer. These plants employ various mechanisms, including the reduction of anti-apoptotic proteins (Bcl-2, Bcl-xL), induction of cell cycle arrest in the S phase leading to apoptosis, and attenuation of superoxide to prevent DNA oxidation [35].

Metabolomic Studies and its exposure to colorectal cancer

Studies indicate an up-regulation of the pentose-phosphate pathway in CRC, particularly due to genetic aberrations [2][36]. Metabolomic investigations, conducted on APC(Min/+) mice and patient tumours, consistently portray metabolic alterations linked to early tumour development[37]. Various substances, such as ginseng [38][39], rice bran [40][41], pomegranate extract [42], natural products [43], chemotherapeutics [44][45], and anti-microbial peptides [46], exhibit potential in diminishing energy consumption and cell proliferation in CRC models. Recognized as an environmentally-mediated ailment, the risk assessment for CRC takes into account the collective impact of diverse exposures. Metabolomics, especially top-down approaches, emerges as a valuable tool for analysing downstream metabolites associated with combined exposures at a population level, facilitating a comprehensive comprehension of CRC by bridging the genetic-environmental gap [47].

Colorectal cancer serves as a paradigm of an environmentally-mediated ailment, demonstrating an escalating occurrence in individuals below 50 years of age [48][49]. Specific environmental determinants linked to CRC encompass high consumption of red and processed meats, pre-existing health conditions (such as obesity, inflammatory bowel diseases, type 2 diabetes), tobacco use, alcohol consumption, disruption of circadian rhythms, and the presence of pathogenic

microbiota [50][51]. The risk of CRC is influenced by genotoxic compounds found in processed and red meats, along with increased secretion of bile acids due to a high-fat diet. Certain dietary elements, including ginseng, rice bran, Vitamin D, fibre, and folate, demonstrate protective effects against CRC [52]. Metabolomic investigations reveal altered levels of metabolites in individuals with CRC, highlighting the need for further analysis to comprehend the biological effects of these metabolites. The distribution of medicinal plant metabolites across various taxonomic families within the database is depicted in the pie chart in Figure 2.

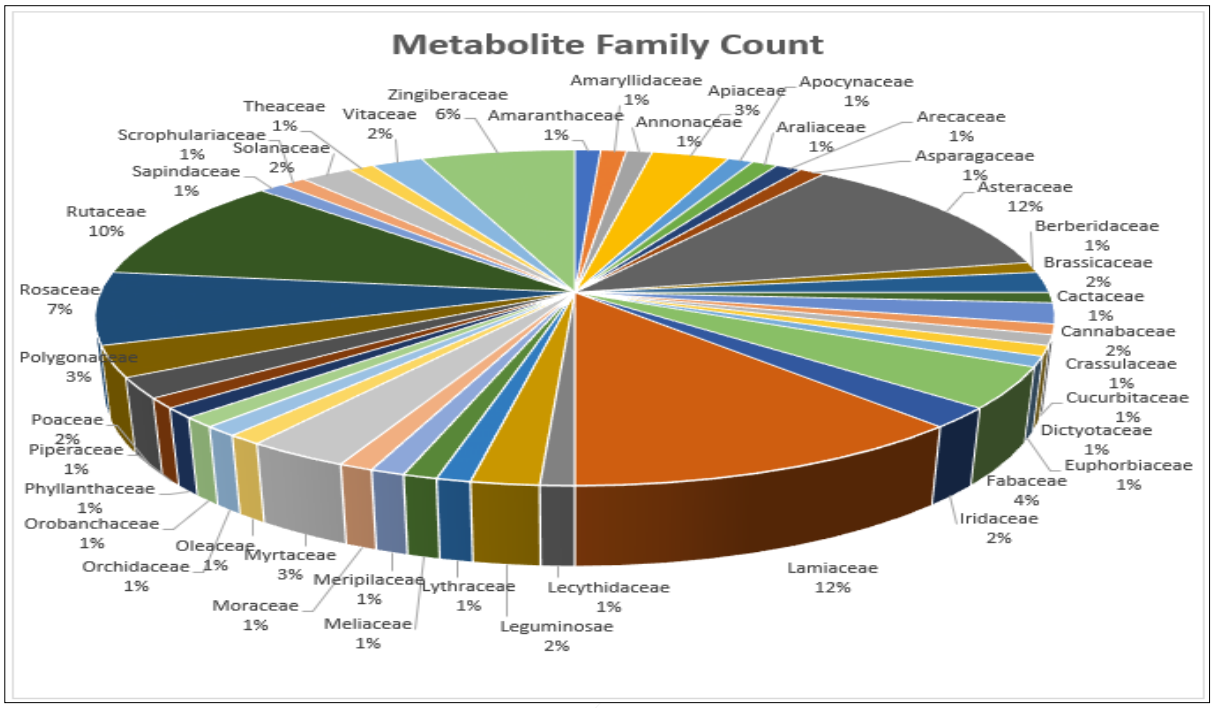

Figure 2 – Medicinal plant metabolites across various taxonomic families

Medical Treatments and Pharmacometabolomic in Colorectal Cancer

Since the inception of metabolomics in 1998[53], the field of pharmacometabolomics has flourished, garnering significant attention and prompting a community-led White Paper urging the U.S. Government to prioritize funding in this area[54][55]. This growth is fuelled by the potential of pharmacometabolomics to fill gaps where genomics alone falls short, marking the advent of a post-genomic diagnostic era crucial for understanding expressed phenotypes. Applications span the identification of disease markers, exploration of molecular disease mechanisms, and the revelation of drug-induced biomarkers, enabling the identification of response phenotypes[54].

Cancer, particularly colorectal cancer, has been a key focus of these strategies. With a substantial lifetime risk of CRC in the U.S., efforts have intensified to apply these methodologies to early detection and prognostication. Notably, acetylated polyamines, such as mono acetyl spermidine and N1, N12-diacetyl spermine, are consistently elevated in CRC patients, offering potential insight into disease progression[56][57][58]. The polyamine synthesis pathway, particularly targeted by the chemotherapeutic difluoro methyl ornithine (DFMO), is a promising avenue for drug development[59]. Serum amino acids and urinary nucleosides have also emerged as candidates for future assays, aiding in disease staging. The overarching goal is the development of a reliable blood or urine screening test for routine clinical use, thereby improving the prognosis for patients[60]. In the context of chemotherapy, pharmacometabolomic profiling has demonstrated the ability to predict drug toxicity in CRC patients, as exemplified by capecitabine treatment. Notably, the host's microbiome significantly influences drug treatment efficacy, advocating for the integration of microbiome activity measurement into pharmaceutical development. The true impact of metabolomics in CRC lies in its integration into multidimensional datasets, combining information from pharmacogenomics, pharmacoproteomic, transcriptomics, and drug

pharmacology to comprehensively understand individual responses to drug interventions[2].

In the Literature Review and Introduction, we now clarify how our work advances the current body of knowledge. While previous studies have explored individual medicinal plants and their potential anti-cancer properties, our work systematically compiles this information into an integrated, user-friendly database. CRCMMDB is unique in its comprehensive inclusion of genomic data, CRC-specific drug targets, and biochemical pathways, offering researchers a holistic view of plant-based cancer treatments. This work not only builds on existing knowledge but also facilitates future research by providing a centralized platform for data retrieval and hypothesis generation in the context of CRC treatment.

Methodology:

Enhancing research performance can be achieved through the provision of researchers with access to a comprehensive, unified data repository on a singular platform. This involves the development of a free, open-source database specifically focused on colorectal cancer. The database, CRCMMDB was developed using Django v4.3.2 integrated with SQLite3, which ensures a robust and optimized web application for data retrieval. The database aims to accentuate the distinct advantages of the disease and underscore its genomic value. It encompasses a wide array of information, including but not limited to natural drugs pertinent to colorectal carcinoma, medicinal plants, and their metabolites. The dataset also incorporates the associated pathways involved in the development of carcinoma. The compilation and analysis of these data involve the utilization of diverse operational skill sets. While there are numerous databases available that offer detailed insights into colorectal cancer, this particular database distinguishes itself by providing a holistic repository of information related to carcinoma. The scope extends beyond general information on carcinoma, encompassing details on the stages of colorectal cancer and therapeutic interventions available for its treatment. Additionally, the database sheds light on natural drugs, including relevant information such as PMID, drug, drugid, chemical structure, source plant, and the mechanism of action. Venturing into the genomics domain, the database includes taxonomic ID, organism name, GeneID, CurrentID, status, symbol, aliases, description, other designations, map location, chromosome, genomic nucleotide accession, start and end positions on the genomic accession, orientation, exon count, and OMIM. Furthermore, it covers medicinal plants and their metabolites, elucidating the associated pathways involved in colorectal cancer. In its comprehensive approach, the database delves into the family of medicinal plants, presenting details such as the plant name, scientific name, and family. This all-encompassing resource serves as a valuable tool for researchers seeking to retrieve essential information in the field. To validate the database, we employed testing techniques such as query validation and integrity checks to ensure accurate data mapping between medicinal plants and their bioactive compounds. The one-to-many relationship schema was validated using relational database principles to ensure comprehensive connectivity among medicinal plant data, CRC-specific drug targets, and associated biochemical pathways. Further, user tests were conducted to verify the ease of data access and query efficiency. We also cross-referenced our plant database with existing NCBI and PubMed datasets to confirm the accuracy of included species and their metabolites. The schematic representation of workflow and methodology employed in the acquisition and consolidation of data for the CRCMMDB database is illustrated in Figure 3.

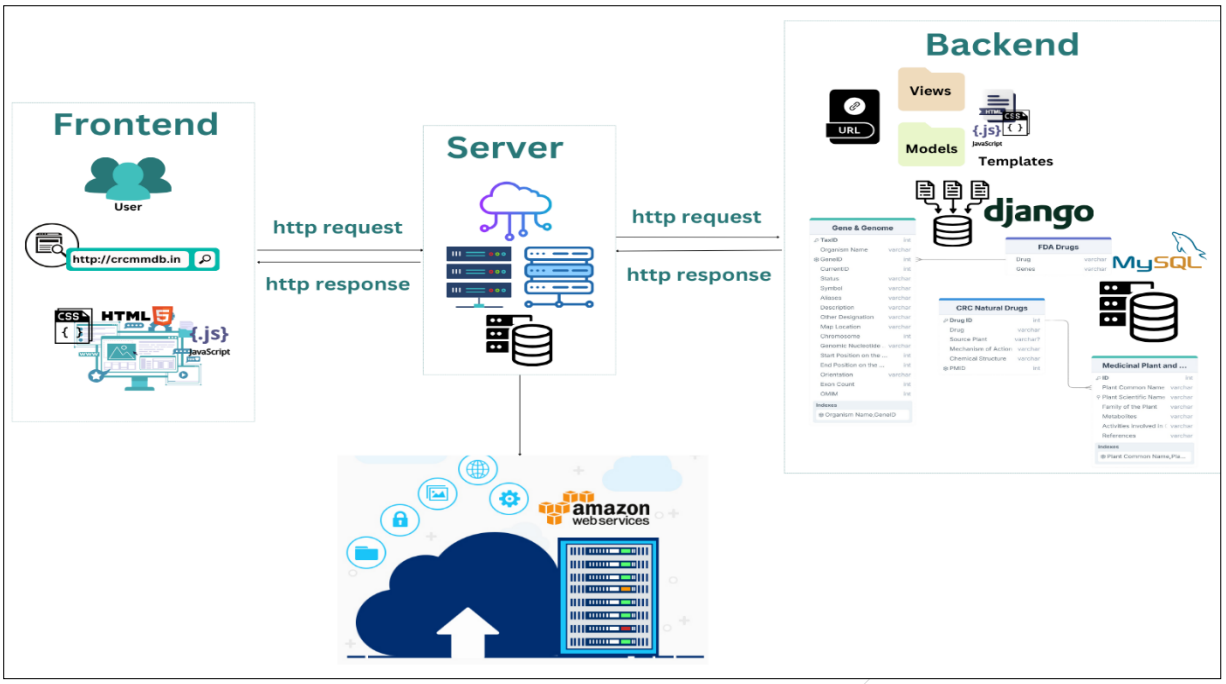

Figure 3 - Workflow and methodology of data acquisition and consolidation for CRCMMDB

Data Collection

The database is primarily composed of 100 medicinal plants, detailing their metabolites/bioactive compounds and associated pathways/activities in CRC. The information is meticulously curated with references and citations from the NCBI database. The database encompasses a comprehensive section providing insights into the introduction and role of colorectal cancer, its stages, factors, prevention strategies, symptoms of carcinoma, and medical conditions. The compiled research papers are sourced from diverse outlets such as literature books, journals, review papers, and databases like PubMed. In addition, the database includes genomic characteristics of plants, featuring taxonomic identifiers (tax_id), organism names (org_name), GeneID, CurrentID, status, symbols, aliases, descriptions, other designations, map locations, chromosomes, genomic nucleotide accession versions, start and end positions on the genomic accession, orientation, exon count, and OMIM. The NCBI database serves as the primary data source for this information. Moreover, there is a dedicated section on natural drugs, providing details such as PubMed identifiers (PMID), drug names, drug IDs, chemical structures, source plants, and mechanisms of action. The families section contains information on medicinal plants, their family affiliations, and scientific names relevant to colorectal cancer. The research papers included are derived from various sources, including databases, multiple journals, literature books, and platforms such as NCBI, PubMed, and PubMed Central. The components encompassed within the database are elucidated in Figure 4.

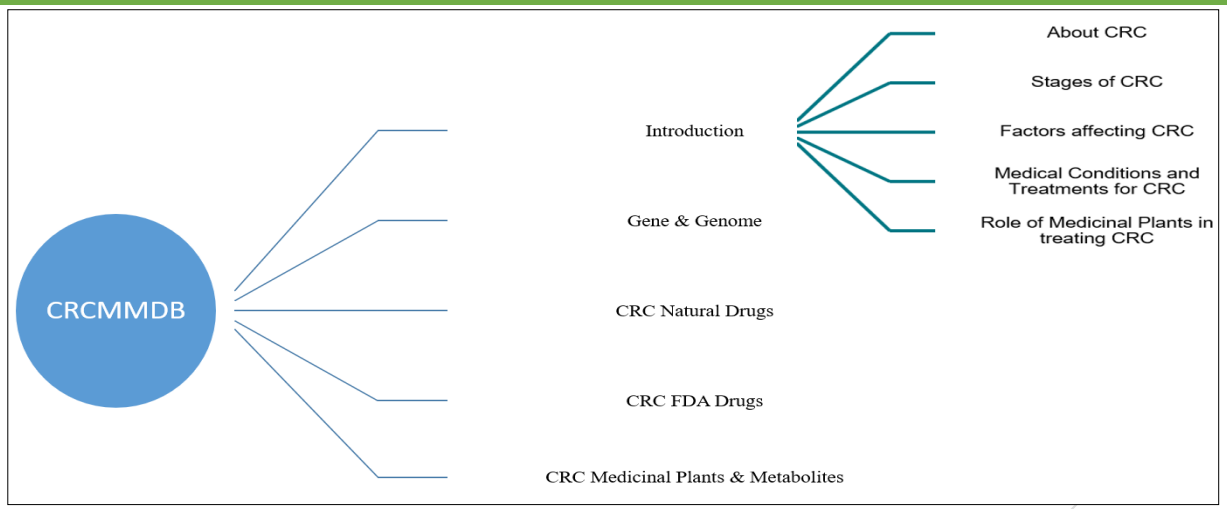

Figure 4 - Comprehensive depiction of the database content coverage

Experimental Setup and Procedure

In the Experimental Setup, we detail the development and data curation process for the Colorectal Cancer Medicinal Plants and Metabolites Database (CRCMMDB). We selected 100 medicinal plants from scientific databases like NCBI and PubMed, focusing on those with proven anticancer properties, especially in CRC. Each plant and its bioactive compounds, such as alkaloids and polyphenols, were validated through in vitro and in vivo studies for their roles in cancer mechanisms like apoptosis and cell cycle inhibition. These compounds were mapped to CRC-specific genes and pathways using KEGG, ensuring accurate associations with tumor suppressor genes and oncogenic pathways.

Technically, CRCMMDB was built using Django v4.3.2, a Python web framework, and SQLite3 as the backend database for handling structured data. Django's ORM facilitated efficient data management, and the relational schema allowed for easy connections between plants, bioactive compounds, and cancer pathways. The user-friendly interface includes advanced search options, detailed plant profiles, and secure access. Rigorous testing ensured data integrity and query performance, making CRCMMDB a reliable tool for researchers in CRC treatment exploration.

Result

Database Design

The database comprises entities, namely genomics, natural drugs specific to colorectal carcinoma, medicinal plants and associated metabolites, and bioactive compounds with potential effects on carcinoma within the medicinal plant family. The data model employs one-to-many relationships throughout the data frame, facilitating an unrestricted number of connections. Comprehensive logging is implemented for all data flow. The web development framework employed is Django v4.3.2 with integrated sqlite3and the design flow of the database is represented in **Figure 5**. Renowned for their reliability and optimization prowess, widely acclaimed web design frameworks like Django and SQLite3 are indispensable in the development of resilient web applications.

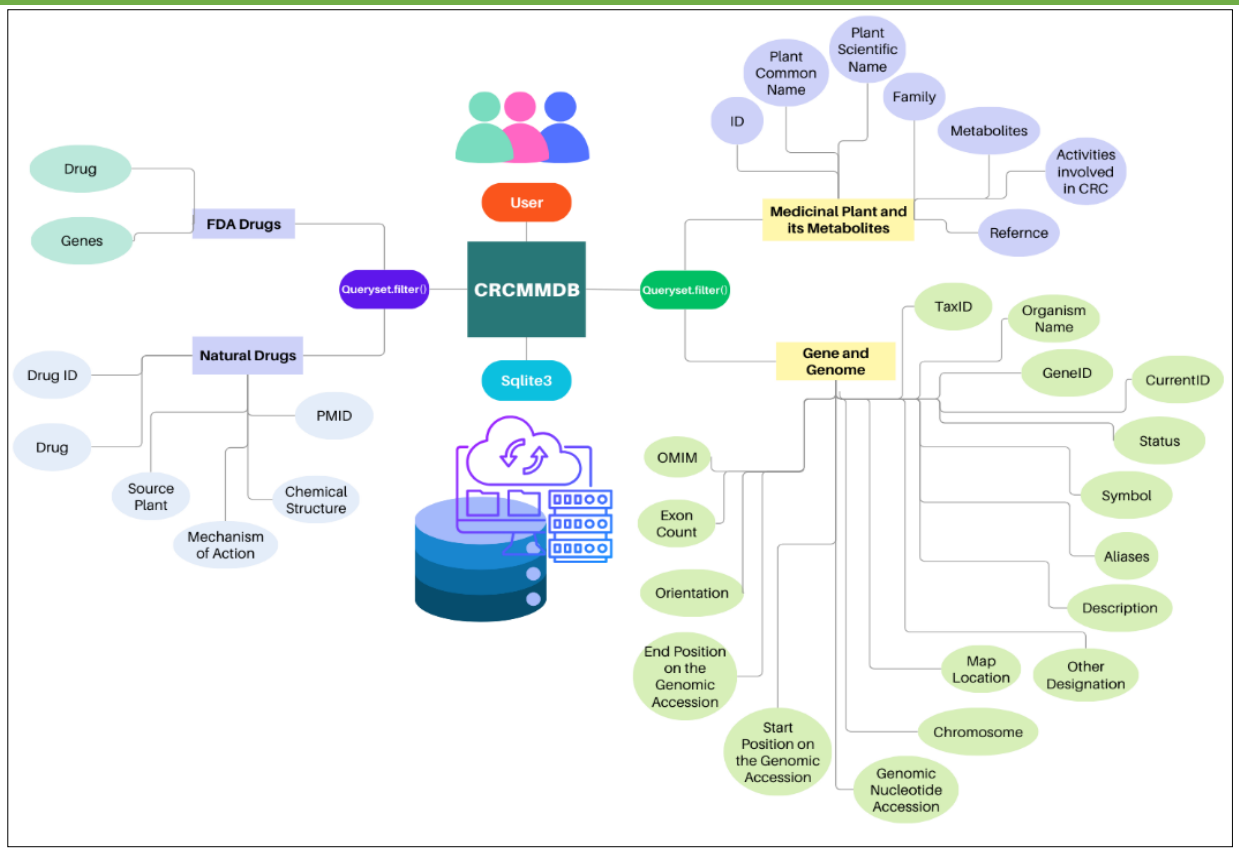

Figure 5 – Schematic Overview of the Database Design Flow

Key Features

The Colorectal Cancer Medicinal Plants and Metabolites Database (CRCMMDB) serves as an extensive repository for consolidating information related to natural drugs, biological compounds, and medicinal plants associated with colorectal cancer. The database addresses the challenge of scattered data by integrating genomics and information on natural drugs, medicinal plants, and their metabolites. It covers various aspects of colorectal cancer, including stages, risk factors, prevention, symptoms, and therapies, thereby enhancing accessibility for researchers. Within the "natural drug" section, the CRCMMDB provides a curated selection of substances from therapeutic plants, offering details such as PMID, drug, drugid, chemical structure, source plant, and mechanism of action. The platform supports evidence-based research by organizing entries on medicinal plants, metabolites, pathways involved in colorectal carcinoma, and references. Its user-friendly design and advanced search capabilities aim to streamline data retrieval, making it a valuable resource for physicians, researchers, and pharmaceutical scientists exploring alternative treatments for colorectal diseases. Moreover, the database delves into the significance of metabolomic studies in understanding colorectal cancer, recognizing environmental factors contributing to the disease, and highlighting the role of pharmacometabolomic in predicting drug responses and guiding therapeutic interventions. Through meticulous data collection from diverse sources such as NCBI PubMed, the CRCMMDB aspires to be a pivotal tool for advancing research, supporting evidence-based treatments, and fostering the exploration of non-pharmacological interventions for colorectal disorders. The database design utilizes Django v4.3.2 with SQLite3 integration, ensuring a reliable and optimized platform for researchers seeking a comprehensive understanding of colorectal cancer.

Discussion

While the experimental design and data integration strategies are sound, the significance of CRCMMDB lies in its ability to bridge the gap between modern oncology and ethnopharmacology. By consolidating data on natural treatments, CRCMMDB enables a more integrative approach to CRC therapy, potentially facilitating the development of less toxic and more cost-effective treatments. However, we acknowledge that while the database provides a strong foundation, further experimental validation

of the plant-derived compounds' efficacy in clinical settings is necessary. Future work will focus on expanding the database to include clinical trial data to strengthen its applicability in translational medicine.

CRCMMDB represents a significant advancement in consolidating medicinal plant data for CRC treatment, it is important to emphasise the limitations. Many bioactive compounds in the database have shown promising results in preclinical studies, but their clinical efficacy remains to be fully validated. Moreover, while the database offers a wealth of information, further research is necessary to confirm the safety and effectiveness of these natural compounds in real-world clinical applications. Moving forward, the integration of clinical trial data and patient outcomes will be critical for improving the database's practical relevance to both researchers and clinicians.

Conclusion

The Colorectal Cancer Medicinal Plants and Metabolites Database (CRCMMDB) is a pivotal and exhaustive repository within the domain of colorectal cancer research. Given the escalating global incidence of colorectal cancer, there is an imperative need for a consolidated and easily accessible data repository. CRCMMDB meets this exigency by amalgamating information on natural drugs, medicinal plants, their metabolites, and genomics into a user-friendly platform. The database not only furnishes intricate insights into the stages, influencing factors, and preventive measures for colorectal cancer but also accentuates the potential therapeutic advantages of medicinal plants and their bioactive compounds. The database's inclusivity of a diverse spectrum of information, spanning genetic factors to the mechanistic actions of medicinal plants, underscores the requisite multidimensional approach for the efficacious management of colorectal cancer. This database emerges as a crucial resource that enhances traditional treatment approaches by providing a curated collection of natural drugs from medicinal plants, validated through extensive research. By integrating diverse data sources and focusing on bioactive compounds relevant to colorectal cancer, CRCMMDB bridges the gap between contemporary scientific inquiry and traditional knowledge, facilitating collaboration among researchers and clinicians. As interest in natural therapies grows, this database not only underscores the importance of exploring medicinal plants but also serves as a vital tool in advancing effective management and prevention strategies for colorectal cancer.

Abbreviations:

CRC- Colorectal Cancer
CRCMMDB- Colorectal Cancer Medicinal Plants and Metabolites Database
NCBI: National Center for Biotechnology Information
ORM: Object Relational Mapper
TCGA: The Cancer Genome Atlas
OMIM: Online Mendelian Inheritance in Man
APC: Adenomatous Polyposis Coli

Data availability statement

The article/supplementary material encompasses the ground-breaking findings introduced in this study. We strongly encourage directing any additional queries to the corresponding author.

Author Contribution:

Pankaj Kumar Tripathi: Data Curation, Methodology, Software, Investigation, Resources, Formal Analysis Writing - Original Draft, Writing - Review & Editing, Visualization.
Chakresh Kumar Jain: Conceptualization, Supervision, Validation. All authors contributed to the article and approved the submitted version.

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Conflict of Interest

The authors confirm that they carried out the study without any involvement in commercial or financial affiliations that might create a potential conflict of interest.

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