

FLAVONOIDS IN ACACIA CATECHU BARK EXTRACTS AND BIBLIOGRAPHIC ANALYSIS IN GUNA, MADHYA PRADESH, INDIA

ARCHANA TIWARI^{1*}, AVINASH TIWARI²

¹Department of Botany, Government P. G. College Guna-473001, Madhya Pradesh, India. ²Jiwaji University, Gwalior-474011, Madhya Pradesh, India

*Corresponding author: Archana Tiwari; *Email: archanaashish19@gmail.com

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ABSTRACT

Objective: The objective of this work is to examine the overall flavonoid content in bark samples of *Acacia catechu* obtained from the Guna region of Madhya Pradesh, India, using several extraction methods. Furthermore, this study has incorporated current literature, conducted bibliographic analysis, examined co-authorship studies, and gathered other pertinent material to augment comprehension and underscore the importance of the research.

Methods: For the purpose of this experiment, a total of thirty samples of test plants were gathered from the research region throughout various seasons. Each individual sample was prepared with six different solvents. Following this, a standardized laboratory technique was used to undertake quantitative testing. The bibliographic analysis was conducted using Dimension AI and VOS viewer software in the timeframe of 1975-2024 (till March 8, 2024).

Results: Findings indicated that the polar organic solvents methanol, ethanol, acetone, and the aqueous extracts were shown to display a substantial quantity of flavonoids, chloroform extracts exhibited negligible and benzene extracts were found to be entirely devoid of the same. The comparative bibliographic investigations have confirmed the need to study the possible medicinal properties of test plants in the Guna region.

Conclusion: This preliminary study has the potential to identify new, economically viable, and readily available sources of flavonoids, which are natural antioxidants present in the indigenous flora of the Guna region.

Keywords: *Acacia catechu*, Flavonoids, Dimension AI, Acetone extract, Bark, Bibliographic analysis, Antioxidant

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INTRODUCTION

Flavonoids are a class of secondary metabolites primarily composed of a benzopyrone ring structure with monophenolic or polyphenolic groups [1]. These bioactive phytochemicals, distributed across different plant parts, augment the medicinal properties and biological effects of the plants. Based on their chemical nature and occurrences, they have categorized into several subgroups, such as anthoxanthins (including flavanone and flavanol), flavanonols, flavans, chalcones, anthocyanidins, and isoflavonoids [1, 2].

Flavonoids exhibit various medicinal characteristics such as, in many researchers these have reported for their antioxidant properties, anti-inflammatory effects, antimicrobial, anti-arthritis, antiangiogenic, anti-cancer properties, anti-inflammatory, neuroprotective, antitumor and modulation of cellular enzyme activity [2-4]. Preparations derived from apple peel, rich in flavonoids, have demonstrated efficacy as antihypertensive medications and are implicated in the prevention of cardio-metabolic disorders, as well as the preservation of cognitive function in aging individuals [5].

Many flavonoids are recognized for their therapeutic potential and are commonly found in fruits, stems, grains, nuts, peels, vegetables, flowers, leaves, pods, and seeds, for example, oranges, lemons, and grapes etc., notably, contain abundant flavonoids, including naringenin and hesperetin [2, 3]. Other foods that are rich in the same are Legumes, buckwheat, soya beans, onion, tomato skin, broccoli, red pepper, red wine, Parsley, kale, thyme, olive oil, apples, cherries, strawberry, and grapefruit etc., [3-5].

Some non-food plant parts have been known for their flavonoid content are barks, heartwood etc [6], one such example is bark of *Acacia catechu* plant [7]. *Acacia catechu* is widely grown and belongs to the Fabaceae family as a deciduous tree [8]. The tree's wood and bark are highly valued for its important medicinal properties, which are the main factor contributing to the plant's enormous appeal [7,

9]. The plant is often known by several names, such as black catechu, black cutch, catechu, cutch tree, dark catechu, and gum catechu [7-9]. Few earlier phytochemical analyses of *Acacia catechu* bark revealed the presence of alkaloids, flavonoids, glycosides, phenolic compounds, several kinds of terpenes, saponins, steroids, and tannins etc [7, 9-11].

Catechin is a flavonoid and often found in large quantities in *Acacia catechu* bark and seems to be accountable for the antioxidant activity of the plant [12]. The catechu extract, derived from the heartwood of the tree, contains 66.9% catechin and 23.1% epicatechin. Research has shown that the catechin, epigallocatechin gallate (EGCG), significantly hinders the functioning of the telomerase enzyme [7, 13]. This enzyme is essential for the growth of cancer cells since it preserves the tips of their chromosomes. Epicatechin is a colourless white powder with a crystalline structure that falls under the flavonol group of flavonoids. It acts as a powerful antioxidant, mimicking insulin and serving as an anti-diabetic agent while also enhancing heart function. Epicatechin-3-gallate may be used to treat dental issues like dental caries and periodontal diseases [14, 15]. Quercetin-3-O-rutinoside and quercitrin are types of flavonoid glycosides known as quercetin, which is abundant in *Acacia catechu* bark. Additional quercetin components with potent antioxidant properties have been identified in significant quantities in *Acacia catechu* bark [13-15].

Acacia plants are abundant in India, especially in Madhya Pradesh. The abundant variety of flowers in Guna region makes a substantial contribution to the country's herbal resources [16]. Research indicates that while there has been much work on ethnomedicinal plants in India, certain interior areas like the Guna district need more study to discover novel traditional treatments [10, 11, 17].

The bibliographic analysis summarizes the research, publications, and timings of investigations conducted. Commonly used databases

include Dimensions, Scopus, and PubMed [18]. The research used a dimension database together with the VOS viewer program [19]. Dimensions is a database that contains abstracts, citations, research funding and connects grants to subsequent articles, clinical trials, and patents [20]. Dimensions is a division of Digital Science and Research Solutions Ltd, based in London, United Kingdom. Bibliometric networks may be created and seen using the freeware program VOS viewer [18, 20]. Citation, bibliographic coupling, co-citation, or co-authorship relationships may be utilized to establish these networks, which may comprise journals, researchers, or individual articles [19, 20]. Bibliometric networks may be readily explored and analyzed with this tool. Density visualizations provide a rapid summary of the main regions within a bibliometric network. Overlay visualizations may be used to display changes over time [19-21].

Despite extensive research on the phytochemistry and pharmacology of *Acacia catechu* bark, the available data and literature review indicate that the thick forests with similar flora in Guna district of central India have not been scientifically investigated [22]. This study aims to fill this gap by consolidating data on the total flavonoid content in *Acacia catechu* bark samples collected from the Guna district of Madhya Pradesh, India, using various extraction techniques. The bark samples were analyzed comparatively for the effects of season, different extraction systems, time intervals, and other factors. The quantitative data obtained was collected and examined at various levels. Additionally, existing literature, bibliographic analysis, co-authorship studies, and publications in different research categories, other relevant information have been compiled to enhance the understanding and significance of this study [19-21].

MATERIALS AND METHODS

Chemicals

Quercetin, aluminum chloride, sodium hydroxide, sodium nitrite, aluminum chloride, phosphoric acid, hydrochloric acid, toluene, ethyl acetate, n-hexane, dimethyl sulfoxide (DMSO), ethyl ether, ethanol, benzene, Sulphuric acid, methanol, acetone and distilled water were obtained from Hi Media Laboratories Ltd., Mumbai, India. Sodium chloride, sodium sulphate anhydrous, and all other reagents were purchased from Sisco Research Laboratories (SRL) Pvt. Ltd and E-Merck (India) Ltd., Mumbai, India.

Collection and processing of bark samples

For this study, a total of 30 different plant samples were randomly collected over two consecutive years (2016 and 2017) from the Biloniya hamlet in Guna, Madhya Pradesh, India. The specimens were deposited in the herbarium of the School of Studies in Botany, Jiwaji University, Gwalior, with voucher numbers AC-101A-1010/SOB2016 and AC-102A-1020/SOB2017. The collection area had geographical coordinates of approximately L24.650000 and A77.320000, covering an area of one square kilometer. To assess the seasonal impact on the total polyphenolic content, five plants were sampled during winter (mid-January), summer (mid-May), and the rainy season (mid-September) each year. Bark samples weighing between 2500 and 3000 grams were randomly collected from *Acacia catechu* trees at a diameter of breast height (DBH) of 1.3 meters above the ground. The samples were manually cleaned with a cotton cloth upon collection and transported to the laboratory under aseptic conditions. Subsequently, the bark samples were dried for almost one month, in the shade. Following the drying process, the bark samples were ground at room temperature using a mechanical grinder and sieved through a 0.5 mm mesh. The powdered materials were then stored at 4 °C for further experimentation [7, 22].

Preparation of bark extracts

At ambient temperature, 50 grams of bark powder underwent extraction using 1000 milliliters of double distilled water (at a ratio of 1:20 weight/volume) with continuous magnetic stirring for a duration of 3 h. Subsequently, the mixture was allowed to stand for 24 h to yield the aqueous extract, which was then filtered and dried before being weighed. For the extraction using organic solvents (80% ethanol, methanol, benzene, chloroform, acetone), 50 grams of

finely powdered samples were thoroughly blended with 1000 milliliters of solvent (at a ratio of 1:20 weight/volume) at room temperature. After being subjected to 12 h of agitation on a shaker rotating at 150 revolutions per minute, the mixtures were left undisturbed for an additional 24 h. The resulting solutions were first filtered through muslin cloth and then re-filtered using Whatman No. 1 filter paper. The pure extracts were obtained by complete solvent evaporation under reduced pressure from the filtered solutions. The dried extracts were stored (at 4 °C) for subsequent processing. For both *in vitro* and *in vivo* testing, the dry powders were dissolved in fresh double distilled water [7, 22, 23].

Total flavonoids quantification

This was done following the methodology of Leontowicz *et al.* (2003). In brief, 0.25 milliliters of the extracts were combined with 1.25 milliliters of distilled water to achieve concentrations of 25, 50, and 100 parts per million (ppm). Subsequently, 75 microliters of a 5% sodium nitrite solution and 150 microliters of a 10% aluminum chloride (AlCl₃.6H₂O) solution were added. After a 5-minute incubation period, 0.5 milliliters of a 1 M solution of sodium hydroxide (NaOH) were introduced. The final volume was adjusted to 2.5 milliliters using distilled water. Optical density was measured at 510 nanometers by comparing it to a blank sample prepared in the same manner. Additionally, a reference sample containing a known concentration of quercetin was prepared and utilized for comparison purposes. The results were expressed as milligrams of quercetin equivalent per 100 grams of the extract's dry weight [24].

Bibliographic study

Our objective was to assess the cumulative publication output over the past 50 y concerning the studied medicinal values of flavonoid of *Acacia catechu* bark extract, particularly within the Guna region. To accomplish this, we utilized the Dimensions database as the primary source of research publications. Data regarding the number of research articles published annually was gathered from 1975 up to March 8th, 2024 (1 p. m.) using keywords such as "flavonoid of *Acacia catechu* bark extract" and "flavonoid of *Acacia catechu* bark extract of Guna district, Madhya Pradesh" [18, 25]. The dimensions database yielded data that satisfied the specified criteria, including the year of publication, journal type and title, authors, keywords, document type etc., were exported in CSV (comma-separated values) format. The analysis of co-authorship, co-occurrence, citation, bibliographic coupling, publications in different research categories, and themes etc., were conducted using VOS viewer version 1.6.10 [26].

Statistical analysis

For better understanding, the obtained results were analyzed based on three criteria and outcomes were divided into three sections. Section 1 focused on a comparative study of the polarity and nature of solvents used for extracting total polyphenolic content. In Section 2, data were analyzed to compare the seasonal variations, specifically assessing the impact of winter, summer, and monsoon seasons on the total polyphenolic content within the same set of samples. Section 3 involved the comparison of samples collected in the same seasons of different years grouped according to the individual solvent systems used. The aim was to identify any differences in their total polyphenolic content. The values are presented as mean ± standard error (SE). Statistical analyses were performed using unpaired Student's t-tests and one-way analysis of variance (ANOVA). A significance level of 5% or less was considered statistically significant. The results of bibliographic analysis were depicted in terms of fig. and numbers.

Data presentation

In all the following figures, the abbreviations and symbols used are as follows: Meth (methanolic extract), Eth (ethanolic extract), Aqu (aqueous extract), Ace (acetone extract), Chlo (chloroform extract), Benz (benzene extract). Samples 1-5, collected in winter (January 2016), are represented as group-1 (G1); Samples 6-10, collected in summer (May 2016), are represented as group-2 (G2); Samples 11-15, collected in the rainy season (September 2016), are represented as group-3 (G3); Samples 16-20, represented as group-4 (G4), were

collected in winter (January 2017); Samples 21-25, collected in summer (May 2017), are represented as group-5 (G5); and Samples 26-30, collected in the rainy season (September 2017), are represented as group-6 (G6).

RESULTS

The results revealed varying levels of total flavonoids in different extracts, ranging from high to low. Findings from Section 1 indicated that extracting bark samples in acetone solvent yielded the highest ($p < 0.05$) flavonoid content among all tested solvents. Conversely,

extracting in an aqueous medium resulted in a significantly higher quantity of flavonoids compared to all other extraction methods ($p < 0.05$). The aqueous extraction system demonstrated a moderate flavonoid content, falling between acetone and other solvents. As depicted in fig. 1, the order of total flavonoid content was as follows: Acetone > aqueous > ethanol > methanol > chloroform. However, chloroform extracts presented notably lower levels of flavonoids compared to polar solvents such as acetone, water, ethanol, and methanol ($p < 0.001$). Benzene extracts from all samples were devoid of flavonoids (fig. 1).

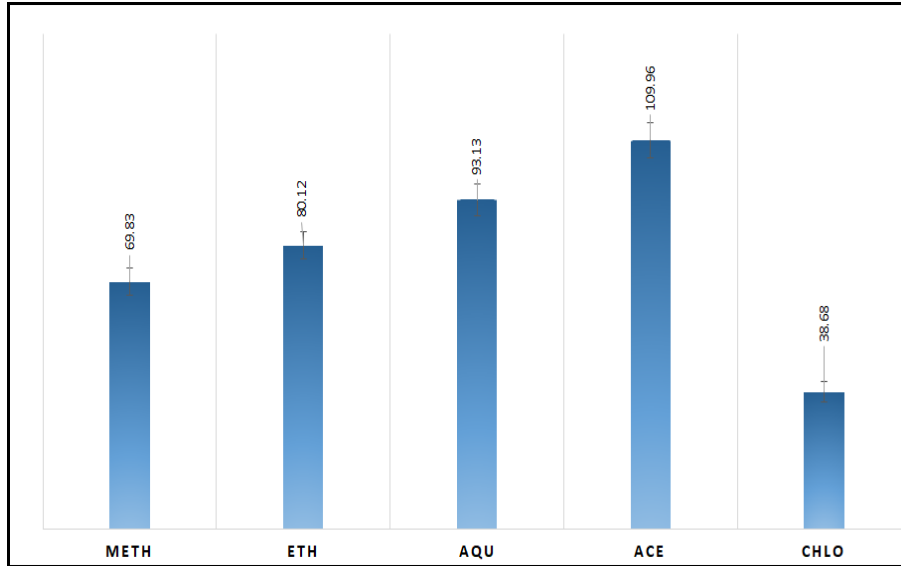


Fig. 1: Comparative study of total flavonoid content in different solvents used for extraction of bark samples. Values are expressed in mean ± SE (n=30 for each bar)

The results of the analysis in Section 2 are presented in fig. 2. This graph illustrates the comparison of the three seasons studied for all extracts. To calculate this, plant samples collected over two consecutive years (total 10 samples from each season) were aggregated to gather data season-

wise. The graph distinctly shows the highest flavonoid content in samples collected during the summer ($p < 0.05$). However, for each extraction system, no significant change was observed between samples collected in winter and monsoon seasons.

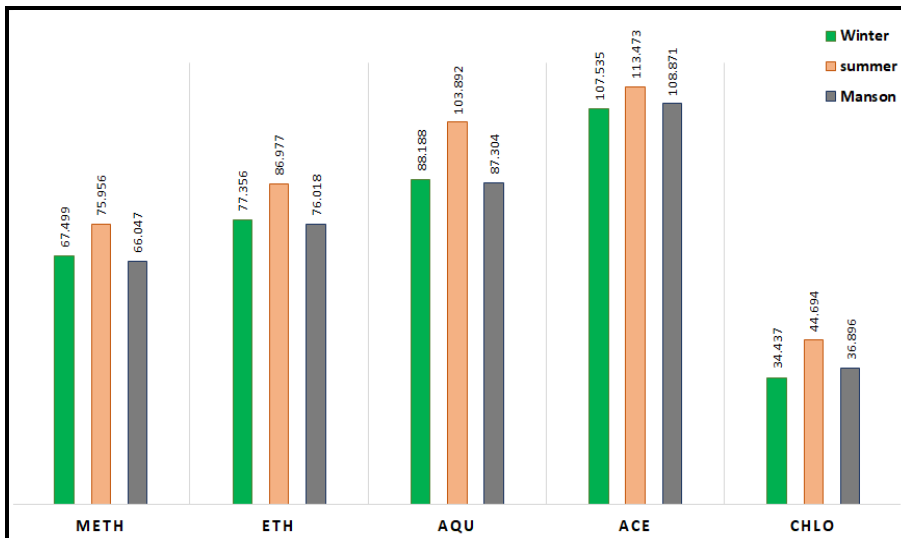


Fig. 2: Comparative study of total flavonoid content in different seasons (i.e., winter, summer and Monsoon) of bark samples. Values are expressed in mean ± SE (n=10 for each bar)

In Section 3, samples from six different groups of individual solvent systems were compared for their total flavonoid content.

For this analysis, samples from all six groups were aggregated and compared, aiming to discern any changes in flavonoid content in

plant samples collected during the same season but in different years. As depicted in fig. 3, for all extracts, no significant difference was observed among samples from groups 1 and 4, groups 2 and 5, and similarly between groups 3 and 6. Thus, samples collected during the same seasons of different years exhibited consistent flavonoid content for this extract. Though the line graph clearly indicated flavonoid content in each tested solvent system, hence

data displayed consistent trends in the findings. The indicated data revealed a significant presence of flavonoids in the test samples. In conclusion, acetone extracts from samples obtained in summer are the most effective solvent for extracting compounds from the bark samples. However, aqueous, methanolic, and ethanolic extracts were also shown to have significant amount of the same.

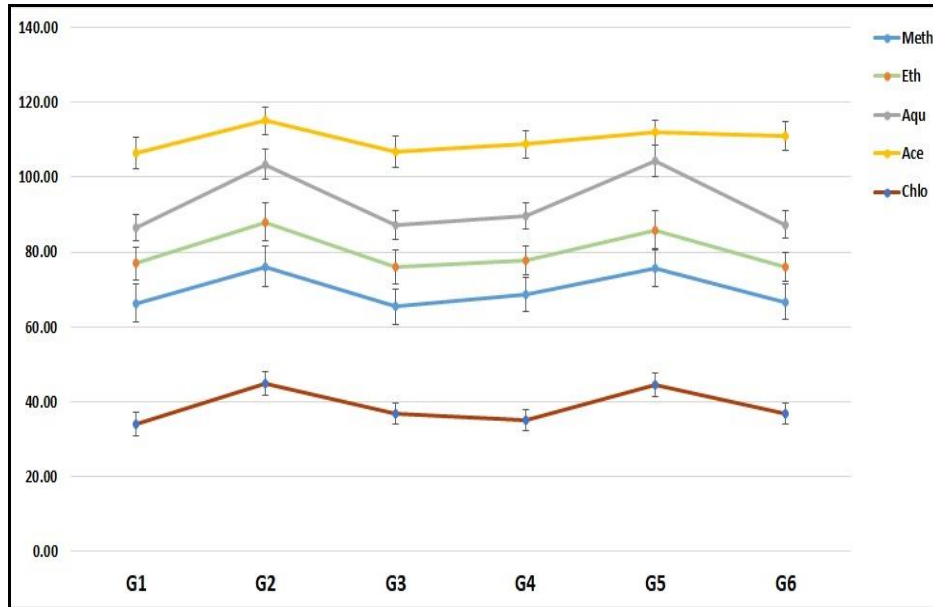


Fig. 3: Comparative study of total flavonoid content of six groups for each solvent system. Values are expressed in mean±SE (n=5 for each bar)

A bibliographic analysis spanning the past 50 y has been conducted to gain insights into the existing research on the topic. The study revealed a total of 2,972 publications pertaining to "flavonoids of *Acacia catechu* bark extract" from 1975 to March 8, 2024. This encompasses 1,091 articles, 1,227 book chapters, and 490 contributions to edited volumes, among others. The distribution of publications per year is depicted in fig. 4, indicating a continuous

increase in research output over time. Furthermore, a search using the terms 'flavonoids of *Acacia catechu* bark extract in Guna district, Madhya Pradesh' yielded a total of 48 hits from 1975 to the present (March 8, 2024). This includes 8 research publications, 30 references from edited books, and others from various sources. These findings underscore the limited extent of research conducted on this topic, particularly within the Guna region (fig. 5).

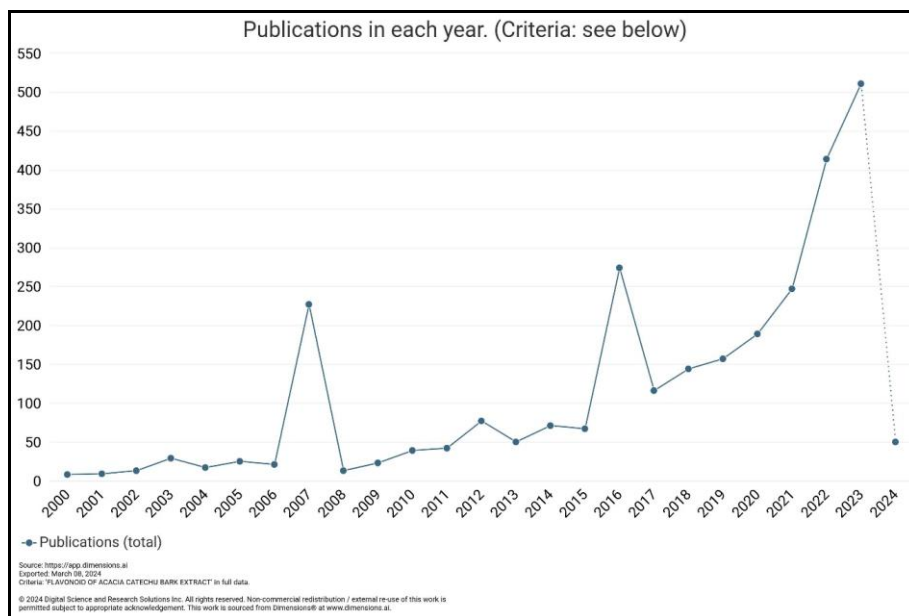


Fig. 4: Database showing number of publications from 2000-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract'

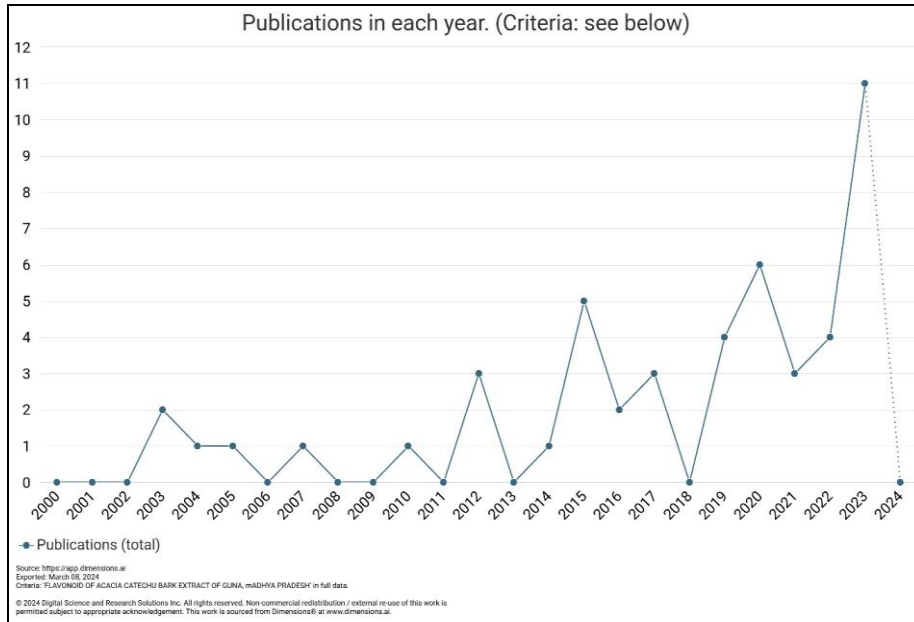


Fig. 5: Database showing number of publications from 2000-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract of Guna district, Madhya Pradesh'

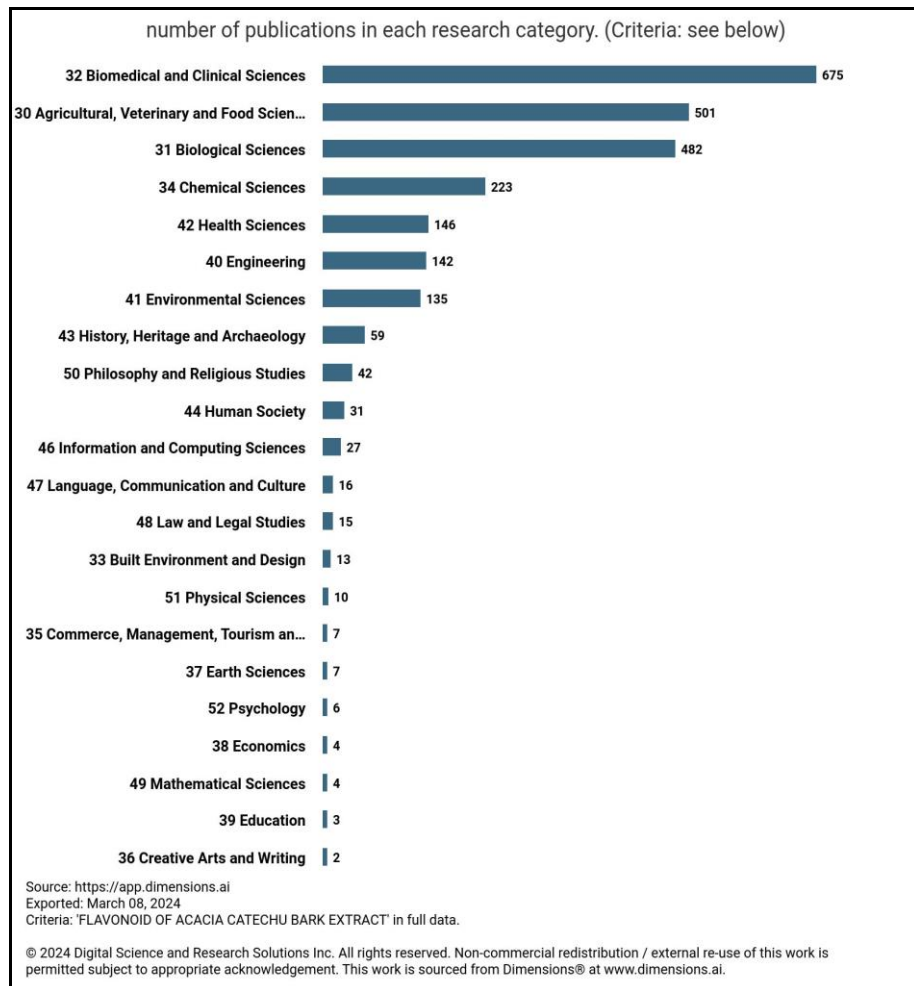


Fig. 6: Database showing number of publications in different research categories from 1975-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract'

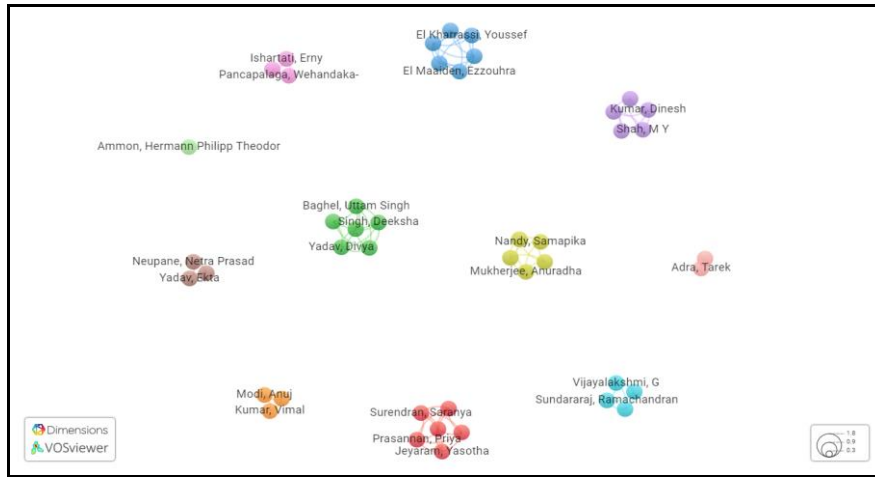


Fig. 9: Co-authorship study using dimensions database and VOS viewer from 1975-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract of Guna district, Madhya Pradesh'

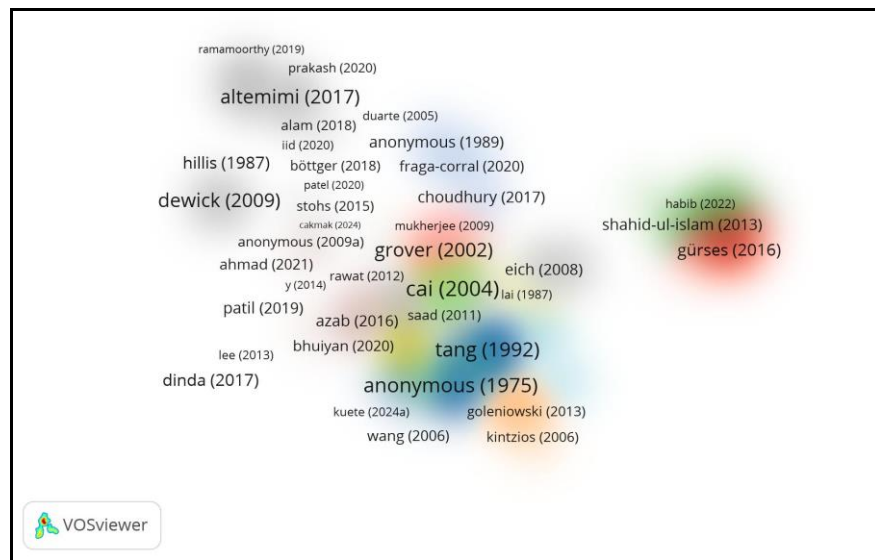


Fig. 10: Density visualizations using dimensions database and VOS viewer software from 1975-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract'

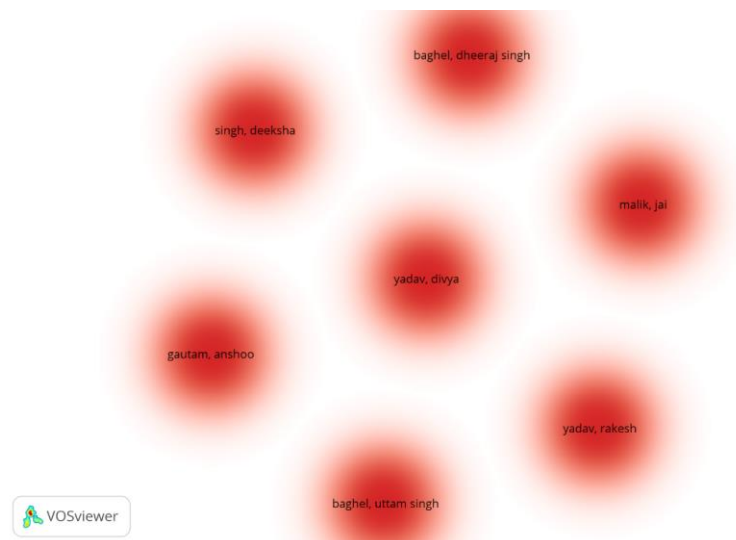


Fig. 11: Density visualizations using dimensions database and VOS viewer software from 1975-March 8, 2024 on 'flavonoid of *Acacia catechu* bark extract of Guna district, Madhya Pradesh'

DISCUSSION

Due to vast number of side effects caused by synthetic drugs, both people and the pharmaceutical sector is now interested in the use of traditional therapeutic herbs [2, 3, 5]. Ethnobotany has discovered several pharmacologically active substances such as aspirin, digoxin, catechin, quinine, curcumin, taurine, anthracene, and opium that can safely be used by people [7, 27]. The main concern of this study was to instigate untapped flora of Guna district, Madhya Pradesh so that, at least indigenous people can be able to scientifically utilize local plants for therapeutic purpose. Though, bibliographic data has cleared that the scientific reports of the same are meager, hence, these results have been discussed with some other researches and with the other reported plants of this area.

As mentioned earlier, flavonoids are a diverse group of natural phenolic compounds [5, 28]. Earlier researchers have said that the bark of the *Acacia catechu* tree is an effective treatment for wounds [8, 10, 29, 30]. The bark extract has shown astringent properties. It is used to stop or reduce bleeding from wounds due to its efficacy as a hemostatic agent [31]. Proanthocyanidins, anthocyanins, isoflavones, flavones, flavonols, flavanones, and other substances are all types of flavonoids which have been known for their protective efficacies [32]. Flavonoids such as catechin, hesperetin, cyanidin, daidzein, proanthocyanidins, and quercetin are often found in many foods [28, 33]. Phenylalanine in flax seed and other grains is transformed into lignans, a kind of polyphenols [34]. Though, in this study, only quantitative analysis has been done, but this was aimed as preliminary research to further analyze the possible medicinal properties of the same. The outcome of the present study revealed the most suitable solvent and season for the extraction of flavonoid from bark of concern plants. Since the same has already been studied for its a number of medicinal properties these have been discussed here. For example, *Acacia caesia* bark has significant pro-healing properties as per ethnopharmacology. The medicinal effects of *Acacia caesia*'s bark extracts may be attributed to the higher amounts of alkaloids, flavonoids, glycosides, and saponins present [23, 35]. In a separate study, the plant was discovered to be used for wound healing in rats and was proven to be more efficacious than conventional ointment [17, 34].

Many researches have shown that the *Acacia catechu* bark extracts have the capacity to scavenge free radicals and possess anti-inflammatory properties, making them beneficial for treating microbial infections and promoting wound healing [29, 32, 34]. Green plants include flavonoids known as catechins that have inhibitory effects on viruses and some bacterial cells such as *Vibrio cholerae*, *Streptococcus mutans*, and *Shigella* [7, 34]. Flavonoids are thought to have antibacterial properties via interacting with extracellular proteins and bacterial membranes. The antibacterial action of some substances is attributed to their ability to inhibit signal receptors and enzymes, destabilize the cytoplasmic membrane, and block extracellular microbial enzymes [34]. Quinones are stable free radicals that may interact with nucleophilic amino acids in microbial proteins, leading to a decrease in their activity. Some known bioactive molecules like catechin of studied plant sample have been recognized for their free radical scavenging potential [6, 9]. Catechin, epicatechin, and its gallic acid conjugates are widely found in vascular plants and are often used in traditional herbal remedies like *Uncaria rhynchophylla* [36]. These two isomers are mostly present in chocolate, tea, and grapes from the *Vitis vinifera* species [2-4, 27]. The heartwood extracts of *Acacia catechu* contain significant quantities of catechin and epicatechin, which are derivatives of gallic acid, along with lower levels of flavonoids [38]. Catechin is categorized as a flavan-3-ol molecule, a kind of secondary metabolite that serves as an antioxidant in plants [39]. It is categorized as a flavonoid, a subset of the polyphenolic category. Along with above mentioned activity, many other protective effects of catechin from *Acacia catechu* bark have been documented in various reports. These findings supported the possible therapeutic potential of the bark extracts examined in the present investigation [7-9, 17, 32].

Plant-derived metabolites' targeted effect may be studied using a novel method known as molecular docking [39]. Research

demonstrated a docking analysis between the active components of *Acacia catechu* and human salivary amylase. Epicatechin gallate, a flavonoid, was the only active component that formed eight distinct hydrogen bonds with human salivary amylase, indicating a significant ability to interact with this enzyme [39, 40]. Although several studies have shown that catechu suppresses pancreatic alpha-amylase, certain investigations suggest a conflicting result. The histologic findings showed increased mucin production and reduced fibrosis around ducts and blood vessels, suggesting that Epigallocatechin gallate (EGCG) supplementation has a strong antioxidant impact and might be recommended as a protective measure for salivary glands before radiation therapy. Recent studies indicate that the active ingredient in *Acacia catechu* may attach to human salivary amylase [8, 10, 17, 30, 41].

The solubility of plant flavonoids in different solvents have been studied earlier also [7, 24, 29]. In general, free flavonoids exhibit solubility in ether, methanol, ethyl acetate, chloroform, and methanol, but some are less soluble in water. Some researchers have seen that the acetone demonstrates the maximum solubility of quercetin (reported as 80 mmol/l) [42]. Though this study found that the flavonoids exhibit the lowest solubility in water due to their hydrophobic nature, but in present study the test samples have been found to exhibit significant amount of flavonoids in aqueous solvent this revealed the possible presence of hydrophilic side chains attached with flavonoids of test samples [39]. Though, similar to above mentioned study maximum solubility of the same have been seen in the acetone solvent.

Further investigation into the mechanisms that govern the physiological impacts of flavonoids derived from different plants could potentially yield novel approaches to the prevention and treatment of numerous physiological disorders. For example, in a study, it has been seen that a natural flavonoid compound from *Scutellaria baicalensis* extracts, combined with *Acacia catechu* have been shown to activate immune system [43]. The flavonoids from these plants have been seen to inhibit cyclooxygenase and 5-lipoxygenase enzymes involved in producing inflammatory cytokinin, thus were reported for their immune-protective and anti-inflammatory potential [44]. Furthermore, administering this combination has been shown to reduce the production of proinflammatory cytokines such TNF- α , IL-1 β , and IL-6. In addition to this, some reports on the bark extracts of Studied plant have also been known to boost anti-inflammatory response induce antioxidative system via activating immune system. Such findings emphasized the protective and beneficial roles of test plant samples [28, 36, 43, 44].

Quercetin is a flavanol that is a bioactive component belonging to the flavonoid subclass of polyphenols [45]. It is a commonly found flavonoid in the diet, according to many studies. Some researchers have identified quercetin in the bark extracts of *Acacia catechu* [7, 17, 29]. Flavones operate as an antibacterial agent by disrupting microbial envelopes. Flavanols serve as an antibacterial agent by forming complexes with the microbial cell wall and deactivating certain microbial enzymes [46]. These are well recognised as antibacterial, antiviral, and anti-inflammatory medications [7, 45-47]. Flavonoids are thought to have antibacterial properties via interacting with extracellular proteins and bacterial membranes [34]. The antibacterial action of these compounds is attributed to inhibiting QS signal receptors and enzymes, destabilizing the cytoplasmic membrane, and blocking extracellular microbial enzymes [46, 47].

Other than these, research showed that the Isorhamnetin 3-O-neohesperidoside, a flavonoid glycoside, extracted from *Acacia laeta* leaves shown to shield cells from oxidative damage by blocking xanthine oxidase [48]. Furthermore, it has been shown to eliminate a superoxide anion that hinders *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Klebsiella oxytoca* and other types of microorganisms [34]. The therapeutic potential of secondary bioactive chemicals from several test plant species has been demonstrated in multiple studies [34, 43, 44]. So the above-mentioned data revealed the antioxidative, anti-microbial, anti-cancer, immune-modulating and many more medicinal potentials of the same. In recent times,

flavonoids have garnered significant attention in the realms of nutrition and therapeutics [18, 20, 30, 48-50]. The literature study, bibliographic analysis and co-authorship analysis also provide authentic data on the medicinal and health-boosting roles of the same [18, 20, 51, 52]. The smaller number of research articles on the test plants from Guna district again implies the immense need of study in this location. This study might serve as ground for further pharmacological investigations.

CONCLUSION

In conclusion, firstly, using bibliographic data, the research gap on the phytochemistry and pharmacology of *Acacia catechu* plant samples from Guna district of central India has been identified. Then, as mentioned earlier, the different extraction systems were applied to analyzed the flavonoid content. Further investigations into the underlying mechanisms of the biological impacts of plant flavonoids have the potential to provide novel approaches for the prevention and management of physiological diseases. A comprehensive comprehension and awareness of flavonoids and their physiological advantages would facilitate the formulation of dietary guidelines pertaining to flavonoids.

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Nil

AUTHORS CONTRIBUTIONS

I, Mrs. Archana Tiwari, assistant professor, Government P. G. College Guna, District Guna, Madhya Pradesh, India has done the above complete research work under the guidance and supervision of Professor (Dr.) Avinash Tiwari, Vice-chancellor and Professor, School of studies in Botany, Jiwaji University, Gwalior, (M. P.) India, under whom I am pursuing my present research work as Ph. D. candidate.

CONFLICTS OF INTERESTS

Declared none

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