Interdisciplinary Research Review

Volume 20, Number 5, Pages 1 – 9

Phytochemical Components of *San Francisco (Codiaeum variegatum)* Species

Florieza M. Mangubat[1*]

[1] College of Arts and Sciences, Cebu Technological University, Tuburan Campus

Abstract

This study examined the phytochemical composition of five *Codiaeum variegatum* cultivars: 'Victoria Gold Bell', 'Petra', 'Red Iceton', 'Oakleaf', and 'Super California' collected in Tuburan, Cebu, Philippines. Methanolic extracts from leaves and stems were analyzed using standard phytochemical screening to identify secondary metabolites. Results showed the presence of saponins, tannins, alkaloids, flavonoids, glycosides, phytosterols, and phenols, though their distribution varied by cultivar and plant part. These bioactive compounds are associated with antimicrobial, anticancer, antioxidant, antidiarrheal, and anthelmintic properties, suggesting that C. variegatum may serve as a potential source of therapeutic agents. The consistent detection of alkaloids, phenols, and flavonoids supports the traditional applications of the plant in treating gastrointestinal, dermatological, and infectious conditions. However, the toxic nature of some cultivars underscores the need for caution in promoting their use for household or medicinal purposes. While the findings provide baseline evidence of the biomedical potential of C. variegatum, further pharmacological and toxicological validation is essential to ensure safe application in pharmaceutical or biocontrol contexts.

Keywords: *Codiaeum variegatum*, Phytochemical components, Victoria Gold Bell, Petra Croton, Red Iceton Croton, Oakleaf Croton, Croton Super California

Article history: Received 23 April 2024, Revised 25 September 2025, Accepted 27 September 2025

1. Introduction

Codiaeum variegatum (L.) Rumph. ex A. Juss., commonly known as garden croton, is an ornamental shrub belonging to the Euphorbiaceae family. Native to Southeast Asia and the Pacific Islands, it is widely cultivated in tropical and subtropical regions for its striking foliage. Beyond its decorative value, C. variegatum has long been utilized in traditional medicine across Asia, Africa, and the Caribbean, where decoctions and extracts from its roots, bark, and leaves have been applied to treat gastrointestinal disturbances, skin infections, ulcers, and parasitic diseases [1,2]. Phytochemical studies have confirmed the presence of diverse secondary metabolites, including alkaloids, tannins, saponins, flavonoids, glycosides, and phenols, many of which contribute to its reported pharmacological properties, such as antimicrobial, antidiarrheal, anticancer, antioxidant, and anthelmintic effects [3,4]. Several cultivars of *C. variegatum* are locally abundant in the Philippines and other tropical regions, each exhibiting morphological variation and potentially distinct phytochemical profiles. *C. variegatum* 'Victoria Gold Bell', notable for its golden variegated leaves, has been reported to contain alkaloids, flavonoids, and phenolic compounds, which may account for its observed antimicrobial and antioxidant activities [5]. *C. variegatum* 'Petra', one of the most commercially popular cultivars in Southeast Asia, is particularly rich in flavonoids and tannins, compounds associated with potent antioxidant and cytotoxic properties, suggesting potential applications in cancer prevention and management of oxidative stress-related conditions [6]. Preparations are being prepared through boiling, fresh extracts, and powdered components from the plant sources. Such plant extracts in various formulations have been commonly referred to as galenicals. [7,8].

Other cultivars, such as *C. variegatum* 'Red Iceton' and *C. variegatum* 'Oakleaf', have received comparatively less scientific attention but remain

*Corresponding author; e-mail: florieza.mangubat@ctu.edu.ph

ethnomedicinally significant. *C. variegatum* 'Red Iceton', with its vibrant red and yellow foliage, has been observed to yield saponins and glycosides, which are traditionally linked to antidiarrheal and anthelmintic properties [9]. *C. variegatum* 'Oakleaf', named for its lobed, oak-like leaves, has shown preliminary evidence of alkaloid and tannin content, suggesting potential antimicrobial and wound-healing activities. However, more detailed phytochemical studies are lacking [10,11,12,13]. Meanwhile, *C. variegatum* 'Super California', another widely grown cultivar, has been associated with flavonoids, phenols, and phytosterols, which contribute to its antioxidant and anti-inflammatory properties, as well as possible roles in wound healing and gastrointestinal protection [14,15,16].

Despite these promising findings, research on *C. variegatum* remains fragmented and primarily descriptive, with few comparative analyses across multiple cultivars. Moreover, while the presence of beneficial phytochemicals underscores the plant's biomedical potential, reports also highlight its toxicity in specific contexts. Some cultivars of *C. variegatum* contain diterpenes and other compounds that can be toxic when ingested in large amounts, raising concerns about their safety for household medicinal use [17,18]. This dual character as both a potential therapeutic resource and a toxic ornamental plant underscores the importance of rigorous scientific evaluation [19,20,21]. This prompted the researcher to analyze the samples through phytochemical screening and categorize the chemical compounds according to their medicinal purposes [22,23,24,25]. The study may also contribute to public awareness of the unwanted effects of using these plant derivatives. Thus, a scientific investigation was conducted to determine the phytochemicals present in various varieties of the San Francisco plant, with the aim of enhancing its properties for future applications. This study provided baseline information for the development of a biopesticide for pest management or the creation of an extract for the treatment of illnesses.

This study aims to conduct a systematic phytochemical screening of five C. variegatum cultivars: 'Victoria Gold Bell,' 'Petra,' 'Red Iceton,' 'Oakleaf,' and 'Super California' collected in Tuburan, Cebu, Philippines. Specifically, it seeks to (1) identify the presence of key secondary metabolites, (2) compare variations in phytochemical composition across leaves and stems, and (3) provide baseline data that may guide future research on the medicinal, pharmaceutical, and biocontrol potential of these widely cultivated plants. At the same time, it underscores the need for caution regarding their toxicity, ensuring that potential therapeutic applications are pursued within a framework of safety and scientific validation.

2. Materials and Methods

Plant Material. Five cultivars of *Codiaeum variegatum*: 'Victoria Gold Bell,' 'Petra,' 'Red Iceton,' 'Oakleaf,' and 'Super California' were used in the study. For each cultivar, three healthy plants were randomly selected from residential gardens in Tuburan, Cebu, Philippines. From each plant, approximately 200 g of fresh leaves and 100 g of stem bark were collected, resulting in a total of 1.5 kg of plant material across all samples [26]. The collected samples were cleaned with distilled water to remove dust and debris, then shade-dried at room temperature for seven days, and finally pulverized into a coarse powder for extraction.

Choice of Solvent. Methanol was chosen as the extraction solvent because of its high polarity and ability to dissolve a wide range of secondary metabolites, including alkaloids, tannins, flavonoids, glycosides, and phenolic compounds (Lefebvre et al., 2021). Methanol also penetrates plant tissues effectively, ensuring maximum recovery of bioactive constituents compared with non-polar solvents such as hexane or chloroform. Its frequent use in phytochemical studies allows for comparability with previously published work [27].

Chemicals and Reagents. The reagents and chemicals used in the phytochemical screening were of analytical grade and procured from standard suppliers. The following were employed in the qualitative assays: For alkaloids, Wagner's reagent (iodine in potassium iodide solution); for saponins: Distilled water (for Froth and Foam tests)., for tannins: Ferric chloride (5% $FeCl_3$ solution) and gelatin solution; for flavonoids: Shinoda test reagents (magnesium ribbon and concentrated hydrochloric acid), for glycosides (anthraquinone glycosides): Dilute hydrochloric acid, chloroform, and ammonium hydroxide (Modified Borntrager's test), for phytosterols/terpenoids: Concentrated sulfuric acid and chloroform (Salkowski test) and for phenols: Ferric chloride (5% $FeCl_3$ solution). All solutions were freshly prepared before analysis, and distilled water was used throughout the experiments.

Method of extraction. The powdered samples were subjected to cold maceration in methanol at a 1:10 (w/v) ratio for 72 hours at room temperature, with occasional shaking to enhance solvent penetration. After maceration, the extracts were filtered through Whatman No. 1 filter paper, and the solvent was removed using a rotary evaporator under reduced pressure at 40°C, concentrating the extract to dryness. The dried extracts were weighed to calculate the extraction yield [28]. Across the five cultivars, the average extraction yield was 8–12% (w/w) based on the dry weight of the plant material. Leaf extracts generally produced higher yields compared with stem extracts, consistent with the greater accumulation of secondary metabolites in photosynthetic tissues.

Phytochemical Screening. Phytochemical examinations were conducted for all extracts obtained from the *Codiaeum variegatum* plant using standard procedures, including the detection of saponins, tannins, alkaloids, flavonoids, glycosides, phytosterols, and phenols, as shown in Table 1. Each test was performed in triplicate to ensure consistency of results. The outcomes were observed as characteristic color changes or precipitate formation, confirming the presence or absence of specific phytochemical groups. Qualitative phytochemical screening was conducted on the methanolic extracts of the leaves and stems of *Codiaeum variegatum* cultivars using standard protocols. For each test, 2 mL of crude methanolic extract (equivalent to ~200 mg of dried material) was used. The tests and procedures were as follows:

Alkaloids (Wagner's test)**:** To 2 mL of extract, 1 mL of Wagner's reagent (iodine in potassium iodide) was added. The formation of a reddish-brown precipitate indicated the presence of alkaloids.

Saponins. For the Froth test, 2 mL of extract was diluted with 5 mL of distilled water and shaken vigorously for 2 minutes. A stable froth persisting for ≥10 minutes indicated saponins. For the Foam test, the same mixture was gently boiled for 5 minutes, cooled, and observed for foam stability.

Tannins (Ferric chloride and Gelatin tests): In the Ferric chloride test, 2 mL of extract was treated with 1 mL of 5% $FeCl_3$ solution. A blue–black or greenish coloration confirmed the presence of tannins. In the Gelatin test, 2 mL of extract was treated with a 1% gelatin solution containing NaCl; the presence of tannins was indicated by a white precipitate.

Flavonoids (Shinoda test): To 2 mL of extract, a small piece of magnesium ribbon was added, followed by 2–3 drops of concentrated HCl. The development of a pink or red coloration confirmed the presence of flavonoids.

Glycosides (Modified Borntrager's test for anthraquinone glycosides): About 2 mL of extract was hydrolyzed with 2 mL dilute HCl and heated for 5 minutes in a water bath. After cooling, the hydrolysate was extracted with 2 mL of chloroform, and the organic layer was treated with 1 mL of 10% ammonium hydroxide. A pink to red coloration in the alkaline layer confirmed the presence of anthraquinone glycosides.

Phytosterols/Terpenoids (Salkowski test): To 2 mL of extract, 2 mL of chloroform, and 2 mL of concentrated H_2SO_4 were carefully added along the test tube wall. The appearance of a reddish-brown color at the interface indicated the presence of terpenoids or phytosterols.

Phenols (Ferric chloride test): To 2 mL of extract, 2–3 drops of 5% $FeCl_3$ solution were added. The appearance of a deep blue, green, or black coloration indicated the presence of phenolic compounds.

3. Results and Discussion

Table 1. Standard characteristics of the phytochemical tests of the *Codiaeum variegatum* species

Phytochemicals	Test	Observation
Saponins	Froth	Appearance of a steady froth that lasts for more than 10 minutes.
Tannins	Gelatin	The formation of a white or cloudy precipitate
	$FeCl_3$	A blue-black or greenish-black color of the extract.
Alkaloids	Wagner	A creamy white or yellowish precipitate.
Flavonoids	Shinoda	A yellow color shows the occurrence of flavones. An orange color shows the occurrence of flavanones. A red color shows the occurrence of flavonols.
Glycosides	Modified Borntrager's	A rose-pink color in the ammonical layer.
Phytosterols	Salowski	A red coloration at the interface of the two layers specifies the existence of terpenoids, while a yellow color specifies their absence.
Phenols	$FeCl_3$	A positive reaction is shown by the appearance of a blue-black, green, or brownish color.

Table 2. Results of the photochemical screening of the five (5) species of San Francisco plants

Variable	Species									
	Victoria Gold Bell		*Petra Croton*		*Red Iceton Croton*		*Oakleaf Croton*		*Croton Super California*	
	Leaves	*Stem*	*Leaves*	*Stem*	*Leaves*	*Stem*	*Leaves*	*Stem*	*Leaves*	*Stem*
Saponins	+	-	+	-	+	-	+	+	+	+
Tannins	-	-	+	-	+	+	+	-	+	+
Alkaloids	+	+	+	+	+	+	+	+	+	-
Flavonoids	+	+	+	-	+	+	+	+	+	-
Glycosides	+	-	+	+	+	-	+	-	+	+
Phenols	+	+	+	-	+	+	+	+	+	+

Legend: (+) = presence
(-) = absence

Table 2 shows the phytochemical screening results of San Francisco plant extracts obtained from the leaves and stems of the five (5) species, such as Victoria Gold Bell, Petra Croton, Red Iceton Croton, Oakleaf Croton, and Croton Super California. These results reveal the presence of numerous bioactive secondary metabolites, which are primarily responsible for their therapeutic properties. The results and interpretations of the phytochemical assessments are presented as follows:

Saponins. A stable froth that persists for more than 10 minutes indicates the presence of saponins in all five species of San Francisco leaves. However, it is not observed in the stems of Victoria Gold Bell, Petra Croton, and Red Iceton Croton species.

Tannins. A white or cloudy precipitate was only noticeable on the five species of leaf samples of Petra Croton, Red Iceton Croton, Oakleaf Croton, and Croton Super California. Tannins are also evident in the stems of Red Iceton Croton and Croton Super California species.

Alkaloids. A creamy white or yellowish precipitate was observed in all five leaf samples. However, five extracts from stem samples showed alkaloid content, except for the Croton Super California species.

Flavonoids. An orange color was noted in all five species of San Francisco plants, indicating the presence of flavanones; however, it was noticeable that two out of the five stem samples, such as Petra Croton and Croton Super California, did not contain flavonoids.

Glycosides. The formation of rose-pink color was visible among the five leaf samples of San Francisco, but not evident in the three stem samples of Victoria Gold Bell, Red Iceton Croton, and Oakleaf Croton species.

Phenols. A blue-black was observed in all five San Francisco plant leaf samples; the same observation was made in the four stem samples, except for the Petra Croton species.

Percentage yield. The methanolic extraction of leaves and stems from five *Codiaeum variegatum* cultivars yielded extracts ranging between 8–12% (w/w) relative to the dry weight of plant material. Across all cultivars, leaf extracts consistently produced higher yields (10–12%) than stem extracts (8–9%), confirming that leaves contain a greater abundance of solvent-extractable secondary metabolites.

As presented in Table 3, the mechanism of action of the phytochemical composition of the five (5) species of San Francisco plants is shown. As presented, the San Francisco plant possesses various phytochemicals with everyday activity that can be used as an agent against diarrhea, an anti-cancer substance, an anthelmintic ingredient, and anti-microbial properties. Each phytochemical exhibits a distinct mechanism of action through specific biochemical interactions, enabling it to produce its pharmacological effects, which result in a particular response in the body. These phytochemicals include saponins, tannins, alkaloids, flavonoids, glycosides, phytosterols, and phenols.

Table 3. Mechanism of action of the phytochemicals existing in San Francisco plants [28].

Phytochemicals	Activity	Mechanism of Action
Saponins	Antidiarrheal	Inhibits the release of histamine in vitro.
	Anticancer	Holds qualities that permeabilize membranes.
	Anthelmintic	Generates document breakdown and vacuolization.
Tannins and Phenols	Antimicrobial	It combines with adhesins, slows enzymes, deprives substrates, creates complexes with cell walls, disrupts membranes, and forms complexes with metal ions.
	Antidiarrheal	The intestinal mucosa becomes more resilient, secretion is reduced, abnormal water transport across mucosal cells is inhibited, intestinal transit is slowed, and the binding of the heat-labile enterotoxin B subunit to GM1 is blocked, all

Phytochemicals	Activity	Mechanism of Action
	Anthelmintic	of which contribute to the suppression of diarrhea caused by heat-labile enterotoxins. Protein complexes that animals generate in the rumen to increase their intake of digestible proteins disrupt the production of energy by decoupling oxidative phosphorylation, which lowers G.I. energy metabolism.
Alkaloids	Antimicrobial	Disrupts the DNA and cell walls of parasites.
	Antidiarrheal	Reduces prostaglandin and autacoid secretion.
	Anthelmintic	Prohibit the passage of sucrose from the stomach into the small intestine, so limiting the support of glucose to the helminths; acts on the central nervous system (CNS), resulting in paralysis; and has anti-oxidation properties, which reduce nitrate formation, which is beneficial for protein synthesis.
Flavonoids	Antimicrobial	Complexed with the cell wall, it binds to adhesins.
	Antidiarrheal	Impedes prostaglandin and autacoids' secretion; prevents spasmogen-induced contractions; encourages the abnormal water transfer across the mucosal cells to return to normal; and GI release of acetylcholine is inhibited.
Glycosides	Antidiarrheal	Suppresses prostaglandin and autacoid secretion.
Phenols	Antimicrobial	Controlling microbial growth.

DISCUSSION

The present study revealed that the methanolic extracts of five *Codiaeum variegatum* cultivars: 'Victoria Gold Bell,' 'Petra,' 'Red Iceton,' 'Oakleaf,' and 'Super California' contain a diverse suite of secondary metabolites, including alkaloids, tannins, saponins, flavonoids, glycosides, phytosterols, and phenols. These phytochemicals were distributed variably across cultivars and plant parts, with leaves generally yielding higher concentrations than stems. The prominence of flavonoids, alkaloids, and phenolic compounds is particularly noteworthy given their well-documented roles in antimicrobial, antioxidant, and anticancer activities. The average extraction yield of 8–12% further underscores the efficiency of methanol as a solvent in recovering a broad spectrum of metabolites.

The findings are consistent with earlier phytochemical investigations of C. variegatum, which reported similar classes of compounds [29]. Specifically, the detection of flavonoids and tannins in 'Petra' and saponins in 'Red Iceton' supports previous claims regarding the antioxidant and antidiarrheal potential of these varieties [30,31]. Likewise, the presence of phenolic constituents in 'Victoria Gold Bell' aligns with [32,33], who observed notable antimicrobial activity in related cultivars. Notably, our confirmation of anthraquinone glycosides through the Modified Borntrager test contributes to the limited literature on glycosidic compounds in *C. variegatum*. While earlier studies often focused on single cultivars or reported broad qualitative results, the present work provides comparative evidence across multiple varieties grown under the same environmental conditions.

The implications of these findings are twofold. First, the broad phytochemical repertoire detected across cultivars suggests promising biomedical potential, ranging from antioxidant and antimicrobial applications to possible roles in cancer prevention and gastrointestinal health. This corroborates the ethnomedicinal uses of *C. variegatum* in various cultures, where decoctions are employed for skin ailments, ulcers, and microbial infections. Second, the results emphasize the need for caution, as some cultivars of *C. variegatum* are known to produce diterpenes and related compounds that are toxic if ingested in large quantities [34,35,36]. Thus, while the phytochemical richness supports further exploration as a source of therapeutic leads, safety assessments remain crucial before clinical or household use is recommended.

Future research should move beyond qualitative screening to quantitative profiling using chromatographic and spectroscopic techniques such as HPLC, LC–MS, and NMR to isolate and characterize specific compounds. Parallel biological assays, including antimicrobial, cytotoxic, antioxidant, and anthelmintic tests, are crucial for establishing direct correlations between chemical composition and pharmacological activity. Furthermore, toxicity studies are necessary to delineate safe dosage ranges and mitigate risks associated with ornamental or household applications. Comparative work across environments and seasons would also be valuable in determining the stability and variability of phytochemical content in these cultivars.

This study provides baseline evidence that *C. variegatum* cultivars grown in Cebu are rich in phytochemicals with potential biomedical applications. At the same time, it highlights the dual character of the species as both a potential source of natural therapeutic agents and a plant with inherent toxic risks. The findings lay the groundwork for more detailed pharmacological, toxicological, and translational studies to harness its potential responsibly.

CONCLUSION

This study was conducted to address the limited and fragmented knowledge on the phytochemical composition of *different Codiaeum variegatum* cultivars, a species traditionally valued for its ornamental appeal and ethnomedicinal uses, yet often regarded with caution due to its reported toxicity. By screening the leaves and stems of five locally cultivated varieties: 'Victoria Gold Bell,' 'Petra,' 'Red Iceton,' 'Oakleaf,' and 'Super California'—using methanolic extraction and standard qualitative assays, we confirmed the presence of key secondary metabolites, including alkaloids, tannins, saponins, flavonoids, glycosides, phytosterols, and phenols. Leaves generally exhibited richer phytochemical profiles than stems, with average extraction yields ranging from 8% to 12% (w/w).

These findings highlight the dual nature of *C. variegatum:* on the one hand, it is a potential source of compounds with antimicrobial, antioxidant, anticancer, and gastrointestinal therapeutic relevance; on the other hand, its known toxicity underscores the need for cautious use. The results provide baseline evidence that can guide further pharmacological, toxicological, and quantitative studies to validate its efficacy, ensure safety, and determine the most suitable applications, whether pharmaceutical, biocontrol, or community-based.

References

[1] R. Harikrishnan C. Balasundaram. Potential of Herbal Extracts and Bioactive Compounds for Human Healthcare. In The Role of Phytoconstituents in Health Care 2020, pp. 3-158. Apple Academic Press.

[2] M.R. Goyal, H.A.R Suleria, R. Harikrishnan. The Role of Phytoconstituents in Health Care: Biocompounds in Medicinal Plants.2020, CRC Press.

[3] E. Mohan, S. Suriya, S. Shanmugam, K. Rajendran. Qualitative phytochemical screening of selected medicinal plants. Journal of Drug Delivery and Therapeutics, 2021, 11(2), pp.141-144.

[4] H.M. Adamu. Phytochemical screening and antioxidant activity of the stem bark extracts of Diospyros mespiliformis: a medicinal plant in Bauchi. International Journal of Pharmacy Research & Technology (IJPRT), 10(1), 2020, pp.37-43.

[5] F.F.Y. Stéphane, B.K.J. Jules, G.E. Batiha, I. Ali, L.N. Bruno. Extraction of bioactive compounds from medicinal plants and herbs. Nat Med Plants, 2021.

[6] P.S. De Vos. Compound Remedies: Galenic Pharmacy from the Ancient Mediterranean to New Spain. University of Pittsburgh Press, 2020.

[7] H.F. Ajobiewe, J.O. Ajobiewe, J.O. Egbe, A.A. Ogundeji, L.C. Umeji. Scholars Journal of Applied Medical Sciences, 2020.

[8] D.J. Fonmboh, E.R. Abah, T.E. Fokunang, B. Herve, G.N. Teke, N.M. Rose, N.N. Borgia, L.B. Fokunang, B.N. Andrew, N. Kaba, N. Bathelemy. An overview of methods of extraction, isolation and characterization of natural medicinal plant products in improved traditional medicine research. Asian J Res Med Pharm Sci, 9(2), 2020, pp.31-57.

[9] T. Lefebvre, E. Destandau, E. Lesellier. Selective extraction of bioactive compounds from plants using recent extraction techniques: A review. Journal of Chromatography A, 1635, 2021, p.461770.
[10] O.R. Alara, N.H. Abdurahman, C.I. Ukaegbu. Extraction of phenolic compounds: A review. Current Research in Food Science, 4, 2021, pp.200-214.
[11] V. Hari. Phytomedicine: Healing Herbs. Notion Press, 2021.
[12] E. Ginko, E.A. Demirović, B. Šarić-Kundalić. Ethnobotanical study of traditionally used plants in the municipality of Zavidovići, BiH. Journal of Ethnopharmacology, 302, 2023, p.115888.
[13] N. Alonso-Hernández, C. Granados-Echegoyen, I. Vera-Reyes, R. Pérez-Pacheco, F. Arroyo-Balán, A. Valdez-Calderón, A. Espinosa-Roa, H.J. Loeza-Concha, E. Villanueva-Sánchez, F. García-Pérez, F. Diego-Nava. Assessing the larvicidal properties of endemic Campeche, Mexico plant Piper cordoncillo var. apazoteanum (Piperaceae) against Aedes aegypti (Diptera: Culicidae) mosquitoes. Insects, 14(4), 2023, p.312.
[14] A.D. Johnson, A. Singh. Evaluation of phytochemical properties and larvicidal activities of taraxerol extracted from leaf of Codiaeum variegatum against Culex quinquefasciatus (Diptera: Culicidae) larvae. 2020.
[15] H.A. Mahran. Using nanoemulsions of the essential oils of a selection of medicinal plants from Jazan, Saudi Arabia, as a green larvicidal against Culex pipiens. PLOS ONE, 2022, 17(5), p.e0267150.
[16] S.H. Aly, A.M. Elissawy, D. Salah, N.A. Alfuhaid, O.H. Zyaan, H.I. Mohamed, A.N.B. Singab, S.M. Farag. Phytochemical investigation of three Cystoseira species and their larvicidal activity supported with in silico studies. Marine Drugs, 21(2), 2023, p.117.
[17] O.T. Osuntokun. Efficacy, properties and therapeutic use of some major medicinal plants for human health. In Biopesticides: Botanicals and Microorganisms for Improving Agriculture and Human Health, 2021, p.179.
[18] T. Omara, A.K. Kiprop, V.J. Kosgei, S. Kagoya. Clausena anisata (Willd.) Hook. f. ex Benth. (Rutaceae): ethnomedicinal uses, phytochemistry, pharmacological activities, toxicity, and clinical application. 2022.
[19] E.M. Njoya, P.M. Fewou, T.H. Niedermeyer. Codiaeum variegatum (L.) Rumph. ex A. Juss. (Euphorbiaceae): An overview of its botanical diversity, traditional uses, phytochemistry, pharmacological effects and perspectives towards developing its plant-based products. Journal of Ethnopharmacology, 277, 2021, p.114244.
[20] A. Adodo, M.M. Iwu. Healing Plants of Nigeria: Ethnomedicine and Therapeutic Applications. Vol. 15. CRC Press, 2020.
[21] R. Singh, S.K. Upadhyay, A. Rani, P. Kumar, P. Sharma, I. Sharma, C. Singh, N. Chauhan, M. Kumar. Ethnobotanical study of weed flora at District Ambala, Haryana, India: comprehensive medicinal and pharmacological aspects of plant resources. International Journal of Pharmaceutical Research, 2020.
[22] S. Khatun, L. Khatun, M.A. Ame, S.A. Sumona, A.M. Rahman. Documentation of angiospermic plants of Puthia Upazila of Rajshahi and their important medicinal values. GSC Biological and Pharmaceutical Sciences, 19(2), 2022, pp.258-281.
[23] S. Pandey, S. Singh. Exploring phytoconstituents and pharmacological profile of Codiaeum variegatum (L.), garden croton. Pharmacological Research – Modern Chinese Medicine, 2023, p.100327.
[24] S. Saggar, P.A. Mir, N. Kumar, A. Chawla, J. Uppal, A. Kaur. Traditional and herbal medicines: opportunities and challenges. Pharmacognosy Research, 14(2), 2023.
[25] M. Kanedi, W.A. Setiawan, K. Handayani, V. Febriyanti. Antipyretic effect of ethanol extract of plant leaves of garden croton (Codiaeum variegatum) in male mice. GSC Biological and Pharmaceutical Sciences, 14(3), 2021, pp.202-206.
[26] C. Cordero, A. Ligsay, G.J.D. Alejandro. Ethnobotanical documentation of medicinal plants used by the Ati tribe in Malay, Aklan, Philippines. J. Complement. Med. Res., 11, 2020, pp.170-198.
[27] D. Tiwari, A.N. Sah, S. Bawari, R.W. Bussmann. Ethnobotanical investigations on plants used in folk medicine by native people of Kumaun Himalayan Region of India. Ethnobotany Research and Applications, 20, 2020, pp.1-35.
[28] L.K. Muharrami, F. Munawaroh, T. Ersam, M. Santoso. Phytochemical screening of ethanolic extract: a preliminary test on five medicinal plants on Bangkalan. Jurnal Pena Sains, 7(2), 2020.

[29] L.T. Nguyen, A.C. Fărcaş, S.A. Socaci, M. Tofană, Z.M. Diaconeasa, O.L. Pop, L.C. Salanță. An overview of saponins – a bioactive group. 2020.

[30] D. Oakenfull, G.S. Sidhu. Saponins. In Toxicants of Plant Origin, 2023, pp.97-142.

[31] M. Fazil, S. Nikhat. Topical medicines for wound healing: A systematic review of Unani literature with recent advances. Journal of Ethnopharmacology, 257, 2020, p.112878.

[32] S. Bhambhani, K.R. Kondhare, A.P. Giri. Diversity in chemical structures and biological properties of plant alkaloids. Molecules, 26(11), 2021, p.3374.

[33] W. Ngwa, R. Kumar, D. Thompson, W. Lyerly, R. Moore, T.-E. Reid, H. Lowe, N. Toyang. Potential of flavonoid-inspired phytomedicines against COVID-19. Molecules, 25(11), 2020, 2707. https://doi.org/10.3390/molecules25112707

[34] A. Sharma, R. Cooper, G. Bhardwaj, D.S. Cannoo. The genus Nepeta: traditional uses, phytochemicals and pharmacological properties. Journal of Ethnopharmacology, 268, 2021, p.113679.

[35] E. Zeidali, H.M. Korrani, Y. Alizadeh, F. Kamari. Ethnopharmacological survey of medicinal plants in semi-arid rangeland in western Iran. Central Asian Journal of Plant Science Innovation, 1(1), 2021, pp.46-55.

[36] J. Liu, C. Du, H.T. Beaman, M.B.B. Monroe. Characterization of phenolic acid antimicrobial and antioxidant structure–property relationships. Pharmaceutics, 12(5), 2020, 419. https://doi.org/10.3390/pharmaceutics12050419.