A Short Report on the Medicinal Plants from Mindanao, Philippines Based on Secondary Data Published Between 1970 and 2020

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Abstract: Mindanao, Philippines is known to be a hotspot for natural products that are utilized mainly in ethnobotanical applications. However, the lack of comprehensive information detailing the prevalent medicinal plants and known bioactivities prevents their use on a wider scale. A narrative synthesis was conducted based on medicinal plants found in Mindanao as reported from journal articles published electronically within the fifty-year period, 1970 to 2020. A total of 563 medicinal plants belonging to ninety plant families were considered and some of the results of the study are reported here. The top three plant families with the most associated bioactivities were found to be Fabaceae, Asteraceae and Lamiaceae. Antimicrobial and antioxidant properties were the two commonly reported bioactivities. The plant species with the highest number of bioactivities are *Abelmoschus esculentus* (L.) Moench (okra), *Clitoria ternatea* L. (balog balog), and *Luffa acutangula* Roxb. (patola). These plants were found to exhibit additional bioactivities such as antihyperglycemic, analgesic, anti-ulcer, and anticancer properties. Previously reported studies indicated that various phytochemicals or secondary metabolites are responsible for the exhibited bioactivities. These include alkaloids, anthocyanins, flavonoids, sterols, tannins, triterpenes, and phenolic compounds. This paper reports parts of a bigger research work that was aimed to provide the first preliminary and comprehensive report on the medicinal plants of Luzon, Visayas and Mindanao.

Key Words: Mindanao; ethnobotany; medicinal plants; bioactivity; secondary metabolites

1. INTRODUCTION

Plant-based natural products play an integral role worldwide in the field of pharmacology as well as in traditional and contemporary medicines. Around 65% of the global population relies on some form of plant-derived medicines (Sharma & Sharma, 2015). Medicinal plants are not only utilized directly in the development of drugs, but are also used in the creation of chemical models important in designing and synthesizing therapeutic substances. In fact, it is estimated that half of the drugs approved between 1982 and 2012 were inspired by natural products (Veeresham, 2012). This is attributed to the plants' ability to synthesize different bioactive compounds called secondary metabolites (Aye et al., 2019; Bernhoft, 2010).

In the Philippines, a study conducted by Tantengco et al. (2018), determined that 1,500 out of the 12,000 plant species found in the country are used by indigenous communities for medicinal purposes alone. More ethnobotanical studies are important in this aspect as they provide relevant information on

how medicinal plants are popularly used in communities for the prevention of diseases and for the promotion of health (Sofowora et al., 2013). In addition, studies on medicinal plants offer promise in advancing drug development. Overall, the aim of research works in natural products is to gather relevant data that may lead to the synthesis of safer, cheaper, and more effective forms of plant-based alternative medicines.

The Mindanao region is of interest in natural products research because of the different ethnic groups inhabiting the area. However, despite the popularity of traditional medicines in this area, there are no published science-based works summarizing the most bioactive plants found in the region. Gaps in knowledge about traditional medicines have been recognized by the scientific community and these result in researchers publishing more data that can provide further understanding of medicinal plants (Bohlin et al., 2010). The study aimed to provide a narrative synthesis based on a comprehensive compilation of medicinal plants found in Mindanao, Philippines, including all relevant information, as reported in journals published electronically within the fifty-year period, 1970-2020. Specifically, the study aimed to report prevalent plant families, plant species, bioactivities, and secondary metabolites. This paper presents some aspects only of a bigger study conducted about Mindanao plants. The study is significant as it can lead to the generation of a comprehensive and updated ethnobotanical archive of traditional medicines from the Mindanao region.

2. METHODOLOGY

A simple narrative synthesis based on the methods of Popay et al. (2006) was conducted to evaluate the secondary data on the medicinal plants from Mindanao that were collected. The study utilized sources primarily found in electronic databases such as Scopus, Web of Science, PubMed, NCBI, Google Scholar, and ScienceDirect, as well as other institutional databases. The keywords used for the search included "medicinal plants in Mindanao," "ethnomedicine in Mindanao," "ethnomedical practices in Mindanao," "ethnobotanical surveys of medicinal plants in Mindanao," and "bioactivity of medicinal plants in Mindanao." Data collection was further narrowed down by specifying the year interval, 1970-2020. A full text review of each journal article found was conducted to ensure that only relevant literatures were selected based on the appropriate inclusion and exclusion criteria. The inclusion criteria included all studies that performed extraction with or without *in vivo* or *in vitro* bioassays. Hence, medicinal plants with no reported bioactivities were excluded from the study. Environmental parameters (e.g. air, temperature, humidity, wind, precipitation, and pressure) were also excluded since published literature lacks sufficient information on these parameters. All other resources that failed to meet the inclusion criteria were not considered as well. Screened data that met both the inclusion and exclusion criteria were organized using a spreadsheet in order to identify relevant information regarding the plant species. A total of 563 plants belonging to ninety families were evaluated. Some of the relevant information that were generated included plant demographics, plant family, extraction method, bioassays, bioactivity, and secondary metabolite contents. Only some parts of the synthesized data are reported in this paper.

3. RESULTS AND DISCUSSION

3.1 Most Prevalent Plant Families and Predominant Bioactivities

This section presents available data that are primarily based on studies involving plant extraction and subsequent *in vitro* bioassays.

Table 1 shows the top fifteen plant families and associated bioactivities of medicinal plants found in Mindanao. The families, Fabaceae, Asteraceae, and Lamiaceae dominated the list. With regard to bioactivities associated with the plant families, antimicrobial and antioxidant properties were the most commonly reported therapeutic properties.

Among the different plant families evaluated in this study, Lamiaceae, Fabaceae, and Piperaceae had the greatest number of plant species with confirmed antimicrobial effects. These results agree with previous studies on antimicrobial bioactivities that were determined after extraction and *in vitro* assays. For instance, multiple studies have determined the antimicrobial effect exhibited by the essential oils of numerous Lamiaceae plants against microorganisms such as *Staphylococcus aureus* and *Brucella melitensis*, as well as several other bacteria responsible for nosocomial diseases (Moumni et al., 2020). These essential oils were found to contain high concentrations of monoterpenes. One proposed mechanism for the ability of different monoterpenes to

exhibit antimicrobial effects is that these compounds were found to elicit toxic effects on bacterial membrane structures, thereby leading to alterations in membrane permeability and the consequent leakage of intracellular materials (Trombetta et al., 2005).

Table 1. Most prevalent plant families in Mindanao and predominant bioactivities.

Family	Total no. plants	Predominant bioactivity	No. of bioactive plants
Fabaceae	45	Antimicrobial	16
Asteraceae	44	Wound-healing	12
Lamiaceae	34	Antimicrobial	17
Euphorbiaceae	29	Antimicrobial	7
Piperaceae	26	Antimicrobial	10
Malvaceae	21	Antimicrobial	8
Moraceae	19	Antioxidant	4
Poaceae	17	Anticancer, antimicrobial	4
Apocynaceae	16	Antimicrobial	5
Zingiberaceae	15	Antioxidant	5
Musaceae	13	Antioxidant	2
Solanaceae	13	Antioxidant	6
Urticaceae	12	Antioxidant	5
Arecaceae	11	Anti-inflammatory, Antioxidant	4
Apiaceae	10	Anti-inflammatory, Antioxidant	3

With regard to the antioxidant bioactivity, among the different plant families examined in this study, Solanaceae, Urticaceae, Arecaceae, and Moraceae had the greatest number of plant species with confirmed antioxidant effects. These results agree with previous studies that examined the antioxidant properties of different plant species under the family Solanaceae. In these reports, both extraction and *in vitro* assays were performed. It was determined that the antioxidant properties can be attributed to the high phenolic content of some plants (Medina-Medrado et al., 2015). Several mechanisms were found to have been influenced by these phenolic compounds. They serve as hydrogen donors, metal chelators, and enzyme inhibitors. These roles have inhibitory effects on free radicals production (Pereira et al., 2009). For plants belonging to the family Urticaceae, the antioxidant properties were attributed to various secondary metabolites, namely, lignans, sterols, flavonoids, alkaloids, triterpenes, and phenolic compounds (Assaf et al., 2021). The antioxidant activity of plant species under Arecaceae is supported by a study conducted by da Silva et al. (2021) which described that this property is one of the most recurring bioactivities exhibited by plants under this family. Similar to family Solanaceae, Arecaceae is also found to have significant amounts of phenolic compounds which were found to confer antioxidant effects (de Souza et al., 2020).

Regarding the anti-inflammatory bioactivity, plant species belonging to the family Arecaceae were found to exhibit antioxidant effects (Table 1). This result is consistent with previously reported studies. Phytochemical analysis of plants belonging to the family Arecaceae confirmed the presence of several secondary metabolites such as alkaloids, terpenes, fatty acids, and phenolic compounds that have been associated with anti-inflammatory activities (Dubo et al., 2020). Moreover, plants under this family have been reported to contain lauric acid as a major component (da Silva et al., 2021). Lauric acid is a saturated fatty acid that has been found to exhibit anti-inflammatory effects (Intahphuak et al., 2010). Similarly, various studies have also been conducted on the anti-inflammatory effects of different plant species under the family Apiaceae (Derouich et al., 2020). It has been determined that edible plants in this family generally contain polyacetylenes, such as C17-polyacetylene, which were found to confer an anti-inflammatory effect (Christensen & Brandt, 2006).

3.2 Most Bioactive Medicinal Plants

The bioactivities of 563 medicinal plants included in the study were carefully evaluated. The top plants with the most number of reported bioactivities were determined accordingly and only the top three plants are presented in Table 2. Based on the results, *Abelmoschus esculentus* (L.) Moench (okra), *Clitoria ternatea* L. (balog balog), and *Luffa acutangula* Roxb. (patola) have the highest number of reported bioactivities. The plants were reported to exhibit various bioactivities that included antimicrobial, anti-inflammatory, antihyperglycemic, analgesic, anti-ulcer, and anticancer properties.

Previous studies confirmed that the therapeutic properties of plants are due to the presence of certain phytochemicals or secondary metabolites. The numerous bioactivities exhibited by *Abelmoschus esculentus* (L.) Moench. are supported by previous studies which have identified the various bioactive components of the plant such as polyphenolic compounds, folic acid, niacin, riboflavin, carotene, thiamine, and oxalic acid (Durazzo et al., 2019).

Multiple bioactivities observed in *Abelmoschus esculentus* are also associated with the presence of polysaccharides (Zhu et al. 2020). According to a study conducted by Al-Shawi et al. (2021), differences in the type of monosaccharide that make up the plant's polysaccharides resulted in variations in biological activities.

Table 2. Top plant species in Mindanao with the largest number of reported bioactivities.

Scientific Name	Family	Bioactivities
Abelmoschus esculentus (L.) Moench.	Malvaceae	anticancer cardio-protective antimicrobial renal-protective neuro-protective analgesic anti-ulcer anti-fatigue
Clitoria ternatea L.	Fabaceae	anti-inflammatory antimicrobial antipyretic analgesic diuretic anesthetic antihyperglycemic antihyperlipidemic
Luffa acutangula Roxb.	Cucurbitaceae	anti-inflammatory anticancer antihyperglycemic antimicrobial hepato-protective anti-ulcer analgesic

Similar to *Abelmoschus esculentus,* the numerous bioactivities exhibited by *Clitoria ternatea* L. is supported by previous studies that identified the numerous phytochemicals present in the plant which include anthocyanins, tannins, saponins, phlobatannins, triterpenoids, flavonols, flavonoids, and phenols (Al-Snafi, 2016). Anthocyanins are considered to have one of the most potent physiological effects among plant compounds, resulting in significant bioactivities of *Clitoria ternatea* (de Oloveira Pires Jr., 2021).

The bioactivities exhibited by *Luffa acutangula* Roxb. were found to be attributed to certain bioactive phytochemicals. such as flavonoids, steroids, and tannins which were isolated from the fruit of the plant (Suryanti et al., 2017).

4. CONCLUSIONS

The synthesis of secondary data obtained from journal articles published electronically confirmed the presence of at least 563 medicinal plants in Mindanao, belonging to ninety plant families. The top three plant families with the most associated bioactivities were determined to be Fabaceae, Asteraceae and Lamiaceae. Antimicrobial and antioxidant properties were the two most commonly reported bioactivities. The top three plant species with the highest number of reported therapeutic properties were found to be *Abelmoschus esculentus* (L.) Moench *(*okra*), Clitoria ternatea* L. (balog balog), and *Luffa acutangula* Roxb. (patola). These plants were described to exhibit various bioactivities such as antimicrobial, antioxidant, anti-inflammatory, antihyperglycemic, analgesic, and anticancer properties. Previous studies identified that various secondary metabolites are responsible for these exhibited bioactivities. These include alkaloids, anthocyanins, flavonoids, sterols, tannins, triterpenes, and phenolic compounds. Possible synergistic relationships between certain bioactivities will be examined further in a future work. This paper reports parts of a bigger research work that was aimed to provide the first comprehensive preliminary report on Mindanao plants.

5. ACKNOWLEDGMENT

The proponents of the research study would like to thank the Department of Biology, De La Salle University for the support during the conduct of the research.

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