ANALYSIS OF THE BIBLIOMETRIC IMPACT OF NOVEL BIOMOLECULES DISCOVERED IN PANAMA THROUGH BIOPROSPECTING

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Introduction

In the last 20 years in Panama, important discoveries has been made via prospection, by the dentification and discovery of biomolecules with the potential for health and biotechnology. This work has been achieved mainly through research organized by the International Cooperative Group for Biodiversity of Panama (ICGB) [1].

Following the spirit described in the guidelines of the Nagoya Protocol on "*access to genetic resources and fair and equitable sharing of the benefits derived from their use*" [2] (see ***Figure 1a***). A bibliometric is presented on some biomolecules derived from this search and found in Panamanian natural resources.

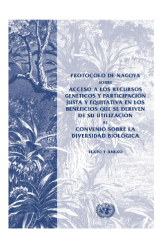
Objectives

The objective of this work is to identify how the biomolecules found in Panama have been reported in the scientific literature. In addition:

- we want to assess how much is known about them
- how this information has been subsequently used and more importantly if this information is publicly accessible.
- Special attention has been place on how these molecules has been or could be introduced into a biobased economy or bioeconomy framework and take advantage of its discovery.
- A repository of the results is present and open to the public

Methods

As a starting point, the results of the project "*Promotion of the application of the Nagoya Protocol in Panama: on Access to Genetic Resources and fair and equitable sharing of the benefits derived from its use*" were taken (see ***Figure 1b***),

a) 

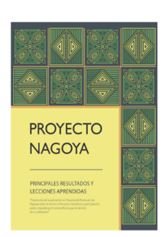
b) 

Figure 1. a) Report on the Nagoya Protocol; b) Report on the Application of the Nagoya Protocol in Panama.

Within the Project "*Discovery of active compounds for pharmaceutical and agrochemical use of terrestrial and marine organisms in protected areas and the improvement of MIAMBIENTE's capacities for their monitoring*", **13 molecules** were reported.

A python script was made to organize, process the bibliometric data. Using of the information contained in the publications and documents on the reported molecules was carried out, focusing on: Titles and Abstract of the articles; Authors and Authors affiliations.
A complete view of the methodology including details of the 13 molecules described in the text, and the overall methodology can be seen in ***Figure 2***.

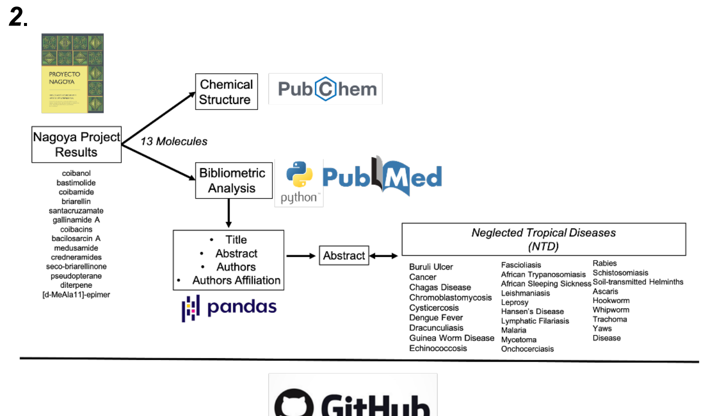


Figure 2. Description of the complete methodology and proposed results.

Results

Bibliometric Analysis

In ***Table 1,*** the molecules are listed, their structure is also shown (confirmed by computational model or crystallography) and it is determined whether or not there is digital access to their structure in PubChem. In the analysis, the number of articles found in PMC was reported for each one of the molecules (***Table 2***). In addition, the contribution of the most prolific national and foreign authors was analyzed and reported in ***Table 3***. In ***Table 4***, the results for authorships are divided by local Institutions. When looking at the authorships of the ***152*** articles found, Over ***120*** articles had 1 or no Panamanian authors, as shown in ***Figure 3***. When looking at those articles with Panamanian authors, in ***Figure 4***, it shows that they tend to work in groups, higher values on the 0.6-0.8 bin.

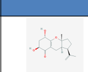
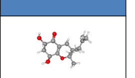
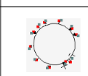
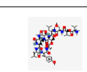
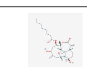
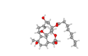
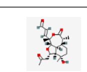
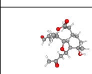
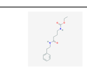
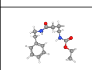
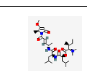
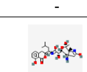
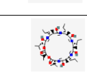
#	Molecule Name	Search Pattern	PubChem Unique Identifier as Compounds (PubChemID)	Website (Information and Structure)	2-D Structure	3-D Structure
1	Coibanol A/B/C	Coibanol	139588374	https://pubchem.ncbi.nlm.nih.gov/compound/139588374		
2	Bastimolide A	Bastimolide	318733489	https://pubchem.ncbi.nlm.nih.gov/substance/318733489		-
3	Coibamide A	Coibamide	274680465	https://pubchem.ncbi.nlm.nih.gov/substance/274680465		-
4	Briarellin A / B	Briarellin	9983138	https://pubchem.ncbi.nlm.nih.gov/compound/9983138		
5	Seco-Briarelline (Cecobrialemilona)	Seco-Briarelline	15275618	https://pubchem.ncbi.nlm.nih.gov/compound/15275618		
6	Pseudopterane Diterpene (Aeucerapterano de Interpeno)	Pseudopterane Diterpene	-	-	-	-
7	Santacruzamate A	Santacruzamate	72946782	https://pubchem.ncbi.nlm.nih.gov/compound/72946782		
8	Gallinamide A	Gallinamide	25209862	https://pubchem.ncbi.nlm.nih.gov/compound/25209862		-
9	Coibacins A/B/D	Coibacins	-	-	-	-
10	Mamaelomide	[d-MeAla11]-Epimer	-	-	-	-
11	Cremenamide A/B	Credneramides	-	-	-	-
12	Bacilosarcin A	Bacilosarcin	273801231	https://pubchem.ncbi.nlm.nih.gov/substance/273801231		-
13	Medusamide A	Medusamide	355358042	https://pubchem.ncbi.nlm.nih.gov/substance/355358042		-

Tabla 1. Information from PubChem found on the 13 reported molecules.

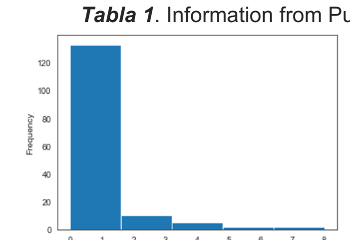


Figure 3 – Histogram of the distribution of Panamanian authors

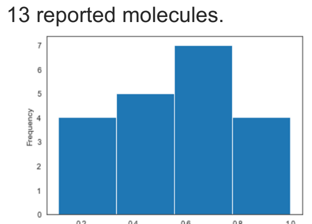


Figure 4 – Histogram of the prpportion of Panamanian authors on articles having at least one Panamanian author.

Molecule Name	Number of Articles
Coibanol	2
Bastimolide	13
Coibamide	20
Briarellin	17
Seco-Briarelline	5
Pseudopterane Diterpene	19
Santacruzamate	20
Gallinamide	20
Coibacins	13
[d-MeAla11]-Epimer	2
Credneramides	7
Bacilosarcin	10
Medusamide	3
Total	152

Table 2. Bibliometric information associated to the molecules found in the PubMed database

Most Prolific Authors	Number of Articles
Gerwick WH	23
McPhail KL	14
Gutierrez M /	10
Rodriguez AD / Taglialatela-Scafati O /	9
Ishmael JE	8
Mayer AMS, **González Y**	7

Table 3. Authors with more publications (Top-6)

Institution Name	Number of Authorships
INDICASAT	58
Smithsonian Tropical Research Institute	7
Universidad de Panamá	4
Universidad Tecnológica de Panamá	0

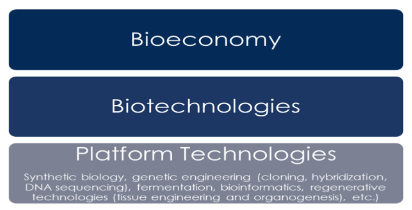
Table 4. Authorships by Local Institutions

Bioeconomy in Panama

According to Aguilar, Twardowski & Wohlgemuth [3] "*bioeconomy is a new paradigm whose aim is to create, develop, and revitalize economic systems based on a sustainable use of renewable biological resources*".

For its development, advances in science, technology, and biotechnology are important [4]. Bioeconomy relies on Biotechnology which, at the same time, relies on a technological platform that includes synthetic biology, bioinformatic, and regenerative technologies among other disciplines [5]; as shown on ***Figure 5***.

Figure 5. Platform technologies, biotechnologies, and bioeconomy: Hierarchy of ties. Adapted from [3]



Based on Matyushenko et al. [5] we adapted the input-output matrix (***Table 5***) for what could possibly be developed in Panama with the reported molecules and also any other molecule discovered in Panama.

<table>
<tr><th rowspan="2">Origin</th><th colspan="4">Application</th></tr>
<tr><th>Biomedicine</th><th>Industrial Biotechnology</th><th>Food Biotechnology</th><th>Agricultural Biotechnology</th></tr>
<tr><td>Biopharmaceutics</td><td colspan="2">Drugs discovery for biomedicine and pharmaceutical industry</td><td>Functional foods and nutritionals</td><td>Biological pest management?</td></tr>
<tr><td>Food Biotechnology</td><td>Fruit, vegetable, herbal plants for bio-drug?</td><td>Fruit, vegetables for cosmetics?</td><td>Functional nutritive ingredients tailor-made products, food proteins.</td><td>Protein- and vitamin-rich complexes</td></tr>
<tr><td>Agricultural Biotechnology</td><td>Vaccines, antibiotics (genetically engineered crops to carry antigenic proteins from infectious pathogens, that will trigger an immune response when ingested)?</td><td colspan="2">Protein isolates and textured proteins, food fiber.</td><td>Enhancing plants and animal traits?</td></tr>
<tr><td>Science</td><td>Mapping of organisms' genomes, biobanks, bioinformatics, systemic medicine, production of nano-based bactericides and virucides (potentially)</td><td>Brain studies for application in Industry; analytical instrumentation</td><td>Enzyme engineering, food flavorings, coloring and preservation?</td><td>Pathogen-Host studies?</td></tr>
</table>

Table 5– Input-output matrix "origin-application" for Panama.

Conclusions

The analysis of the scientific production associated with these molecules can help organize a massive database of Panamanian molecules. It can also be a reference for various species biobank projects that are being developed in our country. The analysis shows that most of the authors are foreigners, although as it was in the Nagoya Protocol there is a good complement of national scientists from INDICASAT-AIP and the University of Panama. No references to the Technological University of Panama were found in the results, something that is intended to change in the short term, using the information collected from this poster for subsequent chemo-informatics analysis. This work clarifies what the molecules of this project are for, about their possible use in the sector to treat diseases such as cancer and malaria

Future Work

We foresee extending the use of this molecules by first studying them computationally, using chemoinformatics and computational docking to see its use in: agrochemical, energy, biotechnological and computational sectors to design new materials in technologies. In addition, we can add other molecules that have been studied in the biodiversity of organisms in the country and carry out programs to access these data, in order to be able to carry out synthetic biology studies that have countless potential applications, from biosensors, bioagents capable of acting in therapeutic form, smart drugs and microorganisms capable of multiple actions, from eliminating or transforming toxic compounds to facilitating industrial fermentations. In any case, the combination of new technologies, advances in biotechnology and better knowledge of natural properties is only just beginning to return the investment.

References

[1] PNUD, "Promoción de la aplicación en Panamá del Protocolo de Nagoya sobre acceso a recursos genéticos y participación justa y equitativa en los beneficios que se deriven de su utilización," 2016. [Online]. Available: https://www.pa.undp.org/content/panama/es/home/operations/projects/environment_and_energy/aplicacion_protocolo_nagoya.html. [Accessed 16 October 2020].

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[5] I. Matyushenko, I. Sviatukha and L. Grigorova-Berenda, "Modern Approaches to Classification of Biotechnology as a Part of NBIC-Technologies for Bioeconomy," British Journal of Economics, Management & Trade, vol. 14, no. 4, September 2016.

INSTITUTIONAL SUPPORT

UNIVERSIDAD TECNOLÓGICA DE PANAMÁ 1981

FACULTAD DE INGENIERÍA DE SISTEMAS COMPUTACIONALES - UNIVERSIDAD TECNOLÓGICA DE PANAMÁ

FACULTAD DE CIENCIAS Y TECNOLOGÍA UTP - 1981

BioCANET
Centro American Network of Bioinformatic and Biocomputing

ISCB INTERNATIONAL SOCIETY FOR COMPUTATIONAL BIOLOGY

SNI Sistema Nacional de Investigación

SENACYT Secretaría Nacional de Ciencia, Tecnología e Innovación