Indonesianomics: An Integrated Natural, Ethnobotanical, and Scientific Resources Database of Indonesia

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ABSTRACT

A critical barrier to enhance the natural resource and ethnobotany plants conservation appears. While open-accessible databases containing natural resource and ethnobotany application have been established in a number of other countries, there is currently no such online database in Indonesia that even known as a mega-biodiversity country. Indonesianomics is a public repository that provides integrated and comprehensive information about Indonesia's natural resources in regard to their medical and ethnobotanical applications. The user can enhance the data by submitting data. This database obtains 100 iTerm records, 999 iJamu records, 4.937 iPlant records, 6.776 iCompound records, 125 iTaxonomy records, 5 iPeptide records, 100 iEthnobotany records, 20 iReference records, 3.972 iJournal records, 5 iBook records, 12 iAuthor records, and 75 iAffiliation records. Indonesianomics present as the starting point to enhance community-driven platform by curating database for further natural product resource in Indonesia. Available at https://indonesianomics.hamfaro.or.id.

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1. INTRODUCTION

Indonesia is a tropical country with >18,000 islands and >68% of them (±131.3 million hectares) forest that ranks Indonesia as the third country with the largest forest area in the world [1, 2]. According to the Rainforest Action Network, Indonesia also classified as one of the most species-rich countries on the earth [3]. 12% of all mammal species, 17% of all bird species, 33% of all insect species, 16% of all reptile and amphibian species, 24% of all fungi species, and 10% of all higher plant species could be found in Indonesia [3]. Among them, many species were already recognized as sources of ingredients of jamu, sources of vegetable simplisia, antimicrobials, anticancer, antiparasitic, antimalarial, antifungal, antiviral, antibacterial, and insecticidal peptides and compounds [4, 5, 6, 7, 8, 9]. Other several species were recognized as agents of land and water conservation, materials of building construction, materials of clothing, ingredients of natural fragrances, preservatives, etc.

Based on the latest report, the potential of Indonesia mega-biodiversity is under massive threat [1, 2, 3, 10]. Deforestation rates in Indonesia were classified as one of the highest rate in the world (±1.17 million ha/yr) [2] and it achieved its highest rate at 2003. At that time, deforestation rate in Indonesia achieved 2.4 million ha/yr [10]. In 2011, Orang Utan Foundation classified ±772 species in Indonesia as threatened species [3, 12]. Furthermore, the Ministry of Environment of Indonesia estimated that deforestation has been losing ±20-30% of mega-biodiversity of Indonesia [12]. As mentioned above, Indonesia mega-biodiversity did not only provide benefits for Indonesian people in terms of ecological and economic values but also provide benefits to the discovery and development projects of Indonesia-derived scientific and ethnobotany information and knowledge.

If one or more component of mega-biodiversity became extinct before being studied, it would be a big loss for Indonesia and also for the world.

Several projects have been doing by the Government, NGO, civilians, and researchers in order to decrease the rate of deforestation and obtain as much as possible information before they became extinct without any information being explored and stored. Numerous single year and multi-year research and conservation-based projects have been conducting by them. In the last decade, more than 10 billion rupiahs has been spent by the Ministry of Research Technology and Education to financially support above mentioned projects [13]. To date, tremendous achievements have been achieved in terms of decrease deforestation and a huge collection of datasets of Indonesia-derived ethnobotany and scientific information. However, that information still located, stored, and maintained on both multiple physical and virtual locations. They can not be accessed by Indonesian or non-Indonesian in an integrated and centralized way. To the best of our knowledge, such database provides several advantages such as: easier to be protected, preserved, reorganized, and updated, easier to be accessed and analyzed, better data integrity and security, less data redundancy, and easier data portability. Moreover, such strategy allows us to access all the information stored in the database at the same time and at the same place, comprehensively and more integrative. Therefore, there is an urgent need to develop an integrated and centralized system not only to gather all existing natural Indonesia-derived information and knowledge but also to enhance the discovery and development of novel Indonesia-derived information and knowledge in the future. Here, we proposed a new term and developed the first version of an integrated and comprehensive database, called Indonesianomics, and defined it as a systematic strategy not only to conserve as much possible as Indonesia-derived natural-, ethnobotanical-, and scientific-based information and knowledge, but also to enhance the discovery and development of the next generation Indonesia-derived natural-, ethnobotany-, and scientific-based information and knowledge in the future.

2. RESEARCH METHOD

For the first version of Indonensianomics, we gathered comprehensive information about native and non-native species, particularly for plants, of Indonesia. Here, we used the Integrated Taxonomic Information System (ITIS) database as the main source of taxonomic information on microbes, fungi, plants, and animals [14]. For plant-related information, we obtained from several databases such as the International Plant Names Index (IPNI) database [15], Tropicos [16], USDA Plants Database [17], the Australian Plant Name Index (APNI) database [18], NCBI taxonomy resources (19), Global Plants (20), New Zealand Plant Conservation Network (21), Botany in British India [22], Plant Systematics [23], Biodiversity Heritage Library [24], Angiosperm Phylogeny Website [25], AlgaeBase [26], and World Checklist of Selected Plant Families [27]. For species entries, we mainly collected licensed images from Tree of Life Web Projects [28]. A list of Indonesian Medicinal Plants was obtained mainly from Database of Indonesian Medicinal Plants [29] and Take out "Jamu" of KNApSAcK [4]. From KNApSAcK family [4], Traditional Chinese Medicine (TCM) Database [30], Traditional Chinese Medicines Integrated Database (TCMID) [31], Traditional Chinese Medicine Systems Pharmacology Database and Analysis Platform (TCMSP) [32], Dr. Duke's Phytochemical and Ethnobotanical Databases [6], FooDB [33], The Human Metabolome Database (HMDB) [34], and Phenol-Explorer 3.6 [35], we collected information about relationship between bioactive compounds with their natural sources (species). Jamu formula were collected from books [36, 37, 38, 39, 40, 41] and Take out "Jamu" of KNApSAcK [4]. Information about basic identifiers and physicochemical properties of compounds were mainly obtained from PubChem [42], DrugBank [43], ChEBI [44], and ChEMBL [45]. A list of Indonesia-derived scientific articles authored by Indonesian and foreigners were obtained from Indonesian Journals through Indonesian Publication Index (IPI) database [46] and International Journals. All entries were categorized by specific keywords. For each keyword, we provided definition obtained from Kamus Hamfaro [47]. All gathered information was stored, maintained, and displayed using Point Finder [48].

3. RESULTS AND ANALYSIS

3.1. Database Architecture

In the current version, we classified all records stored in Indonesianomics into eight main categories: (1) iTerm for terminologies, (2) iJamu for jamu formula and ingredients, (3) iPlant for both medicinal and non-medicinal plants that could be found in Indonesia, (4) iCompound for compounds isolated from Indonesian plants, (5) iTaxonomy for taxonomic information of Indonesian plants, (6) iPeptide for antimicrobial peptides potentially found in Indonesian plants, (7) iEthnobotany for Indonesia-derived and and Indonesianomics-related ethnobotanical information, (8) iReference for reference papers cited by Indonesianomics, (9) iJournal for Indonesian Journals, (10) iBook for Indonesian Books related with field of Indonesianomics data, (11) iAuthor for Indonesian and non-Indonesian researchers who authored and published Indonesia-derived scientifical-based

papers, (12) iAffiliation for Indonesia-based and non-Indonesia-based affiliations of each author and co-author listed in iReference. Indonesianomics database consists of 100 iTerm records, 999 iJamu records, 4.937 iPlant records, 6.776 iCompound records, 125 iTaxonomy records, 5 iPeptide records, 100 iEthnobotany records, 20 iReference records, 3.972 iJournal records, 5 iBook records, 12 iAuthor records, and 75 iAffiliation records. The schematic representation of current data stored in Indonesianomics is visualized in figure 1.

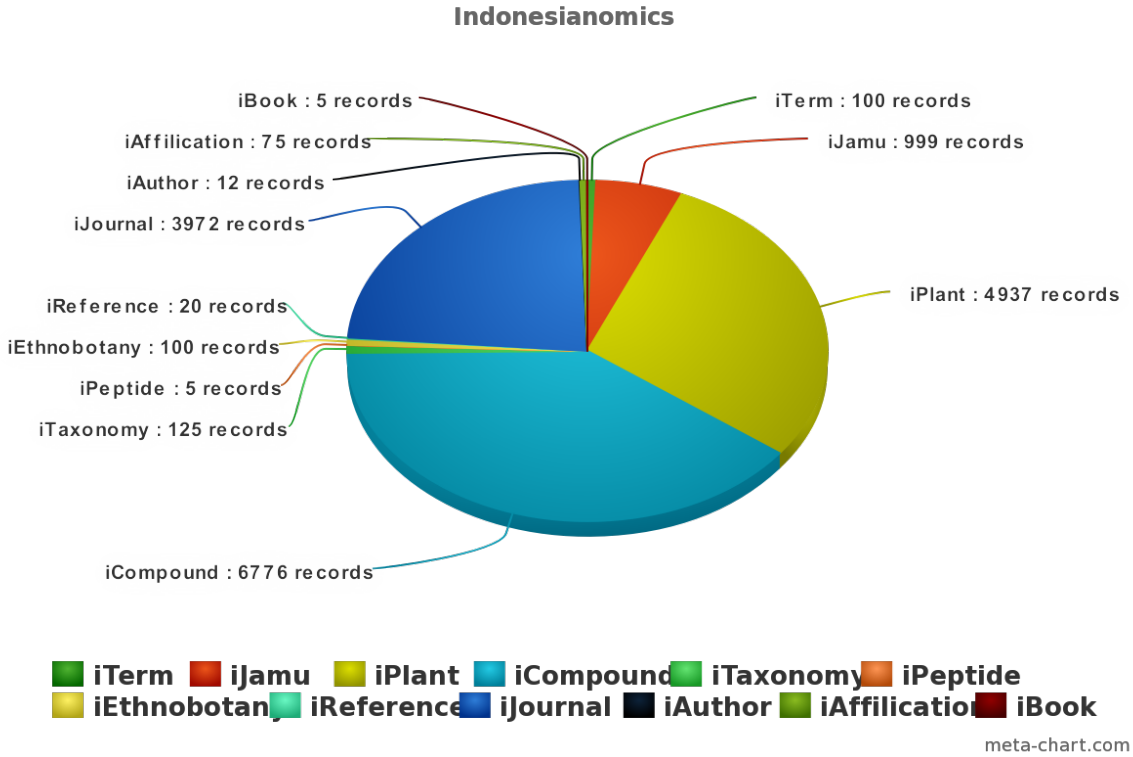

Figure 1. Data statistics of the current version of Indonesianomics (generated using meta-chart) [49].

3.2. Web Interface and Data Access

Indonesianomics already available http://indonesianomics.hamfaro.or.id and will be freely accessed soon after being published in the desired journal. in Each record in Indonesianomics has a unique ID started with its main category initial, such as iTerm ID: 001 for record number one in iTerm section, iTaxonomy ID: 001 for record number one in iTaxonomy, iBook ID: 001 for record number one in iBook section, and so on. In iTerm section, we provided definitions of each terminology, both in Bahasa Indonesia and English language (if available). For each record in iJamu section, we provided information about its applications, ingredients, and procedure about how to make it according to references.

For each record in iReference, we provided information about its original title, authors, the affiliation of each author, year of publication, name of journal, name of publisher, PubMed ID (PMID), PubMed Central ID (PMC ID), digital object identifier (DOI), cited Indonesianomics records, etc. For each record in iJournal and iBook section, we provided similar information as given in iReference section except PubMed ID (PMID), and PubMed Central ID (PMC ID). In iAuthor section, we provided information about name, affiliation, fields of expertises, educational background, and a list of scientific (original and review) papers, books, conference proceedings, and articles to date.

In iEthnobotany section, we provided information for each ethnobotanical application and a list of iPlant used as one of Jamu ingredients. Here, we also provided descriptions of each ethnobotanical application obtained from Kamus Hamfaro. For each record in iPlant section, we provided information about its taxonomy as hyperlinked texts that will direct users to a related page(s) in iTaxonomy section. In iPlant section, we also provided information about its local names, scientific names, description, ethnobotanical applications, compound ingredients, ecological distribution, part(s) used as jamu ingredients, part(s) as sources of bioactive compounds, etc. For each record in iCompound, we provided information about its name, synonyms, molecular weight, molecular formula, International Union of Pure and Applied Chemistry (IUPAC) name, canonical and isomeric simplified molecular input line entry system (SMILES), IUPAC International Chemical Identifier (InChI), InChIKey, Chemical Abstracts Service Registry Number CAS Registry Number, United States Food and Drug Administration - Unique Ingredient Identifier (FDA UNII), predicted physicochemicals and ADMET properties, known bioactivities, known and potential targets, interacting genes, chemical taxonomy, and natural sources.

3.4. Search Feature

In the present version, Indonesianomics was featured by several types of search and browse function. All data stored in Indonesianomics could be browsed by using keywords related to each record. In basic search option, all data could be search based on keywords and their applications. Here, several items could be used as keywords, including name and synonyms for all types of Indonesianomics records. In advanced browse option, record in from iCompound could be browsed based on its molecular formula, molecular weight, canonical and isomeric SMILES, InChI, and InChIKey. Overall, all items listed in subsection 3.3 of this paper could be used as filters in order to browse data in Indonesianomics.

3.5. Online Submission Form

Indonesianomics was built as a mainly Indonesian scientific community-driven database to gather as much as possible data derived from natural, ethnobotanical, and scientifical resources of Indonesia. Therefore, we added an online submission form that can be used by everyone to submit new data, post a comment, submit new review and correction about existing record, etc. There is a red button located on the top-right side of the homepage that can be used by everyone to submit new data.

4. CONCLUSION

Indonesianomics present as the starting point to enhance community-driven platform by curating database for further natural product resource in Indonesia. This database obtains 100 iTerm records, 999 iJamu records, 4.937 iPlant records, 6.776 iCompound records, 125 iTaxonomy records, 5 iPeptide records, 100 iEthnobotany records, 20 iReference records, 3.972 iJournal records, 5 iBook records, 12 iAuthor records, and 75 iAffiliation records. The data will added more as the researcher submit it.

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