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Enabling West African Herbal-Based Traditional Medicine Digitizing: The WATRIMed Knowledge Graph

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Abstract

The purpose of this study is to describe the design and development of the first release of the West African Herbal based Traditional Medicine Knowledge Graph (WATRIMed). It is a resource containing Traditional Medicine (TM) related entities and linked with publicly available knowledge bases in order to facilitate bringing West African TM into the digital world. The core model comprises currently 556 concepts including 143 identified West African medicinal plants and 108 recipes used by tradi-practitioners to treat 110 diseases and symptoms which are commonly encountered in this part of the world.

Keywords:
African Traditional Medicine, Knowledge Bases; Phytotherapy

Introduction

For many people in Africa, Traditional Medicine (TM) is either the first line of treatment or is used as a last resort when all the available possibilities in the conventional medicine are exploited. Although its affordability, it comes with various issues, in particular due to the oral transmission of knowledge and lack of digitized resources that could contributed to making gathered experiences sustainable.

The high usage of TM is often driven by the inaccessibility, unaffordability or unavailability of conventional health care services and medicines in socioeconomic settings that are characterised by a high rate of poverty and a lack of suitable and affordable conventional medicine services and drugs, like in West Africa. That underserved and mostly illiterate, rural people account for the majority of the population, is an additional barrier to access healthcare. In response to the growing recognition of the potential of TM, the supra-national West African Health Organisation (WAHO)[1] has given priority to TM in 2007, with the objective of supporting the institutionalization of African Traditional Medicine (ATM) in member countries' health systems, followed up by WAHO's 2016-2020 Strategic Plan. Within this plan, an important action item is the standardisation of descriptions of herbal and TM. Together with the lack of computable TM data, it is difficult to take benefit from them for primary and secondary use cases including patient follow-up and public health statistics or phytovigilance about available herbal medications. An important step was the launch of the first edition of the West African pharmacopeia in 2013, with inputs from ATM experts coming from different member states [1]. This step is a good asset towards the West African TM standardisation.

In this study, we aim at relying on this endeavor in order to design and develop the first release of the West African Herbal Traditional Medicine (WATRIMed) Knowledge Graph (KG), with the objective of helping to preserve TM knowledge and for bringing West Africa TM to the digital world using a state-of-the-art, flexible and shareable knowledge representation approach. Further, helping to establish bridges with conventional medicine, similarly to previous attempts of digitizing Chinese TM [2] and more general African TM [3,4].

Methods

The West African Herbal Pharmacopeia (aka WAHO herbal pharmacopeia) gathers information on medicinal plants used in West Africa, building on a first African Pharmacopeia including 105 plants created in 1985, followed by a book on medicinal plant analysis in 1986 [1]. It describes every plant by the following features: a summary description of the plant, its ethno-medicinal usage, related clinical information and safety, its chemical constitution, contraindications, the regions where the plant grows, a photograph, information on biological and pharmacological activity, and possible dosages and mode of administration.

The workflow to build the WATRIMed KG comprises three main components:

1. Designing and feeding the TM relational database (TradiMed) from the WAHO Herbal Pharmacopeia resources;
2. Designing the Herbal-based TM (HTM) Ontology, and establish links between TM and conventional medicine entities. This is particularly relevant for supporting phytovigilance activities and taking benefit from the advances in terms of pharmacovigilance and drug usage assessment in conventional medicine;
3. Mapping TradiMed and HTM Ontology and linking them to the external publicly available Knowledge Bases (KB) relevant to the domain.

We identified a set of publicly available KBs, which allow to enrich the core information of West African TM and to widen its scope while opening up the perspective of wide-scale integration: Therefore, the following KBs are considered:

[1] http://www.wahooas.org/index3.php?lang=en

DBpedia[2] for plants and diseases; STITCH[3] and PubChem for chemical compounds; IPNI for plants names and bibliographic references; GeoNames for information about countries and regions; Wikidata and Yago for local dialects and vernacular names of plants and recipes.

The OpenRefine tool[4] is used to query these external KBs and to perform the mapping with the core WATRIMed model.

Results

The TradiMed Database

The database comprises of 25 relational tables which total 3544 tuples. It is hosted in a PostGreSQL server and the schema is available online[5]. Table 1 indicates the statistics about the main entities of TradiMed. As can be seen, 143 plants are identified and documented from the WA countries members.

The Herbal based Traditional Medicine Knowledge Model

The Herbal-based TM knowledge model, referred as HTM comprises 556 main Concepts and 75 Properties. The latter are subdivided into 18 Datatype Properties and 57 Object Properties. The main component is *MedicinalPlant*. It is linked with the *ChemicalCompound* entity by the object property *HasChemicalComponent*. A *MedicinalPlant* has a *BotanicalName* (which is a Datatype Property). The *PlantInRecipe* entity illustrates the n-ary relationship pattern. A *PlantInRecipe* defines the plant part components which constitute a given Recipe. Thus, two property restrictions are used to link *PlantInRecipe* respectively to Recipe and Plant-Part. For example, let's take as an illustration the *1.Rx* recipe of TradiMed, which is a treatment for Malaria. For 100g dosage, it is composed of 40g of the root of the *Cryotolepsis sanguinolenta*, 20g of *Moringa oleifera leaves*, 20g of *Cymbopogon citratus leaves* and 20g of *Khaya senegalensis stem barks*.

Table 1. Current Statistics of the Main Entities of the TradiMed Database

Component	Size (#tuples)
West African Plants	143
Countries	16
Therapeutic Indications	110
Contraindications	148
Local Dialects	122
Traditional Medicine Recipes	108
Chemical Compounds	179
Plant Parts	34

The WATRIMed Knowledge Graph

The following entities of the HTM Ontology have been linked to external resources identified among the publicly available external KBs: *MedicinalPlant*, *TheurapeuticIndication*, *ContraIndication*, *ChemicalComponent* and *Dialect*.

There are 143 *MedicinalPlant* respectively linked to 143 DBpedia entities and 143 IPNI resources. With setting up these external links we were able to enrich the description of the plants, because the information provided by the two KBs is complementary. IPNI references the bibliographic information about the first scientific publication that references a given plant; while DBpedia provides, among others, information including species, fat and fibre content of a given plant. For *TherapeuticIndication*, about 40% of them are linked to DBpedia entities (42 out of 110). However, only 6 out of 110 could be linked to some Yago entity.

Eighteen *ContraIndication* entities have been linked to Yago (12%). All the *ChemicalComponent* entities have been linked to external resources by fetching URLs from STITCH and PubChem. We ensured that any *ChemicalCompound* is consistent and correctly labelled.

For *Dialect*, we have identified 13 out of 122 links with Yago entities and 46% (56 out of 122) links with Wikidata.

Conclusion

We have briefly described the West African Herbal-based TM KG, which is made available to the community at www.watrimed.org together with a SPARQL endpoint. It could therefore be processed both by human and machines. It comprises 556 Concepts and 75 Properties. It is further mapped to a set of external KBs including DBpedia, PubChem and GeoNames. It has been built from the core component of the WAHO's Herbal Pharmacopeia resource and linked to publicly available KBs about plants, diseases and drugs. It is ongoing work which describes 143 plants and 108 traditional recipes identified as treatments of common diseases in West Africa. Future work includes further validation of WATRIMed with ATM experts and enriching the current graph with resources from additional external KBs.

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[2] https://wiki.dbpedia.org
[3] http://stitch.embl.de/
[4] http://openrefine.org/
[5] http://www.watrimed.org