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Visual Representation of African Traditional Medicine Recipes Using Icons and a Formal Ontology, ontoMEDTRAD

Appoh KOUAME^{a1}, Konan Marcellin BROU^a, Moussa LO^b, and Jean Baptiste LAMY^c

^aLARIT-LARIMA, Institut National Polytechnique Félix Houphouët Boigny,
Yamoussoukro, Côte d'Ivoire

^bLANI, Université Gaston Berger, Sénégal

^cLIMICS, Université Paris 13, Bobigny, France, INSERM UMRS 1142, Sorbonne
Université

Abstract. In traditional West African medicine, most practitioners are illiterate for official languages. 1127 local languages exist in this region. The transmission of knowledge in this traditional medicine is notoriously oral. In order to enable practitioners to communicate and preserve this knowledge, we are building SysMEDTRAD, a traditional medicine management system, based on a formal ontology of traditional medicine called ontoMEDTRAD. To overcome the language and illiteracy barriers, we propose to combine realistic photographs of plants with formal iconic descriptions of plants and recipes. This paper presents the formal and automatized representation of traditional African medicine recipes.

Keywords. Ontology, Traditional medicine, ontoMEDTRAD, West Africa, Iconic composition, Non-verbal communication.

1. Introduction

Traditional medicine (TM), despite the progress of modern medicine (MM), still exists. Without seeking to replace or to copy the MM, and even less to be obliterated by it, the TM practiced in Africa and especially in its western part, persists and knows a renewed interest at the dawn of the 21st century. This resurgence is partly justified by the fact that the populations health care needs are insufficiently covered by the MM. In addition, health care costs in MM are often expensive and prohibitive for the disadvantaged social groups [1]. Without any discrimination, almost all social classes, for their health and medical needs, even if they use MM, continue to refer to TM. About 80% of the population commonly uses TM [15]. In West Africa, and particularly in rural areas, every inhabitant knows and uses the therapeutic properties of a number of plants. We are therefore talking about popular medicine. In this part of Africa, we count 15 countries and 1127 local languages [13]. Thus, TMP (Traditional medicine practitioners) face a huge language barrier. Moreover, the majority of them do not know how to read nor to write the official languages. They speak them with difficulty or not at all. Knowledge of TM is widely transmitted orally, when it is not kept secret. Academic and research institutions related TM are almost non-existent in these countries. Most of these TMP are illiterate (the illiteracy rate varies from 65% to 80% [8]) and belong to a wide linguistic and cultural diversity. Consequently, a visual

¹ Corresponding Author, e-mail: kgerappoh@gmail.com

approach can be more appropriated for supporting the collaboration between TMP and also the preservation of TM knowledge.

SysMEDTRAD [2] aims at addressing this problem. It includes ontoMEDTRAD, an ontology of West African TM associated with a visual approach. ontoMEDTRAD is divided in two modules: a terminological module ontoCONCEPT-Term, and an iconic ontoICONE. In a previous work [2], we proposed a formal method for representing medicinal plants with icons. Here, we extend this representation with realistic photographs and we propose iconic recipes of plant-based medicines, automatically generated from the ontology. We focused on malaria [8], one of the most morbid and deadly diseases in Africa.

2. Background

Concerning TM, Ayimdji A. [5] made some tools in Cameroon, but without a visual approach. An ontology for African TM [4] from G. Atemezing, has its object focused on the validation of knowledge managed by a system of agents. It does not address the fact that the TMP are mostly not literate. In Côte d'Ivoire, VetoMed [6] of K. Brou explores some visual aspects, but does not contain an ontology.

Regarding MM, LAMY J.B. *et al.* proposed an iconic language named VCM (Visualization of Concepts in Medicine) for representing symptoms, disorders, treatments and follow-up surveillances [12]. VCM is equipped with formal semantics defined in an ontology [11]. VCM aims at facilitating and speeding up the access to medical data and knowledge, rather than crossing the language barrier.

3. Materials and methods

We carried out field visits to TMP accompanied by translators, in Côte d'Ivoire and Senegal. We collected TM documents from NPTMP, the National Program of TM Promotion (Côte d'Ivoire) and some NGOs such as PROMETRA (Sénégal). Given the highly implicit and hidden nature of TM, we have conducted sensitization activities with 50 Ivorian TMP to increase their openness and their commitment to the project. The Abidjan-based NPTMP manager played a facilitating role in these activities alongside the TMP. We also visited 59 Senegalese TMP, mainly in the Saint-Louis region. From published works [1, 10, 3, 9, 8, 16], we extracted 31 traditional medicines for treating malaria with 28 recipes made of 22 distinct medicinal plants. We extracted realistic photographs of these plants from Wikipedia.

We followed an incremental and progressive general approach. First, we considered three use cases for our system: identifying the plants for a given recipe, preparing the medicine, and administrating it to the patient. We structured the pieces of information describing the medicines and the recipes in a formal ontology of TM. This ontology was manually modelled using the Protégé editor. We also collected various concepts from existing top ontologies (*e.g.* open biological ontologies (OBO), general formal ontology (GFO) and descriptive ontology in linguistics and cognitive engineering (DOLCE)) and domain ontologies (*e.g.* plant ontology (PO) [14]).

Second, for describing and identifying plants, we combined two approaches: realistic photographs showing the leaves and the fruits, and icons showing the main botanic criteria permitting the identification of the plant. Candidate criteria were

extracted from botanic sources [3], and then selected according to their discriminant capacity, as determined by the Weka Ranker and JRIP modules, as described in our previous works [2]. The resulting criteria were integrated into the ontology.

Third, plant icons are obtained by combining various iconemes (*i.e.* small pictograms or colors), each corresponding to a specific value for a given criterion. Three strategies were used for visual representation, inspired by Peirce: analogy *i.e.* visual similarity, index *i.e.* semantic association and symbol *i.e.* arbitrary conventions [7]. Iconic recipes are obtained by the juxtaposition of one or several ingredients. Each ingredient is a part of a plant, and is represented graphically by the photographs and the icons of the plants, and a small icon representing the part of the plant used (*e.g.* leaves or roots). Iconic recipes are then enriched with icons representing the preparation and administration modes.

Finally, pictograms were drawn using the Inkscape vectoral drawing software. The icons and iconic recipes are generated as Scalable Vector Graphic (SVG) image files, automatically from the knowledge in the ontology, using Python scripts and ontology-oriented programming with the OwlReady module [11]. These scripts combine the pictograms and colorize them as needed excepted leaf for which green color is retained.

4. Results

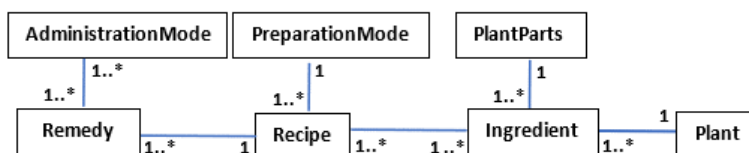


Figure 1: UML model of TM recipes and medicines.

The resulting ontology, previously described in [2], uses the *ALCHOIQ* Description Logic. Figure 1 shows the UML model of the plant-based medicine and recipe in ontoMEDTRAD. A medicine is characterized by a recipe and one or more administration modes (*e.g.* oral route, nasal route with fumigation, topic application during bath, ...). The recipe includes one or several plant-based ingredients and a preparation mode (*e.g.* decoction, infusion, ...). Each ingredient is described by a plant and a part of a plant, using functional object properties. This ensures the uniqueness of ingredients.

The criteria retained for describing plant icons are given in Figure 2, with an example of icon for the plant *azadirachta indica* A. Juss.

Figure 3 gives an example of iconic recipe and its decomposition in icons. This recipe has two ingredients : leaves of *Azadirachta indica* A. Juss. and leaves of *Senna occidentalis* L. It is prepared as a decoction and the resulting medicine can be administered orally or in a bath. We included a total of 28 herbal recipes and 31 herbal antimalarial medicines in the current ontoMEDTRAD ontology.

5. Discussion and conclusion

In this paper, we proposed a formal method for the visual and iconic presentation of plant-based recipes in traditional West African medicine. This approach relies on a formal ontology of TM, namely ontoMEDTRAD.

Many ontologies exist for MM. However, it stands important differences in the way the patient is managed. In TM, diseases are detected by signs and symptoms that are clues and not necessarily by clinical examinations of MM. While remedies of TM are used in their almost natural state, MM often uses a synthetic product chain bound to a chemical industry. Unlike MM practioners, the TMP is at the same time a "physician", a "pharmacist" and a "nurse. Hospitalization and surgery are very rare in TM. Consequently, we did not reuse existing MM ontologies.

A few ontologies were proposed for TM [5, 4]. However, they are embryonic and they lack of medical validation. They also miss the information required for the visual presentation of plants as icons, *e.g.* they do not include the color of flowers and fruits. Therefore, we preferred to design our own ontology.

In addition to plant icons, we have included realistic photographs of the plants.

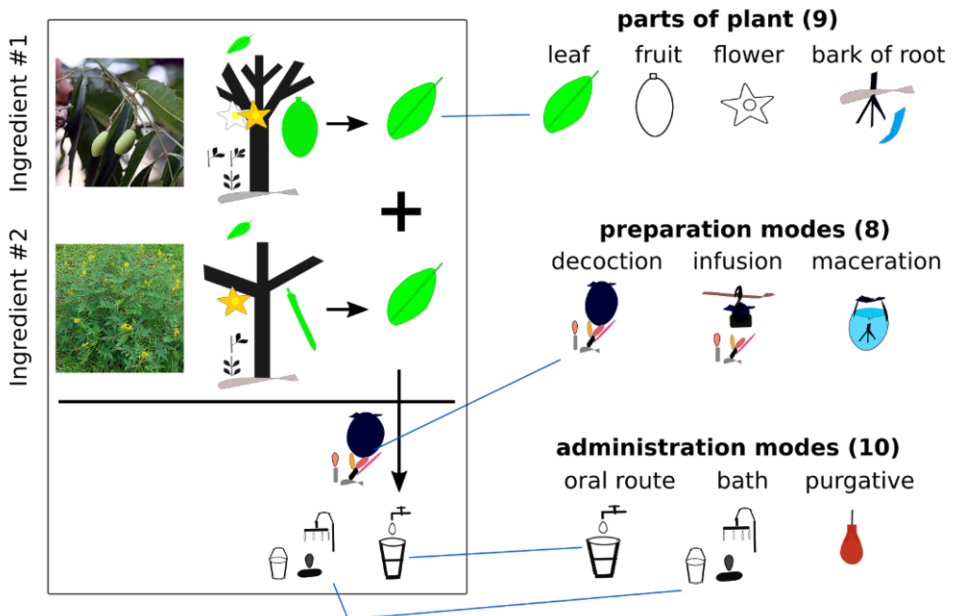


Figure 3: Example of iconic recipe (on the left) and examples of pictograms (on the right) (Numbers between parentheses indicate the number of distinct possible values for each criterion).

Both icons and photographs are visual presentation and description of the plant. They are highly complementary : the photographs allow an immediate recognition of the typical plant individuals, while the icons permit recognizing plant individuals that are significantly different from the photographs, *e.g.* due to the variability of the same plant species according to the various ecosystems, thanks to the botanic criteria that characterize the species. Pictograms were drawn by ourselves, however, they could be improved by a professional graphic designer without modifying the semantics and semiotics of our work. Both icons and photographs allow overcoming the linguistic barriers for TMP. A short training is probably needed before TMP fully understand our iconic language.

This work is part of a larger project aimed at the modernization and the valorization of West African TM. The main perspectives of the present work are : (1) the extension of the iconic and photographic presentation to other concepts such as symptoms, disorders, or mineral and animal medicinal resources; (2) the validation of the proposed visual presentation with TMP; (3) the integration of the visual presentation in a semantic wiki, allowing TMP to collaborate and to write and read medicinal recipes online.

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