Modelization of Recipe in African Traditional Medicine with Visual Ontology Approach, Iconic Sketch

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Abstract. The modernization of African traditional medicine (TM) using IT faces to illiteracy of most of the domain stakeholders. In order to assist traditional medicine practitioner (TMP) in theirs activities, we have propose an icon-based system to visually use plants and recipe in the drug preparation process. Therefore, traditional physicians can easily combine icons for medical prescription. For that, ontoMEDTRAD is an ontology including formal description for knowledge related to iconic representation of plants and recipes. Structurally, ontoMEDTRAD includes two modules: ontoConcept_term and ontoIcone denoting respectively the terms and the icons of concepts in this domain. Thus, avoiding any semantic issues, TMP can be free from language barriers, textual writing and reading in their work of healer. More specifically, this work aims to model plants and recipes in TM and propose compositional iconic language for plants and sketches for recipes.

Keywords: Ontology · Iconic language · African traditional medicine · Plant · sysMEDTRAD · ontoMedtrad · Icon · West Africa

1 Introduction

In West Africa (16 countries), each inhabitant of rural areas knows and uses healing virtues of the plants of traditional medicine (TM). This usage, in addition to being cultural, binds people on their land [2]. In TM, plants are used "as-is" or in simple recipes or remedies, e.g. infusions. African TM plays a growing role in primary healthcare. Some national health programs include TM in complement to modern medicine (MM), but not instead of it. In parallel to MM, 80% of West African population make calls to local MT services [19, 26]. However, TM's knowledge and experiences are disappearing because it mostly relies on oral transmission. The majority of TM practitioners (TMP) is illiterate and some of them prefer secrecy to the diffusion of their knowledge. It would be a great interest to preserve TM's knowledge,

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and this requires a dedicated setting for TMP to exchange, mutualize, share and sustain their knowledge. SysMEDTRAD [14] aims to solve this problem. It is based on a semantic wiki. Its main component is ontoMEDTRAD, itself structured in two modules: ontoCONCEPT-term, a formal ontology of TM concepts, and ontoIcone, an iconic language for the major concepts in TM. Icons have the potential for overcoming linguistic barriers and illiteracy, in a similar way than traffic signs do [6]. The wider scope of our work concerns the TM management based on a visual ontology approach. Ideally, that means to model the concepts in this field (ontoCONCEPT_term) and represent them graphically by icons (ontoIcone). We meet the major interest's requirement with three use cases (competency questions): UC1 determines disease based on symptoms, UC2 determines the recipe for producing the remedy of a given disease, UC3 specifies the administration mode for a given remedy. Here, we focus our analysis on UC2. To define a recipe, the TMP initially selects the plant(s) to be used to design this recipe. Then he determines the plant parts to be used in the recipe. Of the foregoing, it is necessary to develop a graphical approach to present visually the medicinal plants and allow them distinct recognition.

The objective of this paper contains two section strongly linked. One of the two, expresses a compositional iconic language for describing and identifying plants in TM of west Africa. The other concerns the formalization of the recipe and its iconic sketch based on plants icons and iconems of useful parts of plants. We represent each plant by an icon, created by combining several iconems (*i.e.* small icon parts). Each iconem represents a specific botanical criteria such as the color of flowers. In the following section, we describe our methods for selecting criteria, designing iconems and generating icons. Some examples will be given before discussing our approach.

2 Materials and Methods

We chosed to focus on malaria and anti-malarial plants. In the anthology of anti-malarial plants collected in TM, we targeted twenty-two (22) used in thirty (30) recipes [1, 2, 11, 12, 18, 20]. Plant plays a central role in this TM. Relatively malaria, some symptoms remain unchanged, in contrast, vary with the patient nature: child, pregnant woman, adult. So much for this collection and for the conceptual modeling, we went over several sources and results of studies in biosciences as previously mentioned. Our approach includes the benefits in terms of knowledges received from our direct collaboration with TMP (Output and field visits in Côte d'Ivoire and Senegal). We were instructed of important work references on traditional pharmacopoeia [10, 18] and seminars we attended to. We obtained documents of interest from the PNPMT (National Program for TM Promotion, Côte d'Ivoire) and from some NGOs (Non-governmental organization) as PROMETRA (Senegal).

Sometimes, a medicinal plant treats many diseases. A recipe can be limited to a single plant or can include several plants. The plant associations, mismatched, sometimes are dangerous [12] and therefore not recommended unless sufficient control side effects. In popular medicine, plant associations are enough and quite known in rural area (for enema or purge). The components of a **recipe** are plant parts such as: leaf, fruit, bark, stem, root, flower, sap or whole plant. Leaves, fruits, bark are the most often uses

in recipes. Leaf and fruit are predominantly solicited at the respective rates of 60% and 15% [12]. We defined criteria to characterize and individually distinguish our twenty-two (22) plants. Started from around forty criteria mostly obtained from botanical description, we have reduced the number gradually, through an inclusive method of a learning software Weka (Ranker and Jrip) and semiotic elements. Our selection of criteria, relies on three semiological elements coming from the rules relating to the thoughts of S. Peirce (triad dimension), even if F. Saussure's ones (dyadic dimension) have just strengthened us in understanding the signs. Those elements are visual similarity, semantic association and arbitrary convention [6, 22]. The twenty-two plants are represented by icons, with seven (7) criteria ordered by their weight (in Weka's ranker algorithm) that we present in this format: **criterion: weight of criterion: order number**. Thus we have: ***(i) formOfFruit: 3.1181:5; (ii) formFolioleLeave: 3.0151:2; (iii) colorOfFruit: 2.799: 19; (iv) colorOfFlower: 2.2147:21; (v) Silhouette 2.1174:1; (vi) pennation: 1.529:4; (vii) fixingOfFolioleLeave:1,352:6***; *botanic name* is taken for the species instances. To each value taken by a criterion for plant instance, we defined an iconem. An optimization problem appears: minimize the number of both criteria and iconems for better visual representation of all 22 plants species, while still being able to distinguish them individually. We used Python scripts and Inkscape (vectorial) drawing softwares. In part, the methodology Neon [27], was used for conceptual modeling of Plant and Recipe before their formalization under protégé. By using plural techniques and processes of information search, a prominent place was made to revival and verbatim inquries. This gives to our models a sufficient level of invariability, and thus to our ontology ontoMEDTRAD.

3 Results

A silhouette is indispensable for a plant. For the iconic need, we admitted five (5) silhouettes to represent all 22 plants, given the wide variability of botanical description. Accordingly, an iconem has been designed for each silhouette like the Table 1 shows it.

Table 1. Five iconems silhouettes selected.

Silhouette (plant types)	tree	shrub	palm	liana	grass/herb
iconem for Silhouette					

We must recognize visually the plant through its very characteristic traits. With the seven criteria, the 22 species plants have been represented by combining iconems. We generated the icons using a Python script with Owlready-2.0 python module for ontology-oriented programming [16]. This module allowed us to make used ontoCONCEPT-term (ontoMEDTRA, owl). For example, the icon for the plant *Azadirachta indica A. Juss.(Meliaceae)*, is obtained from a silhouette tree and an elliptical shape fruit (Fig. 1).

Fig. 1. Combination of iconems for building (generating) icon of Azadirachta indica A. Juss.

NB: The leaves are green in office, and the silhouettes black. The fruits and flowers can have colors of realist appearance. The "pennation" or not, and the layout of the leaves are in black color. The flower can change color depending on the realist appearance. Another execution of python script provides the plant icon by composing more iconems as Table 2 presents that.

Table 2. Icon of Azadirachta indica A._Juss (neem) based on seven criteria

Name_botanic	*Silhouette*	*formOfFruit*	*colorOfFruit*	*colorOfFlower*	*formFolioleLeave*	*Penantion1*	*fixingOfFolioleLeave*
Azadirachta indica A. Juss.(Meliaceae)	tree	elliptic	green	white, yellow	entireLanceolate	imparipinnate, paripinnate	opposed
icon or pictogram							

The axiomatisation of ontoMedtrad has been enriched with Object properties and Data properties within the meaning of ontology from Gruber [21]. We give an overview via Fig. 2.

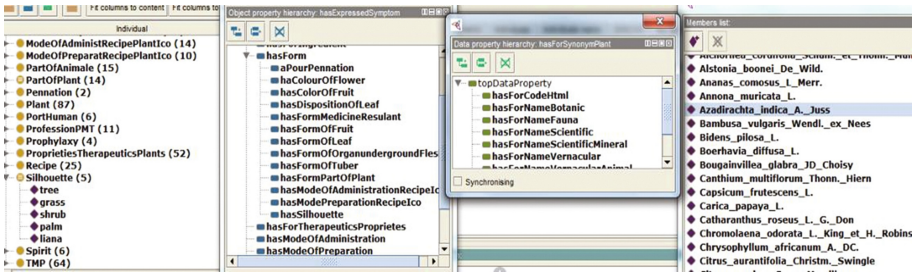

Fig. 2. ontoMEDRAD in protégé

In this work, the main concepts are Plant, Recipe, Ingredient, PartOfPlant, (FormPartOfPlant). Our selected set contains twenty two (22) anti-malaria plants in TM. FormPartOfPlant is like PartOfPlant, but with visual description. It more constant. In our context, an ingredient is an useful part of the medicinal plant. For the iconic need we determine **nine** (**9**) parts concerned notably ***leaf, flower, fruit, stem/trunk, bark of stem/trunk, bark of root, root, sap, whole plant*** (***grass***). Ingredient can be formalized by a couple such *I (FormPartOfPlant, Plant)*. In application we will ensure the

functional unicity of the ingredient. That means two ingredients are equal when they have the same couple's values. A set of ingredients forms the recipe on which we add preparation and administration methods. We can also add to it, the end form of preparation. Furthermore, in recipe, we must ensure that a set (singleton or not) of ingredients remains unique. An ingredient is unitary recipe. We have to avoid to get two recipes with the same set of ingredients (Table 3).

Table 3. Object properties for recipe definition.

domain	object properties	range	characteristic of object properties
Ingredient	*hasFormPartOfplant*	FormPartOfPlant	functional
Ingredient	*hasBasePlant*	Plant	functional
Recipe	*hasForIngredient*	Ingredient	no functional

In the plant icon construction, there is some difficult to integrate perceived reality related dimension. For that reason, in the recipe icon sketch, stem and trunk are been combined and denoted by the same iconem (Fig. 3).

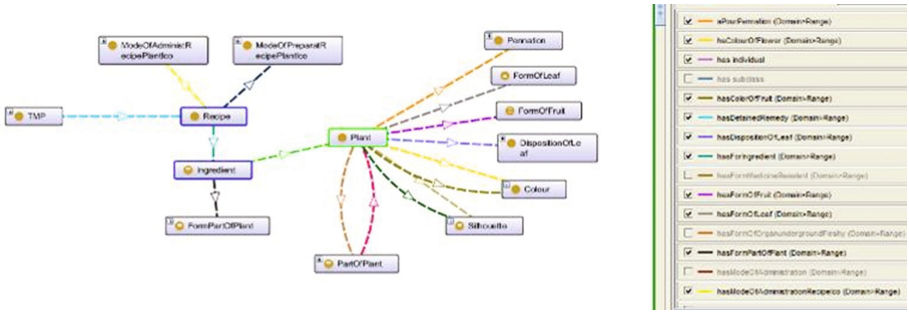

Fig. 3. Formalization of ontoMEDRAD: Plant and Recipe

Some of the iconems for the nine (9) forms of relevant useful parts can be absent in recipe icon. This is justified by the fact that plants not necessarily contain all these forms of parts. Figure 4 shows the list of those nine iconems.

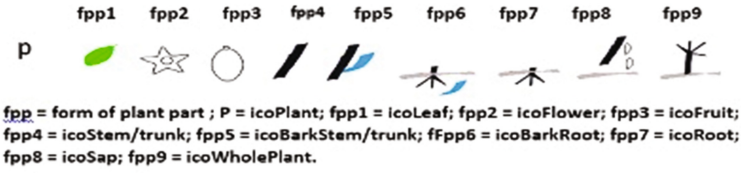

Fig. 4. Nine icons: one for each form of plant's useful part

If P is in our selection of plants, then there exists at least one relevant form part of P, concerned by a recipe. The Table 4 illustrates a recipe (mTRecipe01), extracted from our ontoMEDTRAD. The mTRecipe01 is composed of two ingredients, i1 and i2.

Table 4. mTRecipe01 extracted from ontoMEDTRAD [20]

Plant (P)	Useful part (FPP)	Ingredient (I)	Recipe (R)	MP	MA
Azadirachta indica A. Juss.(Meliaceae)	Le	i1	mTRecipe01	Decoction	beverage
Senna occidentalis L. (Caesalpinaceae)	Le	i2			

Le: Leaf; MP: method of preparation; MA: method of administration

The Fig. 5 shows the iconic sketch of the recipe **mTRecipe01**.

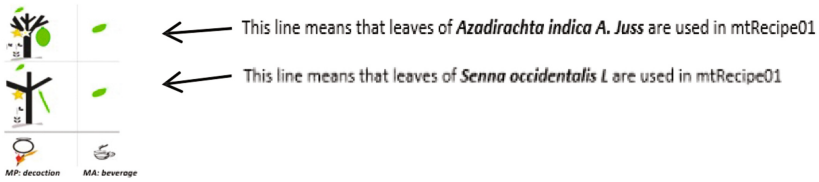

Fig. 5. Sketch icon of the recipe mTRecipe01

4 Discussion

In collecting data, we see that some renowned TMP, barely cover their determination to die with their secret [2]. Others TMP want a knowledge transmission to posterity. Between TMP, lack of trust, of mutual acceptance and knowledge sharing has been proven. Given the highly implicit and hidden character of TM, we have sensitized at least fifty (50) TMP for more openness and adherence to the project (in Côte d'Ivoire and Sénégal). In its completion, the TM discusses the moral, cultural, social and environmental dimension of the patient (overall well-being) [8]. It is sometimes used as lever for discoveries in MM, where most drugs obtained are synthetic products following a long chain of production (biology and active ingredients of medicinal plants). Thickeners, excipients, adjuvants and preservatives are products added. Between MM and TM, the procedures are different. This renders impossible the timely and automatic reuse of the existing terminological and ontological resources of MM, in our ontoMedtrad. Another specificity of the TM is that a TMP ensures inclusive two functions distinctly exerted in MM: he is both "doctor" prescriber and "pharmacist". During diagnosis for determining the disease, PMT adds metaphysical section and some socio-cultural and environmental determinants [7]. In some cases, the provision of health care by the TMP, is in the appropriate recipe form, sometimes extemporaneously. The exchange between patient and TMP is bidirectional, whereas the modern doctor [3] role, in facing the patient, is highly dominant.

After the characteristic traits of TM, degree of variability in botanic description is notorious. For the same medicinal plants, variant descriptions are given. This variability can lead to important differences and contradictions. This large degree of variability in botanic description and in TMP's point of views observed during the visits and collaboration, lead us to operate some choices in order to maintain the formal (computer uses) and visual firstness. *Lannea microcarpa,* part of our plants selection, is alternate and imparipinnate compound leaf, with 15 m high by PROTA (Plant resources of tropical Africa) [10], while the same individual plant is opposing leaf paripinnate with 10 m high according to a website [25]. The morphology of a plant species can depend on the habitat region, country. For example the tree *Adansonia digitata L* in Senegal, is physically strong and imposing, while in Côte d'Ivoire where it is more slender. This shows the limits or shortcomings to use realistic photographs as sublime means of visual recognition of medicinal plants. For this reason we proposed an iconic language rather than using photographs. The physical dimensions related to the morphology of a plant in a photograph can also be misleading. Otherwise, a tree has 5 m height for FAO (Food and Agriculture Organization), whereas, for IFN (National Forest Institute in France), it has 7 [23, 24]. Relatively to the TM, Armel A. made some tools in Cameroon without visual ontology [5]. An Ontology for African TM but not visual, from G. Atemezing, has its object focused on the validation of knowledge managed by a system of agents [8]. In Côte d'Ivoire, by VetoMed, Brou K. explores visual aspects, but does not contain an ontology [13]. In MM, the VCM from J.B. Lamy presents an iconic language for medical knowledge especially drugs, to help doctors for easy and speed reading, with visual ontology validated [16, 17].

5 Conclusion

We proposed an iconic compositional representation for the medicinal plant, the largest source in the recipes prescribed by the TMP. The botanical description is often varied to the same species. The discourse of TMP relative to the prescripted recipe from the same plants to cure the identical diseases, remains also variable. But the icons we proposed avoid this problem. The composition semi-formal, is an arduous task that must be based on a minimum of rules especially since we have a goal to integrate it into a semantic wiki for others categorizations and knowledge extraction. It's difficult, but surmountable. In perspective we must sit an iconic language in inferential goal for TMP, transcending linguistic barriers, text reading and writing. Sketch for iconic recipe is obtained in order to be achieved definitively by python program. Obviously, cover all concepts of TM, constitutes a true challenge. Another perspectives is the validation of the iconic language in two steps: the first with literate TMP group and the second with all TMP. Moreover, it seems that it would be more advantageous to indicate some realistic photos (without being reasoning objects), simply bound to icons obtained, in order to compensate the lack of education of TMP (mostly numerous), pending an acceptable level of standardization.

References

1. Lydie, A., et al.: Nephrolepis biserrata, une Ptéridophyte utilisée comme plante médicinale CI (2014)
2. Assi, L.A.: Abrégé de Médecine et pharmacopée africaines, CI, pp. 1–150 (2011)
3. Konan, A.: Place de la médecine traditionnelle dans les soins de santé primaires, (CI), pp. 54–118 (2012)
4. Amari, A., et al.: Adaptabilité des conditions d'enregistrement des médicaments génériques en CI aux médicaments traditionnels améliorés. J. sci., Lab. de galénique et législation pharmaceutique, UFR sciences pharma. et bio, Univ de Cocody, pp. 1–4 (2006)
5. Armel, A., et al.: Using METHONTOLOGY to build a deep ontology for african traditional medicine: first steps. Départ. Génie Informatique, IUT de Douala, Cameroun, pp. 1–8 (2012)
6. Nakamura, C., et al.: A taxonomy of representation strategies in iconic communication. Int. J. Hum. Comp. Stud. **70**(8), 535–551 (2012)
7. Atemezing, G., Pavón, J.: An ontology for African traditional medicine. In: Corchado, J.M., Rodríguez, S., Llinas, J., Molina, J.M. (eds.) International Symposium on Distributed Computing and Artificial Intelligence 2008 (DCAI 2008). Advances in Soft Computing, vol. 50, pp. 1–10. Springer, Heidelberg (2009)
8. Dozon, J.P.: Ce que valoriser la médecine traditionnelle veut dire, Polti. africaine, n° 28, pp. 1–12
9. Guastello, S.J., Traut, M., Korienek, G.: Verbal versus pictorial representation of objects human computer interface. Int. J. Man Mach. Stud. **31**, 99–120. Engineering, Springer, pp. 1–27 (1989)
10. Kerharo, J., et al.: pharmacopée traditionnelle sénégalaise: plantes médicinales et toxique (1974)
11. N'guessan, K., et al.: Screening phytochimique de quelques plantes médicinales ivoiriennes utilisées en pays Krobou, UFR Biosciences, Labo. Botanique., université de Cocody, pp. 5–1 5 (2009)
12. N'guessan, K., et al.: Étude ethnopharmacologique de plantes antipaludiques utilisées en médecine traditionnelle chez les Abbey et Krobou d'Agboville (Côte d'Ivoire) (2009)
13. Brou, K.M., et al.: VetoMed: un système expert à base d'icônes pour la médecine vétérinaire Traditionnelle, 8 p. (2014)
14. Appoh, K., et al.: Architecture d'un système de gestion des connaissances de la médecine traditionnelle: sysMEDTRAD, INP-HB Larima, UGB Lani, CARI, pp. 1–12 (2014)
15. Appoh, K., et al.: Modélisation conceptuelle d'une ontologie de la médecine traditionnelle (ontoMEDTRAD), INP-HB Larima, UGB Lani, CNRIA, pp. 1–5 (2014)
16. Lamy, J.B., Berthelot, H.: Ontopy: programmation orientée ontologie en Python. In: Actes du congrès d'Ingénierie des Connaissances (IC2015), Rennes, France (2015)
17. Lamy, J.B., Soualmia, L.F., Kerdelhué, G., Venot, A., Duclos, C.: Validating the semantics of a medical iconic language using ontological reasoning. J. Biomed. Inf. **4**, 615–667 (2013)
18. Arbonnier, M.: Arbres-arbustes-et-lianes-de-zones sèches de l'Afrique de l'Ouest (2002)
19. OMS/WHO: Stratégie de l'OMS pour la Médecine traditionnelle pour, 2014–2023, pp. 1–25 (2013)
20. Zerbo, P., et al.: Plantes médicinales et pratiques médicales au Burkina Faso:cas des Sanan (2011)
21. Gruber, T.: A translation approach to portable ontology specifications. Knowl. Acquis. Spec. Issue Curr. Issues Knowl. Model. **5**(2), 199–220 (1993)

22. Whiteside, J., Jones, S., Levy, P.S., Wixon, D.: User performance with command, menu, and iconic interfaces. In: Proceedings of the CHI 1985 Conference on Human Factors in Computing Systems, pp. 185–191 (1985)
23. https://fr.wikipedia.org/wiki/Arbre, (mars/16)
24. http://www.piaulealouer.com/cultbio/index.php/section-table/6-thematiques/55-arbre, (mars/16)
25. http://www.bamanan.org/index.php?option=com_content&view=article&id=81:commentaire-botanique-detaille&catid=3:linguistique&Itemid=3, (mars 2016)
26. http://www.who.int/mediacentre/factsheets/2003/fs134/en/, (mars 2016)
27. Suárez de Figueroa Baonza: M.C.: The NeOn methodology for ontology. In: Suárez-Figueroa, M.C., et al. (eds.) Ontology Engineering in a Networked World. Springer, Heidelberg (2012). doi:10.1007/978-3-642-24794-1_2