ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 10:21 (16 April 2021)
doi:10.15451/ec2021-04-10.21-1-12
ISSN 2238-4782 ethnobioconservation.com

Can socioeconomic factors influence the establishment of information mutation in local medical systems? A case study on the use of plant complexes

Mateus Rocha da Silva Pereira[1]; Janilo Italo Melo Dantas[1]; André Luiz Borba do Nascimento[2] and Taline Cristina da Silva[3*]

ABSTRACT

Information mutations are unintended changes in information that can lead to the establishment of poorly adapted cultural traits in local medical systems. The use of plant mixtures in local medical systems, such as "bottles and lickers" could it be an important model to understand this phenomenon, since the variability of information associated with one plant mixture is high and may lead to increased errors during social transmition. In this study, we sought to investigate whether the socioeconomic variables: gender, age, and education influence the amount of information mutations on the knowledge of plant mixtures. Data collection followed the ethical parameters for research with human beings and consisted of two different applications of semi-structured interviews to access and analyze the Information Unit (IU) in regard to the transfer of information mutations between the individual learner and the individual giving information. We obtained 141 types of plant mixtures mentioned in the study. When analyzing our variables, age and education influenced the number of mutations ($p < 0.0008$). Younger individuals had more information mutations about plant mixtures, and less educated individuals had less information mutations than those with more education ($p < 0.006$). Thus, we encourage ethnobotanical research in other regions of the country to contribute to the effectiveness of information transmitted about medicinal plants in local medical systems.

Keywords: Ethnobotany; Medicinal Plants; Evolutionary Ethnobiology; Traditional Knowledge; Medical Sistems.

1 Laboratório de Ecologia e Evolução de Sistemas Socioecológicos (LEA), Universidade Federal de Pernambuco, Av. Prof. Moraes Rego, 1235 – Cidade Universitária - Recife/PE - CEP: 50670-901.

2 Universidade Federal do Maranhão (UFMA), Campus Bacabal, Av. João Alberto, 700, Bacabal - MA, Brasil- CEP: 65700-000.

3 Laboratório de Etnobiologia e Conservação de Ecossistemas, Universidade Estadual de Alagoas (UNEAL), Campus III, Rod. Eduardo Alves da Silva, Km 3 - Graciliano Ramos, Palmeira dos Índios-AL, Brasil- CEP: 57604-595.

* Corresponding author 🖂. E-mail address: TCS (talinecs@gmail.com)

SIGNIFICANCE STATEMENT

Information mutations are unintended changes in information that can lead to the establishment of poorly adapted cultural traits in local medical systems. The use of plant mixtures in local medical systems, such as "bottles and lickers" could it be an important model to understand this phenomenon, since the variability of information associated with one plant mixture is high and may lead to increased errors during social transmition. In this study, we sought to investigate whether the socioeconomic variables: gender, age, and education influence the amount of information mutations on the knowledge of plant mixtures.

INTRODUCTION

Throughout their evolutionary history, humans dealt with several problems that could affect their survival in the environment. One of these problems is associated with preventing and curing diseases, where medicinal plant use is notable (Alvim et al. 2006). Consequently, the existence of certain diseases and resources used by human beings to cure diseases, was an important adaptive strategy that contributed to the formation of local medical systems (Dunn 1976; Ferreira-Júnior et al. 2015).

In this study, a local medical system is understood as a set of perceptions that individuals have about health and disease, and the strategies they use to improve their health problems (ver Dunn 1976; Kleinman 1978). Any social system, including the medical system, needs two essential characteristics to maintain itself: 1) it needs to be adaptive; and 2) it needs to be functional in order to develop in an environment that is always changing (Bizoń 1976). Thus, a system cannot fail to meet the needs for which it was created (in the case of medical systems: disease cures and/or pain relief) (Bizón 1976).

In local medical systems, the medicinal plant use among individuals is one of the most adopted adaptive strategies (Rios et al. 2017). This use can occur either through the isolated use of plant species (one plant at a time), but also through the use of plant complexes (plants used in association with others) (Dantas et al. 2020). Good examples of plant complexes in local medical systems are bottles, syrups, and lickers. They are plant mixtures with several plants placed together in containers that are closed or taken to decoction with alcoholic or sweetened substances, where over time, the preparation acquires the properties of the chosen species and is capable of treating certain diseases (Rios et al. 2017; Vandebroek et al. 2010; Camargo 2010).

The use and production of plant complexes by human populations could have originated by individual experimentation (see Bussmann et al. 2010; Kujawska et al. 2012) as well as through social transmition of cultural information between individuals in a population, which occurs more often (Rios et al. 2017; Vandebroek et al. 2010). However, cultural information can undergo changes when transmitted from one individual to another (Barkow 1989; Tanaka et al. 2009). These changes can occur intentionally in order to add individual experiences to the information received, and then transmitted, a process called "guided variation" (Mesoudi 2011). On the other hand, the changes can occur unintentionally, produced through errors in the process of social transmission or in recalling information, these events can be called "information mutation" (Mesoudi 2011).

In the case of information mutations, these can occur because they are reconstructed for each new individual who receives it, since each person has unique cognitive and perceptual filters that can change the original information that was received, and sometimes, change the initial content (Laland and Brown 2011). Due to their "unintended" nature, these mutations can alter important elements of the original information, and consequently, lead to the establishment of "Maladapted Cultural Traits" (adopted behaviors that bring individuals harm) (Mesoudi 2011; Barkow 1989). Examples of these poorly adapted traits are plants used for medicinal purposes that do not have the desired efficiency in local medical systems (Tanaka et al. 2009).

Some situations that facilitate the appearance of mutations, includes the incomplete transmission of information, when portions of the same information are acquired by different sources or at different times of learning; (Arkes 1991). Another important factor is the ability of the human mind to make free associations, which could lead to generalizations, a process in which information can be confused as the correct answer to a given situation (Arkes 1991). Another process that could lead to mutations is the causal mismatch, this is a judgement error that attributes a cause-consequence relationship between two factors that have occured simultaneously, but are not related (Arkes 1991). Abbott and Sherratt (2011) demonstrate the causal mismatch with some superstitious habits like wearing the clothes used during a victory match of your football team during every game.

Thus, plant complexes could be a good model to evaluate mutations, because: 1) a plant complex has information formed by many smaller parts (plants, parts of plants, treated diseases, preparation forms), which facilitates the incomplete transmission of information; 2) a plant complex could be used to deal with many diseases at once (Vandebroek et al. 2010), which could lead to a generalization of uses (attributing more uses to the plant complex than it has) or a causal mismatch (attributing the capacity to deal with all diseases to each plant complex).

It is important to highlight that mutations can happen in human populations, but culture is adaptive (Mesoudi 2016). Thus, the majority of cultural information is transmitted with high fidelity, and a smaller part is mutated (Lewis and Laland 2012). Therefore, it is possible that people who deal more often with a given cultural information (for example, plant complexes) are less likely to mutate information.

Since socioeconomic variables influence knowledge on medicinal plants quantitatively (see Torres-Avilez et al. 2016; Toledo and Barrera-Bassols 2010; Dantas and Guimarães 2006), we believe it is also possible that these variables have a qualitative influence on the repertoire of plants and diseases (see Silva et al. 2011), such as the number of information mutations with respect to plant mixtures, a hypothesis that has not yet been tested in ethnobotany.

In terms of socioeconomic variables, some studies have shown that women may know more about medicinal plants than men due to social functions, such as the responsibility of women to care for family health in many cultures (Torres-Avilez et al. 2016). The interference of certain socioeconomic variables in human knowledge related to plant mixtures, such as those discussed in this study, is not absolute, and can vary between different medical systems. Nonetheless, we can only speculate whether women know more about medicinal plants and may have more reliable information regarding plant mixtures.

Another socioeconomic variable that has been shown to interfere with knowledge on medicinal plants is age. Some studies have shown that older informants may come to know more about medicinal plants, through the accumulation of experiences and contact with diseases over a longer period of time (Begossi et al. 2002; Carniello et al. 2010; Toledo and Barrera-Bassols 2010). Thus, it is possible that a group of older people would safeguard information about plant mixtures that is subject to less information mutations, due to experimentation processes over time.

Lastly, we believe that the informants' schooling could also interfere in a greater or lesser amount of information mutations about plant mixtures, since less educated individuals tend to stay out of the labor market and deal with agricultural, hunting, and medicinal plant collection (Dantas and Guimarães 2006; Alves et al. 2008). This factor provides people with a more direct contact with natural resources, and consequently, greater knowledge and a decreased possibility of making mistakes about their respective therapeutic indications and the parts used.

Therefore, in understanding that socioeconomic variables may influence information mutations for plant mixtures in local medical systems, we seek to test the following hypotheses: (1) women will accumulate less information mutations related to the plant part or function in plant mixtures; (2) the knowledge of older people will present less information mutations; (3) individuals with lower levels of schooling will present less information mutations on medicinal plants in plant mixtures.

MATERIAL AND METHODS

Study area

The study was carried out in the Lagoa do Junco community located in the urban area of of Santana do Ipanema, Alagoas, near the Universidade Estadual de Alagoas (UNEAL) (Figure 1). The municipality of Santana do Ipanema, located 209.7 km from the capital Maceió, has a territorial area of approximately 437.875 km2 and an estimated population of 47,654 inhabitants, with a latitude of 9°22'40" South and a longitude of 37°14'42" West (IBGE 2019). The climate is dry, predominantly consisting of hypoxerophilous caatinga vegetation. It is usually very hot, a characteristic of the semiarid region, and the rainy season lasts about four to five months (Lopes et al. 2005).

This community was chosen for this study because the residents frequently use medicinal plants and produce plant mixtures observed through research and extension work linked to UNEAL. The data from the Municipal Health Department shows a total of 63 registered families with about 188 individuals in the community, where 144 are older than 18 years of age. The study area includes a health unit, church, school and commercial establishments, as well as a local forest used to collect natural resources, where medicinal plants are removed for home use, a common local practice for residents to treat their health problems.

Ethical aspects

The study followed the instructions (Resolution 466/12) set by the National Health Council for research with humans. The study was submitted to the Research Ethics Committee (CEP) and received approval under the CAAE number: 97380918.9.0000.5207 from the Universidade de Pernambuco (UPE). It also passed the approval of the Biodiversity Authorization and Information System (SISBIO), under the registration number 64841-1 for the collection of botanical material in the study area.

Additionally, during the initial contact with the studied population, we briefly explained the research

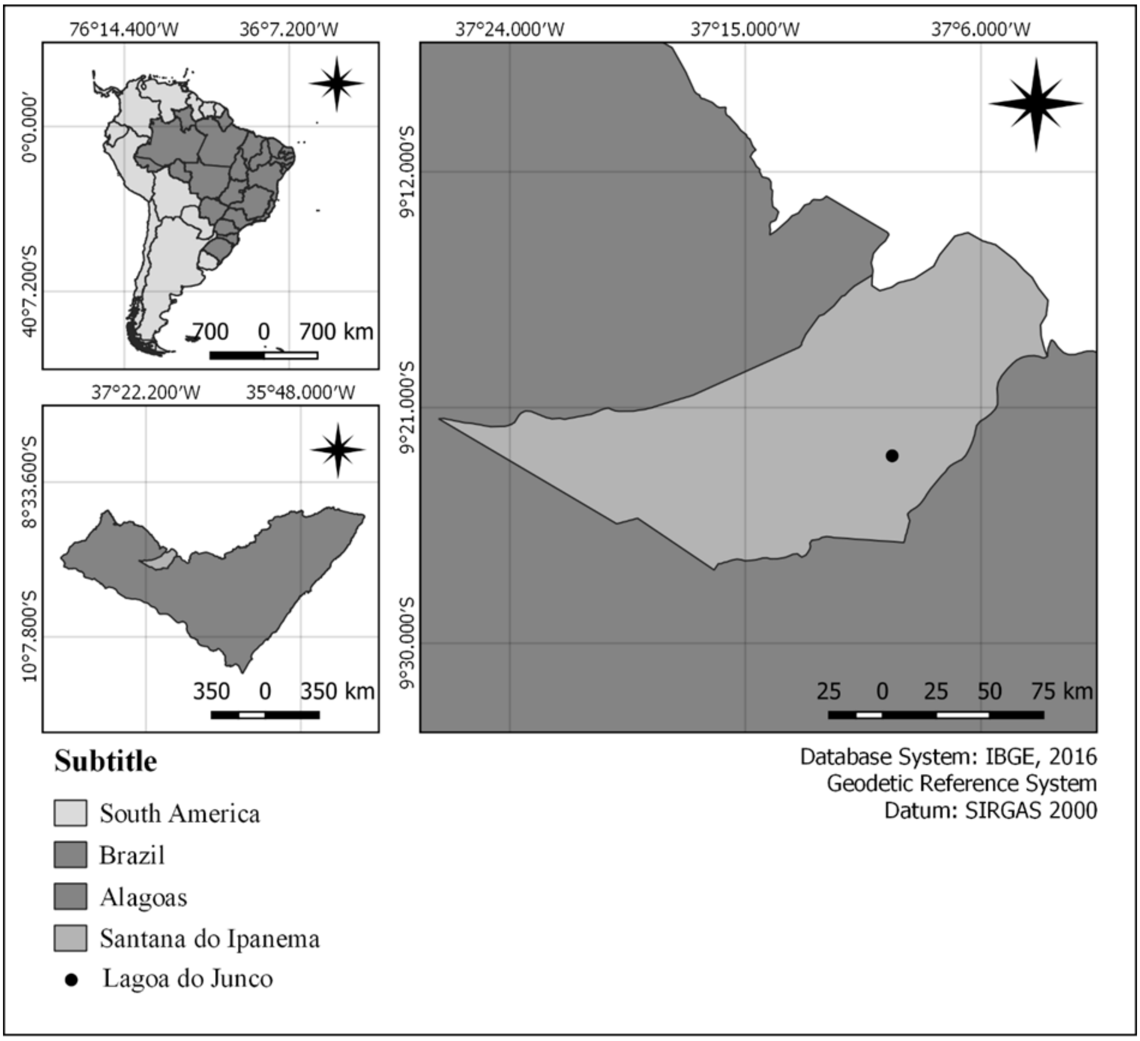

Figure 1. Location of the Lagoa do Junco community, Santana do Ipanema municipality, Alagoas, Brazil.

and asked informants who agreed to participate to sign the Informed Consent Form.

Data collection

Data colletion consisted of access to the local knowledge of individuals in the community between September 2018 and June 2019 during two different stages. As an inclusion criterion, we only accessed the local knowledge of adult residents who were eighteen years of age or older, totaling 120 participating individuals. We performed data collection in two distinct stages, as explained below (Table 1).

We used the free list technique (see Albuquerque et al. 2014) to access local knowledge about medicinal plants, where each participant was invited to mention plant species known or used by them for medicinal purposes.

After the listing, semi-structured interviews were conducted (Albuquerque et al., 2014), in order to investigate the informants' knowledge about the plants used by them in isolation (one plant at a time) and in plant complexes (plants used together with others). In addition, we also used semi-structured interviews to identify transmitting individuals (the person who transmitted the information in the local medical system) and apprentice individuals (the person who learned the information in the local medical system). For example, when conducting the interviews, for each plant mentioned by the informants, we asked the following questions: 1) For what diseases or illnesses is this plant indicated? 2) What part of the plant is used in the treatment? 3) How is the medicine prepared? 4) Of the plants that were mentioned, are there any that are used together with others? 5) If yes, which plants? 6) What health problems are treated with this mixture? 7) With whom did you obtain this knowledge?

After conducting the semi-structured interviews, we analyzed and compared the information from

Table 1. Socioeconomic data of the research participants.

Category		**Interviewees**
Gender	Woman	73
	Man	47
Schooling	Complete primary education	30
	Incomplete primary education	54
	Complete high school	36
Age	21 to 34 years	36
	34 to 47 years	29
	47 to 70 years	19
	60 to 73 years	24
	73 to 86 years	09
	87 years	03

transmitting individuals with the information from individual apprentices in the local medical system, in order to identify possible cases of information mutation among the local knowledge (Dantas et al. 2020). We consider a mutation when: 1) the therapeutic target (disease) indicated by an apprentice individual, was different from that indicated by the individual transmitting the information, and 2) when the part of the plant used in plant complexes indicated by the apprentice was different from that indicated by the transmitting individual (Dantas et al. 2020). In this study, we do not consider changes in the composition of the species present in the mixture as a mutation, due to the risk of involving guided variation. In addition, we consider a mutation when there have been changes both in the information of the learner, as well as in the information of the transmitting individual. In this case, both younger people mentioned learning from their elders, as well as older people mentioned learning from their younger ones.

In order to make sure that the possible changes in information between individuals were really unintentional (mutation), at a different time we carried out a new stage of data collection. This stage consisted of new semi-structured interviews. However, this stage was limited to apprentices and transmitters from the local medical system with possible cases of information mutation, as identified by the first stage of data collection.

To perform this step, each individual apprentice and information transmitter from the local medical system was notified of their information that had been mentioned by them during the first stage of data collection. Then, after being notified, we asked some inductive questions. For example: 1) A couple of days ago (first step) you mentioned that you use this type of mixture to cure disease X. However, can this mixture also be used to cure another type of disease? If so, which one? Why? 2) Have you used this mixture to cure another disease in the past? If so, which one? Why? 3) Have you already indicated this type of mixture to someone to cure another type of disease other than this? If so, which one? Why? 4) A couple of days ago you mentioned that you use X and Y parts of certain plants that are part of this preparation. However, can other parts of X or Y plant be used in the preparation besides these? If so, which ones? Why? After completing this step, the responses of all learners and transmitters were analyzed and compared again. If the new information of the individual learning remained altered/different from the information of the transmitting individual, we consider it as a mutation. If the new information from the apprentice individual coincided with the information from the transmitting individual, we consider it guided variation (Dantas et al. 2020). Additionally, we ensured that we classified the changes found between guided variation and mutation in an appropriate way, for the following reasons: 1) when they were notified of their information with mutations from the first stage, many individuals kept their information altered. For example, when asking the question: "Have you used this mixture to cure another disease in the past? If so, which one? Why?", even though the information was mutated, many responded: I always used this preparation for this purpose, in the same way I learned from my parents or I never used it for another purpose. When asking the question: "Have you already indicated this type of mixture to someone, to cure another type of disease other than this? If so, which one? Why?", even though the information was mutated, many responded: No! I never indicated this preparation for another purpose, as it can only be used for this function. In some cases, when asked about possible changes in their information, many of the individuals themselves argued that they learned the information in such a way, but that they used certain preparations in another way for preferential reasons. For example, when asking the question: "A few days ago you mentioned that you use the X and

Y parts of certain plants that are part of this preparation. However, can other parts of X or Y plant be used in the preparation besides these? If so, which one? Why?", many answered: Yes! my parents recommended I use the bark of plant X for the throat. However, I use the leaves because it is always easier to collect them. Thus, many of the informants' statements were essential in classifying information changes appropriately.

Botanical material collection

With the help of the residents, botanical species found with reproductive organs were collected locally during the research period. Using the technique walk-in-the-woods, the plants were found both in the residents' backyards and in the nearby local forest commonly used by residents for extractive activities (Albuquerque et al. 2014). From the collected material, species were identified with the help of botanical specialists, and exsiccates were prepared and deposited in the Pesquisa Agronômica of Pernambuco Institute (IPA).

Data analysis

After data collection was completed, the cultural mutations were identified and maintained in an Excel spreadsheet containing the number of mutations for each studied variable (response variable). Thus, in order to access which variable would better explain the amount of information mutations, the variables age, schooling, and gender (predictors variable) were analyzed individually using a Generalized Linear Model (GLM) with R MUmIN dredge R version 3.5.1 Copyright© 2017 (R Core Team 2017). The information units for each participant were their socioeconomic data, the number of mutations identified for the mixtures mentioned, and participants who learned mixtures from people not found in the community, therefore, 68 informants were included in this analysis. The variable schooling was reduced to two categories: "Lower level of schooling" (in this group the subcategories were incomplete elementary school and complete elementary school) and "Higher level of schooling" (in this group the subcategories were complete high school and complete higher education). Age was kept in its raw form (for example, 19, 23, 30, 34, etc.). Gender was divided into two categories: "Male" and "Female." Additionally, two categories were considered for the presence of cultural mutation: "0" (representing the absence of mutations) and "1" (representing up to two mutations, maximum number of mutations found), due to the low amount of cultural mutations found in this study.

RESULTS AND DISCUSSION

The participants' knowledge revealed a large amount of plant mixtures, with a total of 141 different mixtures and 52 corresponding medicinal plants cited by the 120 respondents who agreed to participate in the study (82% of the adult population in the community) (Table 2). The plant mixtures mentioned by informants were distributed into five categories of use, such as teas, bottles, lickers, syrups, and medicinal bath preparations). In general, the number of cultural mutations were low (148 cases of mutations for isolated plants and 22 mutations for plant complexes).

Table 2. Plants used for medicinal purposes isolated and as plant complexes by individuals from the Lagoa do Junco community, Santana do Ipanema, Alagoas, NE Brazil.

Common Name	Latin Name	Botanic Family	Voucher
Aroeira	*Myracrodruon urundeuva* Allemão	Anacardiaceae	Dantas, JIM 929563
Seriguela	*Spondias purpurea* L.	Anacardiaceae	Dantas, JIM 92947
Babosa	*Aloe vera* (L.) Burm. f.	Asphodelaceae	Dantas, JIM Estéril
Grajaú	*Fridericia chica* (Humb. & Bonpl.) L. G. Lohmann	Bignoneaceae	Dantas, JIM Estéril
Umburana	*Commiphora leptophloeos* (Mart.) J. B. Gillett	Burseraceae	Dantas, JIM 92951
Rabo de Raposa	*Harrisia adscendens* (Gurke) Britton e Rose	Cactaceae	Dantas, JIM 93420
Muçambê	*Tarenaya spinosa* (Jacq.) Raf.	Capparaceae	Dantas, JIM 92702
Pratudo	*Kalanchoe* cf. *crenata* (Andrews) Haw.	Crassulaceae	Dantas, JIM 92699
Bom Nome	*Monteverdia rigida* (Mart.) Biral	Celastraceae	Dantas, JIM 92952
Melão de São Caetano	*Momordica charantia* L.	Cucurbitaceae	Dantas, JIM 92696
Pião Roxo	*Jatropha gossypiifolia* L.	Euphorbiaceae	Dantas, JIM 92700
Quebra Pedra	*Phyllanthus amarus* Schumach.	Euphorbiaceae	Dantas, JIM 92956
Carrapateira (Mamona)	*Ricinus communis* L.	Euphorbiaceae	Dantas, JIM 92705
Hortelã da Folha Pequena	*Mentha* × *villosa* Huds.	Lamiaceae	Dantas, JIM 92949
Sambacaitá	*Mesosphaerum pectinatum* (L.) Kuntze	Lamiaceae	Dantas, JIM 929562
Manjericão	*Ocimum americanum* L.	Lamiaceae	Dantas, JIM 92948
Hortelã da Folha Grande	*Plectranthus amboinicus* (Lour.) Spreng.	Lamiaceae	Dantas, JIM 929560
Boldo	*Plectranthus ornatos* Codd.	Lamiaceae	Dantas, JIM 949561
Alecrim	*Rosmarinus officinalis* L.	Lamiaceae	Dantas, JIM 949510
Mororó	*Bauhinia cheilantha* (Bong.) Steud.	Leg. Caes	Dantas, JIM 92953
Jatobá	*Hymenaea courbaril* L.	Leg. Caes	Dantas, JIM93419
Catingueira	*Poincianella pyramidalis* (Tul.) L. P. Queiroz	Leg. Caes	Dantas, JIM 92944
Angico	*Anadenanthera colubrina* var. *cebil* (Griseb.) Altschul	Leg. Mim.	Dantas, JIM 92955
Tamarindo	*Tamarindus indica* L.	Leg. Mim.	Dantas, JIM 92701
Mulungú	*Erythrina velutina* Willd	Leg. Pap.	Dantas, JIM 92959
Romã	*Punica granatum* L.	Lythraceae	Dantas, JIM 92697
Acerola	*Malpighia emarginata* Dc.	Malpighiaceae	Dantas, JIM 92945
Hibisco	*Hibiscus rosa-sinensis* L.	Malvaceae	Dantas, JIM 92707
Pitanga	*Eugenia pitanga* L.	Myrtaceae	Dantas, JIM 92703
Goiabeira	*Psidium guajava* L.	Myrtaceae	Dantas, JIM 92706
Capim Santo	*Cymbopogon citratus* (DC.) Stapf	Poaceae	Dantas, JIM 929564
Juazeiro	*Ziziphus cotinifolia* Reissek	Rhamnaceae	Dantas, JIM 92698
Noni	*Morinda citrifolia* L.	Rubiaceae	Dantas, JIM 93422
Pé de Limão	*Citrus* sp.	Rutaceae	Dantas, JIM 92708
Laranjeira	*Citrus* x *aurantium* L.	Rutaceae	Dantas, JIM 92954

Quixabeira	*Sideroxylon obtusifolium* (Roem. & Schult.) T. D. Penn.	Sapotaceae	Dantas, JIM 92946
Pimenta	*Capsicum frutescens* L.	Solanaceae	Dantas, JIM 93421
Erva Cidreira	*Lippia alba* (Mill.) N.E.Br.	Verbenaceae	Dantas, JIM 92704
Testa de Touro	*Kallstroemia tribuloides* (Mart.) Steud.	Zygophyllaceae	Dantas, JIM 92950
Sabugueiro	*Reproductive material Not collected*		
Poeijo	*Reproductive material Not collected*		
Pau Darco	*Reproductive material Not collected*		
Mastruz	*Reproductive material Not collected*		
Jaramataia	*Reproductive material Not collected*		
Gengilin	*Reproductive material Not collected*		
Gengibre	*Reproductive material Not collected*		
Eucalipto	*Reproductive material Not collected*		
Endro	*Reproductive material Not collected*		
Colônia	*Reproductive material Not collected*		
Ouricuri	*Reproductive material Not collected*		
Amora	*Reproductive material Not collected*		
Canela	*Reproductive material Not collected*		

Source: (Dantas et al. 2020)

Regarding socioeconomic variables and their influence on the number of cultural mutations, gender did not indicate significant differences ($p < 0.3$), that is, men and women presented similar numbers of cultural mutations in terms of plant parts and their medicinal functions in plant mixtures (Table 3). In the studied community, we noticed that most of the plants were collected by the husbands during their excursions to the nearby local forest; however, several of the plants mentioned were cultivated by wives in makeshift home gardens and backyards.

Thus, this social division of function can ensure that both men and women equitably know the functions and ways of preparing plants in plant mixtures. Moreover, bark (Albuquerque 2006) and leaf extraction from medicinal plants are most commonly used in the Caatinga. For herbaceous plants collected in backyards, the information about medicinal plants from plant mixtures is more uniform between genders. However, to better understand our findings, further studies are needed that could investigate who prepares plant mixtures, since this factor can be decisive in the construction of this body of knowledge.

If there is no gender division in relation to plant mixture preparation, we expect that there will be no distinction in the number of mutations between genders in relation to plant function. Currently, the ethnobotanical literature shows that the division of social roles between men and women in a community is a major factor in the distribution of knowledge on medicinal plants (Torres-Avilez et al. 2016). For example, in communities where women are responsible for family health and men are involved in other activities that do not necessarily provide them with direct contact to natural resources, women tend to know more about medicinal plants (Voeks 2007; Momsen 2009), which was not the case in the community we studied.

The age of the informants varied between 20 and 90 years, the results of the GLM showed that increasing the age reduces the incidence of cultural mutations (Figure 2). Thus, the variable age most influenced the presence of cultural mutations ($p < 0.0008$), confirming our hypothesis that older people present less mutations in knowledge regarding the part of the plant or its function in a plant mixture when compared to younger people.

We believe that the decrease in cultural mutations on the functions and parts for preparing plant mixtures among older people, is associated with the accumulation of information and experimentation processes provided by time and contact with these resources. Begossi et al. (2002) reinforces the idea that older people have very detailed knowledge about medicinal plants and tend to trust traditional care more than younger people. Another study showed that people who know a greater number of plants are older, and consequently, have historical contact with various diseases (Garro 1986).

The knowledge acquired through greater contact with plants and diseases over time, may be directly related to the greater or lesser number of cultural mutations about plant mixtures. Moreover, if the individual had more contact over time with plants and diseases, they would better understand the variety of plant medicinal functions, ways of preparing and using plants, and reliably sustain the knowledge related to plant mixtures in the medical system. Schooling was another significant variable in the number of cultural mutations ($p < 0.006$), that is, the lower the informants' schooling, the smaller the number of cultural mutations related to plant mixtures (Table 3).

This phenomenon can be explained by the fact that informants who have a higher level of schooling, in general, have better jobs and higher incomes, which reduces the dependence on natural resources, such as medicinal plants (Santos et al. 2008). On the other hand, people who for various reasons had to leave school early or if they had the opportunity to study mostly dedicated themselves to activities associated with a lower income such as agriculture, livestock, among others, have more contact and dependence on natural resources, as is the case with medicinal plants. Thus, less schooling produces an increase in knowledge on medicinal plants as a substitute for pharmaceutical remedies, and consequently, explains a decrease in cultural mutations about plant mixtures in this group of informants.

The variable schooling has been a negative factor in relation to local knowledge, as more educated individuals have lost knowledge about the environment and traditional practices (Sternberg et al. 2001; Quinlan and Quinlan 2007). Thus, the present study also agrees with the idea that increased schooling is negative for the local medical system. Not only in terms of quantity of knowledge, as is already recorded in the literature, but also in the quality of knowledge, since people with higher schooling have a greater presence of cultural mutations.

FINAL CONSIDERATIONS

Our study with residents of the Lagoa do Junco community showed that the frequent use of medicinal plants in plant mixtures in the local medical system has generated cultural mutations, albeit in a small number. We found that people with knowledge on the use of plant mixtures represent reliable sources of knowledge when they are older individuals with less schooling, regardless of gender.

These informants had greater contact with medical use of plant mixtures, which led to fewer errors

Table 3. Socioeconomic variables that influence the number of information mutations on medicinal plants by community residents at Lagoa do Junco-AL.

Socioeconomic variable	Estimate Stg.	Error	Z Value	P
Gender	-0.5691	0.5503	-1.034	0.301136
Age	-3.9696	1.1877	-3.342	0.000831***
Higher level of schooling	-0.1720	0.6942	-0.248	0.804313
Lower schooling level	-2.9354	1.0828	-2.711	0.006708**

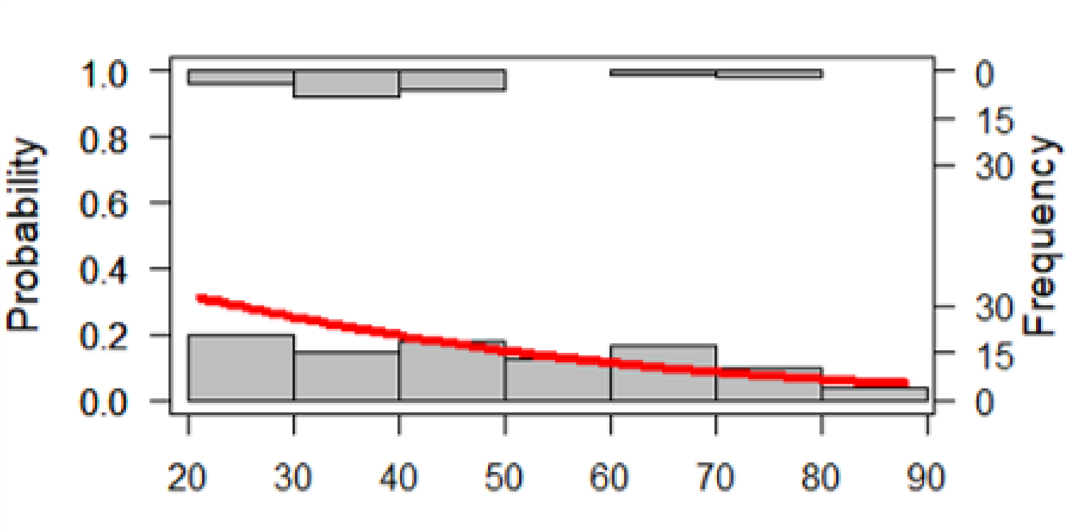

Figure 2. Number of information mutations related to the age variable of community informants, Lagoa do Junco-AL.

in knowledge for this medical system, showing that experimentation with treatments and life experience are two important factors in reducing the presence of cultural mutations. This helps us to better understand how the current transmission of information on medicinal plants used in plant mixtures is being carried out to prevent measures that ensure the smooth functioning of a local medical system.

Our study contributes to ethnobotanical knowledge and encourages new research on informatin mutations and socioeconomic variables in local medical systems to broaden the understanding and discussion of these cultural mutations for other communities in Brazil.

LIMITATIONS

This study has some limitations, we do not consider changes in the composition of the species present in the mixture as a mutation, due to the risk of involving guided variation. However, when we do a self-assessment on the methods we used, we believe that changing the part of the plant or the method of preparation has as much chance of being a guided variation as the composition of the species. Thus, we suggest that future studies that evaluate the transmission of information from individuals, also consider changes in the composition of plant species as a factor to be evaluated in the number of mutations and guided variation.

ACKNOWLEDGEMENT

We would like to thank all the residents of the Lagoa do Junco community who contributed to this study and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for financial support.

DATA AVAILABILITY

The data used to support the finding of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived the idea presented: T.C.S; A.B.N
Carried out the study: M.R.S.P; J.I.M.D
Carried out the data analysis: T.C.S; A.B.N
Wrote the first draft of the manuscript: M.R.S.P
Review and final writing of the manuscript: T.C.S; A.B.N; M.R.S.P; J.I.M.D

REFERENCES

Albuquerque UP, Ramos MA, Lucena RFP, Alencar NL (2014) **Methods and techniques used to collect ethnobiological data**. In: Albuquerque UP, Cruz LVF, Lucena RFP, Alves RRN (eds) Methods and techniques in Ethnobiology and Ethnoecology. New York, NY, Springer, pp. 15-37.

Albuquerque UP (2006) **Re-examining hypotheses concerning the use and knowledge of medicinal plants: a study in the caatinga vegetation of NE Brazil**. *Journal of Ethnobiology and Ethnomedicine* 2: 1-30.

Alves RRN, Silva CC, Alves HN (2008) **Aspectos sócio-econômicos do comércio de plantas e animais medicinais em área metropolitanas do Norte e Nordeste do Brasil**. *Revista de biologia e ciências da terra* 8: 181-189.

Alvim NAT, Ferreira MA, Cabral IE, Almeida-Filho AJ (2006) **The use of medicinal plants as a therapeutical resource: from the influences of the professional formation to the ethical and legal implications of its applicability as an extension of nursing care practice**. *Revista Latino-americana de enfermagem* 14: 316-323.

Arkes HR (1991) **Costs and benefits of judgment errors: implications for debiasing**. *Psychological Bulletin* 3: 486-498.

Barkow JH (1989) **The elastic between genes and culture**. *Ethology and Sociobiology* 10: 111-129.

Begossi A, Hanazaki N, Tamashiro JY (2002) **Medicinal plants in the Atlantic Forest (Brazil): knowledge, use, and conservation**. *Human ecology* 30: 281-299.

Bizoón Z (1976) **The adaptation patterns of the medical system and social change**. In: Sokotowska M, Hotówka J, Ostrowska A (eds) Health, Medicine, Society. Springer, Dordrecht, pp. 331-347.

Bussmann RW, Glenn A, Meyer K, Kuhlman A, Townesmith A (2010) **Herbal mixtures in traditional medicine in Northern Peru**. *Journal of Ethnobiology and Ethnomedicine* 6:10.

Camargo MTLDA (2011) **A garrafada na medicina popular: uma revisão historiográfica**. *Dominguezia* 27: 41-49.

Cano JH, Volpato G (2004) **Herbal mixtures in the traditional medicine of Eastern Cuba**. *Journal of Ethnopharmacology* 90: 293–316.

Carniello MA, Silva RDS, Cruz MD, Guarim Neto G (2010) **Quintais urbanos de Mirassol D'Oeste-MT, Brasil: uma abordagem etnobotânica**. *Acta amazonica* 40: 451-470.

Dantas IC, Guimarães FR (2006) **Perfil dos raizeiros que comercializam plantas medicinais no município de Campina Grande, PB**. *Revista de Biologia e Ciências da Terra* 6: 39-44.

Dantas JIM, Nascimento ALB, Silva TC, Albuquerque UP (2020) **Mutation of Cultural Information on the Use of Plant Complexes in Local Medical Systems**. *Evidence-Based Complementary and Alternative Medicine* 1-11.

Dunn FL (1976) **Traditional Asian medicine and cosmopolitan medicine as adaptive systems**. In: Leslie C (eds) Asian medical systems: a comparative study. Berkeley and Los Angeles, University of California Press, pp. 133-158.

Ferreira-Júnior WS, Nascimento ALB, Ramos MA, Medeiros PM, Soldati GT, Santoro FR, Reyes-García V, Albuquerque UP (2015) **Resilience and adaptation in social-ecological systems**. In: Albuquerque UP, Medeiros PM, Casas A (eds) Evolutionary ethnobiology. Springer, Cham, pp. 105-119.

Garro LC (1986) **Intracultural variation in folk medical knowledge: a comparison between curers and noncurers**. *American anthropologist* 88: 351-370.

Henrich J (2009) **The evolution of costly displays, cooperation and religion: Credibility enhancing displays and their implications for cultural evolution**. *Evolution and human behavior* 30: 244-260.

IBGE - Instituto Brasileiro de Geografia e Estatística (2019) **Cidades e Estados: Santana do Ipanema.** https://ww.ibge.gov.br/cidades-e-estados/al/santana-do-ipanema.html Accessed 07 November 2019.

Kleinman A (1978) **Concepts and a model for the comparison of medical systems as cultural systems**. *Social Science & Medicine. Part B: Medical Anthropology* 12: 85-93.

Kujawska M, Zamudio F, Hilgert NI (2012) **Honey-based mixtures used in home medicine by nonindigenous population of Misiones, Argentina**. *Evidence-Based Complementary and Alternative Medicine* 2012: 579350.

Laland KN, Brown G (2011) **Sense and nonsense: Evolutionary perspectives on human behaviour**. 2nd. Edn. Oxford University Press.

Lewis HM, Laland KN (2012) **Transmission fidelity is the key to the build-up of cumulative culture**. *Philosophical Transactions of the Royal Society B: Biological Sciences* 367: 2171–2180.

Lopes OF, Santos JCP, Barros AHC (2005) **Diagnóstico ambiental do município de Santana do Ipanema, Alagoas**. Embrapa Solos - Boletim de Pesquisa e Desenvolvimento 76 (INFOTECA-E), Rio de Janeiro/RJ.

Mesoudi A (2011) **Cultural evolution: How Darwinian theory can explain human culture and synthesize the social sciences**. Chicago, University of Chicago Press.

Mesoudi A (2016) **Cultural evolution: a review of theory, findings and controversies**. *Evolutionary Biology* 43: 481-497.

Momsen J (2009) **Gender and development**. 2nd. Edn. London, Routledge.

Quinlan MB, Quinlan RJ (2007) **Modernization and medicinal plant knowledge in a Caribbean horticultural village**. *Medical Anthropology Quarterly* 21: 169–192.

R Core Team (2017) **R: A language and environment for statistical com-puting**. R Foundation for Statistical Computing, Vienna, Austria.

Richerson PJ, Boyd R (2005) **Not by genes alone: How culture transformed human evolution**. Chicago, University of Chicago Press.

Rios M, Tinitana F, Jarrín-VP, Donoso N, Benavides JCR (2017) **"Horchata" drink in Southern Ecuador: medicinal plants and people's well-being**. *Journal of Ethnobiology and Ethnomedicine* 13: 1-20.

Santoro FR, Ferreira-Júnior WS, Araújo TAS, Ladio AH, Albuquerque UP (2015) **Does Plant Species Richness Guarantee the Resilience of Local Medical Systems? A Perspective from Utilitarian Redundancy**. *Plos One* 10: e0119826.

Santos MRA, Lima MR, Ferreira MGR (2008) **Uso de plantas medicinais pela população de Ariquemes, em Rondônia**. *Horticultura Brasileira* 2: 244-250.

Silva FS, Ramos MA, Hanazaki N, Albuquerque UP (2011) **Dynamics of traditional knowledge of medicinal plants in a rural community in the Brazilian semi-arid region**. *Brazilian Journal of Pharmacognosy* 21: 382-391.

Sternberg RJ, Nokes C, Geissler PW, Prince R, Okatcha F, Bundy DA, Grigorenko EL (2001) **The relationship between academic and practical intelligence: a case study in Kenya**. *Intelligence* 29: 401–418.

Tanaka MM, Kendal JR, Laland KN (2009) **From traditional medicine to witchcraft: why medical treatments are not always efficacious**. *Plos One* 4: e5192.

Toledo VMM, Barrera-Bassols N (2010) **A etnoecologia: uma ciência pós-normal que estuda as sabedorias tradicionais**. In: Silva VA et al. (eds) Etnobiologia e Etnoecologia: Pessoas & Natureza na América Latina. Recife: NUPPEA, pp. 13-36.

Torres-Avilez W, Medeiros PMD, Albuquerque UP (2016) **Effect of gender on the knowledge of medicinal plants: systematic review and meta-analysis**. *Evidence-Based Complementary and Alternative Medicine* 1: 1-13.

Vandebroek I, Balicka MJ, Ososki A, Kronenberg F, Yukes J, Wade C, Jiménez F, Peguero B, Castillo D (2010) **The importance of botellas and other plant mixtures in Dominican traditional medicine**. *Journal of Ethnopharmacology* 128: 20-41.

Voeks RA (2007) **Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil**. *Singapore Journal of Tropical Geography* 28: 7-20.

Wiley SA (1992) **Adaptation and the biocultural paradigma in medical anthopology: a critical review**. *Medical Anthropology Quarterly* 6: 216-236.

Received: 06 October 2020
Accepted: 02 February 2021
Published: 16 April 2021