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Ethnobotany and conservation of the species *Celtis toka* (Forssk.) Hepper & J.R.I. wood: A way forward for sustainable use in Burkina Faso

Zaïnabou Dabré [a,b,*], Issouf Zerbo [b,c], Blandine Marie Ivette Nacoulma [b], Dodiomon Soro [a], Adjima Thiombiano [b]

[a] *West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), Graduate Research Program on Climate Change and Biodiversity, UFR Biosciences, University Félix Houphouët Boigny, B.P. 165, Abidjan 31, Cote d'Ivoire*
[b] *Laboratory of Plant Biology and Ecology, University Joseph Ki-Zerbo, 03 B.P. 7021, Ouagadougou 03, Burkina Faso*
[c] *University Center of Tenkodogo, University Thomas Sankara, 12 B.P. 417, Ouagadougou 12, Burkina Faso*

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ABSTRACT

Celtis toka (*C. toka*), a critically endangered mystical plant, is a highly valued and overharvested multiuse tree species by local population in Burkina Faso. The ethnobotany of *C. toka* can lead to its sustainable use, therefore it is a great challenge because little information is available on this aspect concerning the species in Burkina Faso as well as in Africa. Thus, this study aims to assess the sustainable use and management of *C. toka* in Burkina Faso.

The study was conducted along a climate gradient (Sudanian and Sudano-Sahelian climatic zones) in Burkina Faso. Data were collected randomly through selected semi-structured interviews with 405 informants (148 women and 257 men) randomly selected from 34 villages and 25 ethnolinguistic groups. Frequency of citation was computed. Kruskal–Wallis test, Mann–Whitney test and Generalized Linear Models analyses were performed to determine whatever information varied according to site and socio-demographic parameters.

Among eight use categories, food (27.89%), livestock (18.97%), shade (16.23%), and pharmacopeia (14.92%) were the most recorded. Leaves (63.83%), roots (19.20%), and bark (17.11%) were the most valued plant parts. All plant parts were used to heal 29 ailments in 37 ways. The most common diseases treated by *C. toka* were vitamin deficiencies (FL = 8.84%), malaria (FL = 8.44%), cast (FL = 5.84%), madness (FL = 3.25%), eye ache (FL = 2.77%) and yellow fever (FL = 2.60%). Sacred forests (39%) and protected areas (27%) were the key biotopes of *C. toka*. Value of *C. toka* was well-treasured in the study sites. The frequency of citation of some use patterns and plant parts varied significantly across some ethnolinguistic groups, sex and generation levels ($p < 0.05$). Management such as sowing (0%), seedling transplantation (0%) and assisted natural regeneration (0%) were lacking. Sacred (37.99%), taboo (25.04%), mystic (11.62%), magic (10.28%) fetish (8.96%) and medico-magic (6.12%) characters of *C. toka* determined the traditional conservation strategies of the species in Burkina Faso.

Our results recommend that the conservation policies and sustainable use of *C. toka* should be prioritized. Furthermore, studies should thus emphasize the domestication potential of *C. toka* for its plant parts.

* Corresponding author. West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), Graduate Research Program on Climate Change and Biodiversity, UFR Biosciences, University Félix Houphouët Boigny, B.P. 165, Abidjan 31, Cote d'Ivoire.
E-mail address: zainaboudabre@gmail.com (Z. Dabré).

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1. Introduction

Non-Timber Forest Products (NTFPs) are wildlife products harvested from forests [1,2]. In Africa, they play a crucial role in the survival of rural and urban populations. They also contribute to the reduction of poverty, food insecurity and enhance nutrition, health and the environment [3,4]. However, the reliance can be either in the form of subsistence uses or as cash income derived from a wide range of timber and non-timber forest products. For instance, in Sub-Saharan Africa, NTFPs contribute to rural livelihoods on a socioeconomic level [5]. In Tanzania, NTFPs provided an important source of additional income for local population, particularly the poorest who mainly depend on subsistence agriculture [6]. In Zimbabwe, NTFPs are a sort of way for people to cope with climate variability [7].

In Burkina Faso, local communities rely heavily on forests and plants for goods and services [8,9]. The most important needs are food, medicine, wood, fodder, fuel, shade, soil fertilization, ornamentation and practices of rituals and customs [10,11]. According to Ref. [12], wild plants contribute about 45% to the total household income in the south-eastern part of Burkina Faso.

The genus *Celtis* contains approximately 60–70 deciduous tree species worldwide [13]. In Africa, this genus has about 12 species [14].

Celtis toka (Cannabaceae), also known as *Ficus toka* Forssk., *Celtis integrifolia* Lam. [15,16], Micocoulier Africain, African Hackberry [17] or nettle tree [18] is one of the most useful wild species, principally used as food for human and animals, livestock, fuelwood, shade, handicraft and construction resources [16,18–26]. Leaves and fruits constitute food and/or livestock in the feeding of mankind and animals [16,18,27]. Leaves and fruits are edible in Sudan [28]; Ghana [29], Senegal [30], Nigeria [31–33], Cameroon [34–36] and Benin [37]. In Nigeria, many studies have shown that leaves were rich in mineral elements such as Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Lead (Pb), Iron (Fe), Manganese (Mn) and Cadmium (Cd) [33,38,39]. Besides, leaves content 8.20% as proteins and Lysine, Threonine, Cysteine, Valine, Methionine, Isoleucine, Leucine, Tyrosine, and Phenylalanine as amino acids [33].

Plant parts of *C. toka* are used to treat diseases such as measles, chickenpox, malaria, back and eye aches, ringworm, fever, sore, mycosis, headache, and mental illnesses [16,40–42]. In Nigerian, roots, leaves, and bark are used in traditional medicine to treat various diseases, including epilepsy [43]. Plant parts are additionally used to treat trypanosomiasis [44]. The bark is similarly used to cure epilepsy in Cameroon [45]. The medicinal use of *C. toka* was also emphasized in Mali [46] and Senegal [25,42].

In addition, *C. toka* has custom or ritual virtue for some ethnic groups in Africa [17].

C. toka was assessed on the IUCN Red List of Threatened Species in 2023 as Least Concern (LC), and its current population trend is stable at present ([47], accessed on May 18, 2023).

C. toka has a very wide distribution and large population, with no major threats currently existing and no significant future threats identified [47]. Despite being classified as LC globally [47], *C. toka* is threatened, rare, critically endangered, and even extinct in some temperate regions and the Sahelian region of Africa [40,48–51]. Nevertheless, the species is thought to be extinct in Senegal, Guinea-Sudan, and Uganda [52]. Additionally, *C. toka* is threatened in Benin [27], northern Cameroon [53], the Sahel region of Africa [54], and either extinct or endangered in Chad [51].

C. toka is an important species, but it is currently rare in Yemen [49] rare and threatened in Saudi Arabia [50]. According to research, *C. toka* is known to be facing natural regeneration challenges [53]. Among the 12 species [14] from the genus *Celtis*, only one (*C. toka*) is found in Burkina Faso [55]. Unfortunately, *C. toka* is endangered and on the verge of extinction in Burkina Faso [40,48,56,57].

According to Ref. [48], *C. toka* is a critically endangered species and is on the verge of extinction one day [17,40,56,58] in Burkina Faso. For instance, also reported that since 2000, *C. toka* has disappeared in eastern Burkina Faso, except in sacred groves.

Moreover [56], found that *C. toka* was the most threatened species in the farmlands of Burkina Faso. Furthermore, *C. toka* is endangered in the Northern and Southern Sudanian zones of Burkina Faso [17]. [57] showed that *C. toka* is rare in communities in the strict Sahelian, southern and northern regions of Burkina Faso. More recently [59], stressed that *C. toka* is extinct in the communal area of Sudano-Sahelian climatic zone and threatened in Sudanian climatic zone of Burkina Faso. Despite its usefulness, there is least information to promote and ensure its conservation and sustainable use in Burkina Faso. Unfortunately, ethnobotany on *C. toka* has never been studied in Burkina Faso before. However, the lack of reliable information is the greatest obstacle to effective conservation planning in Burkina Faso. This study aims to evaluate the sustainable use and management of *Celtis toka* in Burkina Faso. Explicitly, the study aims.

i) to document the various local uses and management of *C. toka;*
ii) to assess the socio-demographical factors (ethnolinguistic groups, sex, and generations) that impact the use patterns and organs of the species.
iii) to determine the conservation strategies of local communities to ensure the sustainable use of *C. toka* in Burkina Faso.

2. Materials and methods

2.1. Materials

2.1.1. Description of the study area

The study was carried out from November 2020 to January 2022 in two climatic zones (Sudanian (Sz) and Sudano-Sahelian (SSz)) in Burkina Faso (Fig. 1). Thirty-four villages were surveyed.

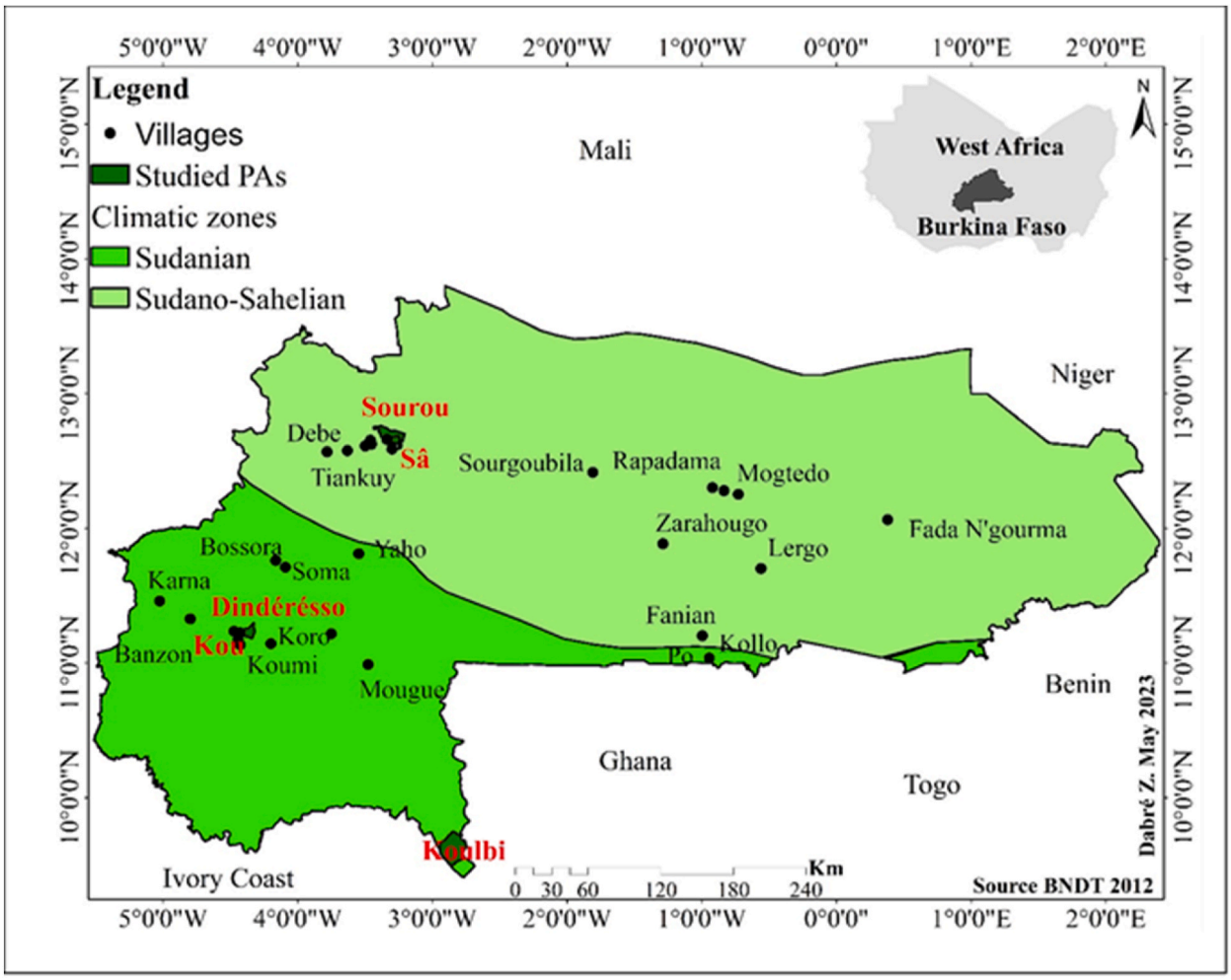

Fig. 1. Localization of the study sites in Burkina Faso.

The main rivers of Sz are Mouhoun, Comoé and Léraba [60] and the key soil types are leptosols, vertisols, regosols, cambisols, and luvisols [61]. The rainy season lasts for 5–6 months, with annual rainfall reaching or exceeding 1100 mm. Temperature ranges between 20 and 25 °C define this zone. The flora of Sz is conquered by Sudanian and Guinean species [17] like *Chlorophora excelsa*, *Elaeis guineensis*, *Antidesma venosum*, *Dialium guineense*, *Cola laurifolia*, *Antiaris africana*, *Carapa procera*, and *Manilkara multinervis.*

Sz is comprised of the following socio-linguistic groups: Bobo (dominant), Bozo, Turka, Bambara, Sambla, Senoufo, Bwaba, Dafing, Tièfo and Toussian.

In SSz, where rainfall ranges between 600 and 900 mm over 4–5 months. Temperature ranges between 20 and 30 °C [17,62]. The types of soils are poorly developed, and this includes lithosols and hydromorphic soils. The hydrographic network is made up of tributaries of streams and rivers such as Sourou, Nakambé, Nazinon, and Sissili [17]. The SSz vegetation is a mosaic of various savannah types (wood savannahs, shrubs, and trees) and forests. The vegetation is considered as Sudanian and some Sahelian species: *Crateva adansonii, Ptercarpus santalinoides*, *Mitragyna inermis*, *Acacia seyal*, *Vitex chrysocarpa; Adansonia digitata*, *Sclerocarya birrea*, *Parkia biglobosa*, *Lannea microcarpa Azadirachta indica*, *Vitellaria paradoxa, Grewia bicolor,* and *Faidherbia albida* etc.*,* as most common species. SSz is made up of Bobo, Dafing, Mossi, Fulani (Peul-Rimaibe) Bisa, Gourmatché, Gourounssi and Bwaba.

People from Both Climate Zone (BCz) are farmers, hunters, and traders except Fulani who are mostly cattle breeders.

2.1.2. Description and ecology of C. toka

Celtis toka is either a deciduous [13], semi-deciduous [63,64] or evergreen to semi-deciduous tree species [65] that can grow up to 25 m in height and 220 cm in diameter at breast height (Appendixes: Fig. 2 A). A monoecious plant whose leaves are simple, alternate,

dark green or light, oval with a point at the top. The petiole of the leaf measures 0.5 cm in length. There are three main veins at the bottom of the limb and secondary veins per side for each main vein. Each secondary vein is divided into other veins (tertiary veins) (Appendixes: Fig. 2 D). Barks are either smooth (Appendixes: Fig. 2 B) or scale (Appendixes: Fig. 2C), light grey with cavities or not, and dark or ashy. Inflorescences are pubescents and branched panicles. Male flowers are sessile, and females are pedicellate. Flowers are without petals (Appendixes: Fig. 2 E). Fruits are drupes and present various colours: orange, red, bright yellow, purple, gold, and brown. They contain white seeds (Appendixes: Fig. 2 G). Compared to the genus *Ziziphus*, *C. toka* has no thorns (Appendixes: Fig. 2 F). The propagation of *C. toka* may be done through seeds, root suckers, seeding sprouts, water sprouts or coppices. Its dispersal aspect is frequently made by wind, rainwater, birds, bats and sometimes by small ruminants. The agent of pollination are birds, mammals (bats) and insects (bees, wasps). This plant grows in a wide range of soil types and environmental conditions from moist savannah, dried savannah, woodlands, forests, gallery forests (ponds, streams, and rivers), sacred forests, farmlands, fallows, and rocky areas.

2.2. Methods

2.2.1. Sampling performance and data collection

To prevent the spread of the Coronavirus, the prospection and survey were conducted while maintaining social distancing and other precautions (wearing a nose mask and using hand sanitiser). Before the survey, a prospection was conducted to confirm the presence of *C. toka* in the selected sites, to get the consent of the authorities and villages' leaders, and to adjust the questionnaire. A random sampling scheme was used to select informants. Data was gathered using a semi-structured interview method. Overall, 405 consent rural people (203 in Sz and 202 in SSz) were randomly selected based on the knowledge of *C. toka*. There were 146 females (91 in Sz and 55 in SSz) and 259 males (112 in Sz and 147 in SSz) consenting informants interviewed. This bias may be explained by the fact that few women were familiar with the species. The survey focused on (i) the informant's ethnolinguistic groups, age, sex, activity, and school level [66] and ii) the informant's knowledge of the species uses, management, and conservation. Villages were chosen based on the presence of *C. toka.* In this study, we used translators who spoke the informants' native languages.

2.2.2. Data analysis

Before the analyses, informants were grouped into two generations (adult: <55 and old: ≥55 years) followed by Ref. [67]. Twenty-five ethnolinguistic groups were involved. Ethnolinguistic groups such as Bobo, Bozo and Dioula on first hand, Dafing, Bwaba, Bobo and Mossi on the other hand were examined respectively in Sz and SSz as major ethnolinguistic groups. Minorities included Sambla, Dafing, Miniankas, Mossi, Samo, Dioula, Tièfo, Toussian and Bwaba in Sz and Fulani, Gourounssi, Bissa and Gourmatché in SSz were grouped as others to perform statistical analysis.

The recorded usages were computed and organized by use patterns to determine the species' uses. Eight use categories (food, fodder, shade, energy, pharmacopeia, sacred tree, magic tree, building) were cited by informants. Focus is given to the medicinal use of *C. toka* because they were used in a variety of ways by households. We assessed the variation of use patterns across climatic zones, ethnolinguistic groups, sex, generations, and the interaction between factors by using Generalized Linear Model with Poisson error and using the log function as the function of the link to accounting for the non-normal errors and the increasing variances with increasing mean that is associated with counted data.

For each use pattern, Relative frequency of Use (RF), Fidelity Level (FL), Use Diversity (UD) and Use Equitability (UE) were computed in each climate zone (CZ). UD and UE were used to determine the distribution of knowledge and perceptions regarding the uses, management, and conservation practices of *C. toka* within the community (Table 1). The non-parametric Kruskal-Wallis test and Mann–Whitney at the threshold of significance of 5% were applied to evaluate significant differences in use diversities between sex, generation and ethnolinguistic groups for each climatic zone [66]. The non-parametric tests were used to overcome the non-normal distribution of the data [68]. All statistical tests were accomplished using R4.05 software [69].

Table 1
Measurement of knowledge and perceptions regarding uses, sociodemographic impact, and conservation strategies of *C. toka* within communities in Sz and SSz of Burkina Faso.

Index	Computation	Description	References
$RF = \frac{FU}{SF} x100$	Frequency of uses (FU) cited by a given informant divided by the number of total uses times 100.	Measures the ratio of the number of times a pattern of *C. toka* occurs in the set of all number of use patterns. The value ranges from 0 to 100.	[70]
$FL = \frac{Ip}{Iu} x100$	Number of informants (Ip) related to a specific use divided by the total number of informants (Iu) times 100.	Measures the grade of consensus between informants. FL is considered significant when this is directly above 5% (FL >5%).	[71]
UD = U cx/U ct	Number of indications recorded by pattern (U cx) divided by the total number of indications for all the patterns (U ct).	Expresses how many uses patterns *C. toka* is used and its contribution to the total usage. The value ranges from 0 to the number of use categories that use it	[72]
UE = UD/UDmax	Use-diversity value (UD) is separated by the index's maximum value (UD max).	UE measures the contribution of diverse uses to the overall use of a species, regardless of the number of use categories. The range of values is between 0 and 1.	[72]

Table 2
Variation of local knowledge on *C. toka* in two climatic zones of Burkina Faso.

Criteria/Patterns	Variant	Sudanian								Sudano-Sahelian									
		Bobo (n = 145)		Bozo (n = 17)		Dioula (n = 21)		Others (n = 20)		Bobo (n = 28)		Bwaba (n = 64)		Dafing (n = 47)		Mossi (n = 37)		Others (n = 26)	
		F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL
Motivation for conservation	Multiuse tree	61	**42.07**	11	**64.71**	18	**85.71**	11	**55**	3	**10.7**	17	**26.6**	15	**32**	24	**64.86**	20	**76.92**
	Magic tree	14	9.66	4	23.53	0	0	2	10	1	3.57	14	21.9	8	17	6	16.22	6	23.08
	Sacred tree	60	**41.38**	9	**52.94**	3	14.29	4	20	1	3.57	5	7.81	7	15	10	**27.03**	11	**42.31**
	Agroforest tree	26	17.93	14	**82.35**	4	19.05	4	20	11	**39.3**	1	1.56	22	**47**	24	**64.86**	10	**38.46**
	Shade	29	20	2	11.76	14	**66.67**	9	**45**	1	3.57	9	14.1	3	6.4	23	**62.16**	11	**42.31**
	Rare	2	1.38	4	**23.53**	1	4.76	3	15	2	7.14	21	**32.8**	17	36	37	**100**	15	**57.69**
	ΣF	192	–	44	–	40	–	33	–	19	–	67	–	72	–	124	–	73	–
Use patterns	Food	143	**98.62**	16	**94.12**	12	**57.14**	19	**95**	28	**100**	64	**100**	45	96	4	**10.81**	2	8
	Fodder	120	**82.76**	11	**64.71**	15	**71.43**	18	**90**	5	**17.9**	64	**100**	33	70	37	**100**	26	100
	Energy	51	**35.17**	5	29.41	8	**38.1**	13	**65**	1	3.57	47	**73.4**	18	38	24	**64.86**	11	**42.31**
	Shade	78	**53.79**	12	**70.59**	17	**80.95**	16	**80**	1	3.57	34	**53.1**	22	47	16	**43.24**	9	**34.62**
	Pharmacopeia	57	**39.31**	5	29.41	6	**28.57**	20	**100**	2	7.14	17	**26.6**	15	32	22	**59.46**	5	19.23
	Sacred tree	60	**41.38**	9	52.94	3	14.29	4	20	1	3.57	5	7.81	16	34	10	27.03	11	42.31
	Magic	14	9.66	4	**23.53**	0	0	2	10	1	3.57	14	**21.9**	8	17	6	16.22	**6**	**23.08**
	Building	4	2.76	0	0	0	0	0	0	0	0	1	1.56	0	0	1	2.7	**1**	3.85
	ΣF	527	–	62		61	–	92	–	39	–	246	–	157	–	120	–	71	–

n: number of informants per ethnolinguistic groups, F: frequency, FL: fidelity level, ΣF: sum of frequency per ethnolinguistic group, Bold values: FL>20%, unbold value: FL<20%.

3. Results

3.1. Diversity of use of C. toka

3.1.1. Local names of the species C. toka

C. toka was referred to as 49 vernacular names in 25 ethnolinguistic groups across the study areas. However, for a single ethnolinguistic group, several local names were attributed. The main meaning of the local names was either taboo, fetish, sacred, magic, mystic, fodder, or sweet stew plant. Some names were related to the size and height (gobda, kaa) or the number of *C. toka* trees (Kankami (many *C. toka* trees*)* or Kankama (Single *C. toka* tree)). Nonetheless, a few informants were unable to give a precise sense of the name of the species in their respective dialects (Appendixes: Table 2).

3.1.2. Frequencies and fidelity levels of the use categories and plant parts

C. toka provides various functions including custom, cultural, ecologic, and socio economical. Custom and cultural values were food (27.89% of which 29.86% in Sz and 25.92% in SSz), fodder (18.97% of which 23.70% in SSz and 14.23 in Sz), pharmacopeia (14.92 of which 16.28% in Sz and 13.56% in SSz), energy (11.33% of which 10% in Sz and 12.66% in SSz), shade (16.22% of which 19% in Sz and 13.56% in SSz), Sacred tree (5.24% of which 6.50% in Sz and 4% in SSz) and others. Although eight specific use patterns were recorded across its entire distribution range, seven of them were found to be important (FL> 20%). BCz shares the same number of usage categories. However, the FL of motivation highlighted the uses of food, fodder, shade, pharmacopeia, and energy value as the most important (Table 2). Almost all respondents of BCz widely expressed that they use *C. toka* for food, fodder, shade, pharmacopeia, and energy purposes. In SSz, Bobo sociolinguistic groups valued the species in terms of food (FL = 98.62), fodder (FL = 82.76%) and sacred tree (FL: 41.38%) more than Dioula culture (FL: 57.14%). Whereas Bwaba and Dafing cherished the species in food (FL = 100%) and fodder (FL = 95.74%), Mossi culture valued less the species in terms of food (FL: 10.81%) in SSz. Hence, the motivation for conservation was similar ($p > 0.05$) between ethnolinguistic groups, sex, and generations in both climatic zones (Table 3). The results of the GLM analysis at the level of motivation revealed that the conservation of *C. toka* for multiuse and sacred trees varied significantly between ethnicity ($p < 0.05$) and sex ($p < 0.05$) (Table 3).

The most used plant parts of the sacred species were leaves (63.83% of which 60.35% in Sz and 55.95% in SSz), roots (19.20% of which 18% in Sz and 16.99% in SSz) and barks (17.11% of which 16.41% in Sz and 14.78% in SSz). Leaves, flowers, and fruits had various usage patterns. However, leaves were the most widely used organs and were used as food, fodder, and pharmacopeia. In BCz, fruits and seeds were also used as food. Some of the respondents (20.69% of Bobo culture in Sz) highlighted that the pounded leaves were often used to cook To during the hunger period by some of their ancestors. Though, pounded leaves were sold in some local markets in BCz.

3.1.3. Traditional medicinal uses of C. toka

In total, 29 diseases have been recognized to be healed with *C. toka* organs. The most common diseases treated by *C. toka* were vitamin deficiencies (FL = 8.84%), malaria (FL = 8.44%), cast (FL = 5.84%), madness (FL = 3.25%), eye ache (FL = 2.77%) and yellow fever (FL = 2.60%). All organs were involved in the composition of medicines. Roots were the most frequently used organs and were used to heal 15 ailments which were mostly ringworm, diarrhea, backache, toothache, ulcer, measles, and chickenpox followed in decreasing order by bark (12), leaves (12), fruits (3), seeds (3) and flowers (2) (Appendixes: Table 5). This form of knowledge is generally kept by elders, bozo (Fishermen/women), dosso (hunters) and traditional healers.

3.2. Impact of sociodemographic factors on the use of C. toka

3.2.1. Diversity and distribution of knowledge according to socio-professional groups

Diversity and distribution of knowledge of different socio-professional groups on the use of *C. toka* were not homogeneous (Table 4). However, in BCz, farmers (UD:0.51; UE: 1) have a perfect distribution knowledge of the use of *C. toka* as food, followed by farmers and traders (in Sz; UD: 0.04; UE: 0.23), farmers and blacksmiths (in SSz; UD: 0.22; UE: 0.43), farmers and breeders; and farmers and traditional healers (UD:0.03; UE: 0.06).

Table 3
Results of GLMs testing for differences in overall use value between climatic zones, sociocultural groups, sex, and generation.

Motivation of conservation	CZ	Ethnolinguistic groups (Eg)	Sex (S)	Generation (G)	CZ x Eg	E x S	G x S
Agroforest tree	0.138	0.4464	0.6258	0.3509	0.0984	0.6499	0.672
Magic tree	0.364	0.803	0.717	0.41	0.435	0.374	0.203
Multiuse species	0.34849	0.77754	0.35637	0.8574	0.0592	**0.00476**	0.5796
Rare	0.913	0.94	0.979	0.422	0.83	0.989	0.654
Sacred tree	0.766	0.164	0.345	0.609	0.773	**0.03**	0.51
Shade	0.898	0.263	0.338	0.923	0.123	0.178	0.612

Bold values: $p < 0.05$. Unbold values: $p > 0.05$.

Table 4
Use Diversity and distribution of knowledge of socio-professional groups on *C. toka* in Burkina Faso.

CZ	Activities	Fo	P	Mt	St	F	B	E	Sh
		Use Diversity							
Sz	Farmers	**0.16**	0.07	0.02	0.03	0.07	0.00	0.09	0.09
	Farmers and Blacksmith	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Breeders	**0.03**	0.02	0.00	0.01	0.01	0.00	0.02	0.02
	Fishermen/Women	0.02	0.00	0.00	0.01	0.01	0.00	0.01	0.00
	Forest Managers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hand workers	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Farmers and Housemaids	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00
	Farmers and Hunter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Mechanic	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	Farmers and Orchard Owner	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Trader	**0.04**	0.01	0.00	0.00	0.02	0.00	0.02	0.02
	Farmers and Traditional healers	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Watchmen	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
SSz	Farmers	**0.51**	0.23	0.05	0.11	0.23	0.03	0.30	0.29
	Farmers and Blacksmith	**0.22**	0.05	0.08	0.05	0.16	0.00	0.10	0.09
	Farmers and Breeders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fisherman/woman	0.02	0.01	0.01	0.00	0.02	0.00	0.01	0.02
	Forest Managers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hand workers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Housemaids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hunters	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Mechanics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Orchard Owner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Traders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Traditional healers	**0.03**	0.01	0.01	0.01	0.02	0.00	0.01	0.02
	Farmers and Watchmen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Use Equitability								
Sz	Farmers	**1.00**	0.46	0.10	0.20	0.43	0.03	0.57	0.58
	Farmers and Blacksmiths	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.01
	Farmers and Breeders	**0.18**	0.10	0.02	0.04	0.07	0.02	0.09	0.11
	Fishermen/women	0.10	0.02	0.02	0.06	0.06	0.00	0.06	0.01
	Forest Managers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hand workers	0.09	0.02	0.00	0.01	0.03	0.00	0.04	0.08
	Farmers and Housemaids	0.06	0.01	0.00	0.01	0.04	0.00	0.05	0.01
	Farmers and Hunters	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00
	Farmers and Mechanics	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.05
	Farmers and Orchard Owners	0.04	0.02	0.01	0.01	0.01	0.00	0.02	0.01
	Farmers and Traders	**0.23**	0.08	0.00	0.01	0.11	0.01	0.12	0.10
	Farmers and Traditional healers	0.04	0.04	0.01	0.02	0.02	0.00	0.03	0.02
	Farmers and Watchmen	0.06	0.04	0.00	0.00	0.02	0.00	0.02	0.03
SSz	Farmers	**1.00**	0.46	0.10	0.21	0.45	0.05	0.58	0.56
	Farmers and Blacksmiths	**0.43**	0.10	0.16	0.10	0.32	0.01	0.20	0.17
	Farmers and Breeders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fishermen/women	0.04	0.02	0.01	0.01	0.03	0.00	0.03	0.03
	Forest Managers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hand workers	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	Farmers and Housemaids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Hunters	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Mechanics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Orchard Owners	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Farmers and Traders	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01
	Farmers and Traditional healers	**0.06**	0.01	0.02	0.02	0.05	0.00	0.02	0.03
	Farmers and Watchmen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CZ: climatic zones, Sz: Sudanian climatic zone, SSz: Sudano-Sahelian climatic zone, Fo: Food, P: Pharmacopeia, Mt: Magic tree, St: Sacred tree, F: Fodder, B: Building, E: Energy and Sh: Shade. Bold values are values which been demonstrated to be more important.

3.2.2. Effect of sex, age, and ethnolinguistic groups on Celtis toka use categories

Most use patterns were similar among sex, generations, and ethnolinguistic groups ($p > 0.05$). The analysis at the level of uses categories showed that the use of *C. toka* for sacred and magic was only dissimilar among sex ($p < 0.05$) in Sz. Overall use categories were more important for men than women. In sacred use, for example, men (1.87 0.85) valued the species more than women (1.31 0.63). There is a significant difference in the food use of *C. toka* between generations and ethnolinguistic groups ($p < 0.05$) in SSz. Energy and pharmacopeia use varied only among ethnolinguistic groups ($p < 0.05$) (Table 5). In Sz, the food uses category was more important for Dioula (1.65 ± 0.86), followed by others (1.63 ± 1.02), Bobo (1.59 ± 0.70) and Bozo (1.44 ± 0.63). The food use category was important for Dafing (1.44 ± 0.78) in SSz, the old generation valued the species for food, sacred and magic use. (Table 5).

Table 5
Sociodemographic parameters effect on use categories of *C. toka*.

CZ		n	Food	Fodder	Energy	Building	Shade	Pharmacopeia	Sacred tree	Magic tree
Sz	Ethnolinguistic groups									
	Bobo	145	1.59 ± 0.70	1.86 ± 0.76	1.60 ± 0.70	1.75 ± 0.5	1.69 ± 0.73	2.04 ± 0.71	1.65 ± 0.69	1.55 ± 0.68
	Bozo	17	1.44 ± 0.63	1.5 ± 0.76	1.63 ± 0.74	–	2 ± 0	2 ± 0.71	1.36 ± 0.67	1.60 ± 0.64
	Dioula	21	1.65 ± 0.86	1.67 ± 1	1.44 ± 0.88	–	1.55 ± 0.82	2 ± 0.89	2 ± 0	2 ± 0
	Others	20	1.63 ± 1.02	1.69 ± 1.11	1.69 ± 1.11	–	1.89 ± 1.27	1.91 ± 1.14	2.75 ± 1.5	1.76 ± 1.40
	Kruskal-Wallis test		0.8333	0.3622	0.7833	–	0.6991	0.792	0.1589	0.1395
SSz	Bobo	28	1 ± 0	1 ± 0	1 ± 0	0 ± 0	1 ± 0	1 ± 0	1 ± 0	1 ± 0
	Bwaba	64	1.26 ± 0.51	1.26 ± 0.51	1.24 ± 0.52	0 ± 0	1.24 ± 0.49	1.94 ± 0.54	1.36 ± 0.54	1.17 ± 0.42
	Dafing	47	1.44 ± 0.78	1.36 ± 0.70	1.89 ± 0.90	0 ± 0	1.73 ± 0.88	2.44 ± 0.73	1.94 ± 0.90	1.87 ± 0.86
	Mossi	37	1.36 ± 0.6	1.72 ± 1.5	1.32 ± 0.75	1.2 ± 0	1.4 ± 0.55	3.15 ± 1.89	2 ± 1.41	2 ± 1
	Others	26	1.15 ± 0.63	1.82 ± 1.54	1.43 ± 0.79	1 ± 0	1.5 ± 0.76	3.25 ± 1.89	2 ± 1.32	1.31 ± 0.56
	Kruskal-Wallis test		**0.02837**	0.3889	**0.01699**	NA	0.1321	**0.01337**	0.0817	0.0601
Sz	Generation									
	Old	108	1.52 ± 0.74	1.68 ± 0.88	1.60 ± 0.81	2 ± 0	1.70 ± 0.79	2.09 ± 0.82	1.81 ± 0.61	1.8 ± 0.91
	adult	95	1.67 ± 0.73	1.88 ± 0.79	1.64 ± 0.72	1.67 ± 0.58	1.73 ± 0.79	2 ± 0.77	1.59 ± 0.69	1.46 ± 0.87
	Mann-Whitney test		0.108	0.1562	0.6208	1	0.891	0.7058	0.4997	0.307
SSz	Old	83	1.37 ± 0.66	1.38 ± 0.64	1.46 ± 0.70	1 ± 0	1.48 ± 0.69	2 ± 0.72	1.61 ± 0.74	1.59 ± 0.73
	Adult	119	1.17 ± 0.49	1.24 ± 0.76	1.29 ± 0.65	0 ± 0	1.31 ± 0.67	2.46 ± 1.27	1.4 ± 0.71	1.31 ± 0.64
	Mann-Whitney test sex		**0.02455**	0.05651	0.1723	NA	0.1554	0.3103	0.2262	0.1906
Sz	Women	91	1.51 ± 0.67	1.71 ± 0.78	1.62 ± 0.76	1.5 ± 0	1.67 ± 0.74	2.03 ± 0.78	1.31 ± 0.63	1.23 ± 0.79
	Men	112	1.67 ± 0.76	1.86 ± 0.89	1.63 ± 0.79	1.67 ± 0.58	1.75 ± 0.82	2.03 ± 0.78	1.87 ± 0.85	1.65 ± 0.89
	Mann-Whitney test		0.1134	0.4813	0.9874	1	0.697	0.8548	**0.02163**	**0.0264**
SSz	Women	55	1.13 ± 0.41	1.33 ± 1.04	1.28 ± 0.57	0 ± 0	1.23 ± 0.53	3 ± 1.73	1.29 ± 0.59	1.17 ± 0.68
	Men	147	1.3 ± 0.61	1.29 ± 0.57	1.4 ± 0.71	1 ± 0	1.47 ± 0.74	2.03 ± 0.74	1.61 ± 0.77	1.54 ± 0.75
	Mann-Whitney test		0.1074	0.4079	0.6057		0.2003	0.2207	0.135	0.123

CZ: climatic zones, Sz: Sudanian climatic zone, SSz: Sudano-Sahelian climatic zone, M: Men, W: Women, bold values: *p*-value <0.05, unbold values: $p > 0.05$.

Table 6
Variation in local knowledge on *C. toka* in two climatic zones of Burkina Faso.

Criteria/Patterns	Variant	Sudanian								Sudano-Sahelian									
		Bobo (n = 145)		Bozo (n = 17)		Dioula (n = 21)		Others (n = 20)		Bobo (n = 28)		Bwaba (n = 64)		Dafing (n = 47)		Mossi (n = 37)		Others (n = 26)	
		F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL	F	FL
Habitat	Rocky hills	15	10.34	0	0	5	**23.81**	2	10	0	0	0	0	0	0	0	0	8	**30.77**
	Sacred forests	63	**43.45**	0	0	5	14.29	2	10	0	0	0	0	3	6.38	10	27.03	0	0.00
	Protected areas	20	13.79	0	0	3	4.76	4	20	1	3.57	0	0	20	42.55	11	29.73	3	11.54
	Galleries/Part lands	46	**31.72**	17	100	1	**61.90**	21	100	27	**96.43**	58	**90.63**	24	**51.06**	37	**100**	12	**46.15**
	Fallows	0	0		0	13	0	0	0		0	6	9.38		0	3	8.11	0	0.00
	ΣF	129	–	17	–	22	–	27	–	28	–	64	–	47	–	61	–	23	–
Propagation and regeneration practices	Non-assisted tree regeneration	145	**100**	15	**88.24**	19	**90.48**	20	**100**	28	**100**	61	**95.31**	47	**100**	37	**100**	26	**100**
	Assisted tree regeneration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sowing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Transplantation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ΣF	145	–	15	–	19	–	20	–	28	–	61	–	47	–		0	14	–
Current management of the species	State	16	11.03	2	11.76		0	1	5	0	0	2	3.125	1	2.13	0	0	0	0
	Individual	35	**24.14**	2	11.76	4	19.05	0	0	0	0	4	6.25		0	3	8.11	4	0
	Collective	80	**55.17**	5	**29.41**	15	**71.43**	10	**50**	28	**100**	44	**68.75**	46	**97.87**	18	**48.65**	15	**100**
	Pruning	49	**33.79**	8	**47.06**	13	**61.90**	14	70	4	14.29	62	**96.88**	32	**68.09**	19	**51.35**	11	**73.33**
	Fire protection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Grazing Protection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ΣF	214	–	21	–	39	–	29	–	32	–	124	–	91	–	49	–	**47**	–

n: number of informants per ethnolinguistic group, F: frequency, ΣF: sum of frequency per ethnolinguistic group, FL: fidelity level. Bold values: FL>20%, unbold value: FL<20%.

Table 7
Results of GLMs testing for differences in overall use value between climatic zones, sociocultural group, sex, and age.

Indigenous Knowledge	Variables	Estimate	Std. Error	t value	Pr (>|t|)
Biotopes	(Intercept)	−1.797124	0.315952	−5.688	<0.0000
	Climate	−0.192799	0.130602	−1.476	0.1399
	Ethnolinguistic groups	0.090209	0.035119	2.569	**0.0102**
	Sex	−0.00524	0.111776	−0.047	0.9626
	Age	−0.001295	0.111108	−0.012	0.9907
Propagation and regeneration practices	(Intercept)	−1.38617	0.315677	−4.391	<0.0000
	Climate	0.001506	0.157493	0.01	0.992
	ethnolinguistic groups	−0.00011	0.037343	−0.003	0.998
	Sex	0.000837	0.111999	0.007	0.994
	Age	−0.00161	0.11235	−0.014	0.989
Current Management	(Intercept)	−1.86 E+00	2.53E-01	−7.338	<0.0000
	Climate	−3.27E-02	1.35E-01	−0.242	0.8087
	Ethnolinguistic groups	6.20E-02	2.93E-02	2.112	**0.0347**
	Sex	8.49E-02	8.97E-02	0.946	0.3443
	Generations	6.74E-02	8.83E-02	0.764	0.445

Bold values: $p < 0.05$, unbold values: $p > 0.05$.

3.3. Traditional perception of occurrence habitats, management practices and the attitudes of informants to maintain and conserve C. toka

3.3.1. Local perception of occurrence habitats of C. toka

Local knowledge of the habitat of the species varied significantly across ethnolinguistic groups ($p < 0.05$) in BCz However, there was no significant difference between sex and generations ($p > 0.05$) (Table 7). The species was reported to be present in both protected areas mainly gallery forests (ponds, streams, and rivers (27%)) and communal areas (rocky areas/rocky hills (11%), sacred forests (39%), farmlands (19%) and fallows (3%)). In Sudanian climatic zone, *C. toka* could be found either in the top, slope, or bottom of the rocky areas. *C. toka* was mentioned in almost all land use types in BCz (Table 6). The species was scarce in fallows in Sudanian climatic zone. It was reported by some (Bobo and Bwaba in Sz) that *C. toka* only appeared in old compounds (where ancestors lived before).

3.3.2. Traditional propagation and current management practices for C. toka conservation

No regeneration practice (Assisted tree regeneration, sapling transplantation and sowing) was recorded by interviewees during the survey. Management such as collective, individual, and state was recorded in BCz. Moreover, *C. tota* individual trees were not protected from fire and animal grazing in BCz (Table 6). Pruning was chiefly experienced by most traditional cattle breeders and farmers. Farmers for instance, often pruned branches to decrease the shade effect on yields. In addition, to make more space, they sometimes cut down an entire *C. toka*. Cattle breeders pruned the species to feed their cattle, and this was more common in SSz ($14.29 < FL < 96.88$) than Sz ($33.79 < FL\ 70$) (Table 7). The management of *C. toka* varied greatly between ethnolinguistic groups ($p < 0.05$) in the study sites. However, this management was similar across climatic zones, generation, and sex ($p > 0.05$) (Table 7).

Traditional conservation strategies mentioned by the sociocultural groups were either sacred (37.99%) or taboo (25.04%) or mystic (11.62%) or magic (10.28%) or fetish (8.96%) or medico -magic (6.12%). In Sz, Bozo culture perceived *C. toka* as a sacred tree (FL: 52.94%) and a magic tree (FL: 23.53%) while Bobo (FL: 40.81%) and Dioula (FL: 12.50%) sociolinguistic groups believed that the species is sacred. In SSz, the species was perceived as magic by the Bwaba ($FL = 21.88\%$), Dafing ($FL = 17.02\%$) and Mossi ($FL = 16.22\%$) cultures. The sacred aspect, on the other hand, was more perceived by Dafing culture ($FL = 34.04\%$) and Mossi ethnolinguistic groups ($FL = 27.03\%$). Locals define a sacred tree as a traditional tree under which customs or cultural activities take place. Taboo and fetish have been defined in the same way as sacred trees but with little differences. Sacred, taboo and fetish are almost synonymous. The location determines the name. For example, Bobo, Marka, and Mossi all designated *C. toka* as a sacred, fetish, and taboo species, which all refer to cultural and customary activities. The term fetish was used by the Bozo culture because they worship *C. toka* as their God. As for the Dafi people, they use the term taboo because in this culture it is forbidden to pass under *C. toka* or to point at it. Mystics are evil spirits, demons, and genies who have haunted the species for centuries. Magic is the power that *C. toka* plant parts must be used to solve problems. For instance, the presence of *C. toka* bark or roots in the pirogue protects fishermen/women from ferocious water animal attacks, particularly hippopotami in rivers. Furthermore, a *C. toka* organ hung at the entrance of a house could protect it from wizards and witches. The ability of *C. toka* to cure evil spirit diseases is referred to as medico-magic.

4. Discussion

4.1. Socio-cultural importance of C. toka and diversity of use categories

Globally, 49 specific local names were given to *C. toka* although some informants were not able to give the exact meaning of the name of *C. toka* in their respective mother tongues. Some vernacular names perceived by local people could be a pointer to how vital the species is in their culture. Based on the value and the organ used, local names of *C. toka* differ from one ethnolinguistic group to another. “Nongon Na baa”, “kamignan”, “Sondeyni or Seideni” respectively in Dioula, and Bobo and which mean delicious stew made from fresh dried and pounded leaves. “Ganki” denotes the use of the species as fodder by Fulani culture. The local name Ganki has been

stressed by Fulani in Cameroon [21]. Additionally, Bambara culture from Mali highlighted "Kamaua, Gamya" as *C. toka* local name [46]. *C. toka* is a wild food tree, some of them were considered either a "taboo" "sacred" "magic" or even a "fetish'' where their areas any person (mostly children, women, and strangers) should not point the finger or worse go under it. It is for instance the case of local names "Djo", "Djo la", "Yobo", and some vernacular names "Kamignan", "Mabri'', "Mambri'', "Sondeyni or Seideni", "Yibiligou'' and "Yibourougou''. Most custom or cultural ritual activities and decisions of elders are taken under *C. toka* as stressed by Ref. [17]. Similar differences in names by ethnic group were noted by Ref. [73] on Strychnos spinosa Lam. in Benin and [74] on *Bombax costatum* Pellegr. and Vuillet in Burkina Faso.

The food use stated throughout this study concerned mostly leaves followed by fruits and seeds. They were eaten by both humans and animals (cows (leaves), sheep ((leaves), birds (fruits), some small ruminants (fruits, leaves), some mammals (leaves, fruits), termites (leaves, fruits) etc.). The species plant parts are mainly eaten row by children (fruits and seeds) and adults (fruits) during times of shortage. Fruits and seeds were taken raw by local people. Local communities (Bobo and Bwaba) mostly used dried fresh leaves to cook delicious stew. However, 28.06% of respondents believed that the stew of *C. toka* is as sweet as *Adansonia digitata* L. stew. Edible plant parts reported in this study are also consumed raw in Burkina Faso [19,40] and other parts of Africa during plenty and food scarcity [20,21]. Hence, the high value (61.23%) of leaves in food might be attributed to the fact that leaves are not toxic [13,38,75]. In the study sites, fruits were often difficult to be found because of the competition between birds, mankind (severe pruning) and the probability to the low productivity of the species. Some local people thought that *C. toka* does not produce any fruits. This could be the reason of the overharvesting of either leaves or fruits. According to informants, fruits and seeds were as sweet as *Ziziphus mauritiana* Lam. fruits and *Sclerocarya birrea* (A. Rich.) Hochst. seeds. In Ethiopia for instance, food insecurity was combated by combining fruits of *C. toka* with some wild edible plants [76]. Moreover, in Senegal, *C. toka*'s fruits were consumed by Malinke culture [77]. Besides, the nutrient contents, amino acids, and proteins of *C. toka* leaves could explain why they are valued by locals. In Nigeria for instance, many studies have shown that leaves were rich in mineral elements such as Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Lead (Pb), Iron (Fe), Manganese (Mn) and Cadmium (Cd) [33,38,39]. Furthermore, leaves content 8.20% as proteins and Lysine, Threonine, Cysteine, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine as amino acids [33]. However, plant protein provides health and physical function to mankind [78]. Besides, coumarins, flavonoids, mucilage, triterpenoids and steroids are phytochemical constituents of *C. toka* leaves' [79]. Food use of wild plants was highlighted by Ref. [80] on Afzelia africana Sm. [73], on Strychnos spinosa Lam. [81], on *Piliostigma thonningii* (Schumach.) Milne- Redh. and [74] on *Bombax costatum* Pellegr and Vuillet. Locals also used the species as energy (firewood and charcoal), but due to the scarcity of *C. toka*, they replaced it with other species. Moreover, informants sometimes used either the wood from fallen trees, or the branches cut during the agricultural installation to generate their energy. In addition, this species is seldom used as charcoal.

This ecologically, socio-economically [65], culture, and sociocultural species was furthermore highly valued as fodder for animals in the SSz (23.70%) than in the Sz (14.23%). This could probably be the reason for the installation of Bella people who pruned leaves to feed their cattle. The use of the species as livestock is in agreement with the findings of several authors [16,18,19,24]. This survey puts in evidence a weak building of *C. toka* in shed and house constructions due to the lightness of the wood and the high attacks of ants. Few (0.84%) informants from Sz only used it for cooking (wooden spoon) and farming tools (daba).

In the study areas, 10.16% of local people acknowledged that *C. toka* is used to heal 29 diseases. However, several diseases testified in this study had been mentioned by many studies in Africa. The healing action of *C. toka* in cases of sore, malaria, mycosis, headache, and mental disease was in agreement with previous studies [16,40–42]. Leaves, roots, bark, seeds, and flowers were used in preparing traditional human and animal medicines. Roots were the greatest used plant part and were used against ringworm, diarrhea, backache, toothache, ulcer, measles, and chickenpox. Moreover, they were also used in the treatment of rheumatism, paralysis, epilepsy, sterility and mental diseases [16,38]. However [41], have reported that barks were sold in Cameroon and they were used in curing hernia, and intestinal helminthiasis. In Burkina Faso, no toxicological tests have approved the effectiveness of the formulation in disease treatments like in Nigeria [13,38,75]. Therefore, this medicine use should be taken with attention. Even though, *C. toka* is a mystical or sacred tree, it is pruned and/or debarked by some locals. Promoting *C. toka* will help with food security, provide income for women, provide good health and well-being; and treat a variety of diseases as four of the 17 internationally supported United Nations Sustainable Development Goals (SDGs) declared by the United Nations [82]. Medicinal studies were done on *Moringa oleifera* [83] and on *Bombax costatum* Pellegr. and Vuillet [74].

4.2. Impact of sociodemographic parameters on the use of C. toka

Diversity and distribution of knowledge on the use patterns of *C. toka* were heterogeneous among various socio-professional groups. However, farmers (UD:0.51; UE: 1) have a perfect distribution knowledge of the use of *C. toka* than other socio-professional groups. This could be explained by the fact that farmers made up most of the interviewees. Moreover, farmers are more familiar with the species than other socio-professional groups. Thus, this knowledge varies among farmers as itemized by Ref. [84].

Furthermore, the study emphasizes differences in some form of uses across the ethnolinguistic groups, ages and sex as stated by Ref. [85] on *Sclerocarya birrea* (A. Rich.) Hochst. [80], on *Afzelia africana* Sm [66]; on *Lannea macrocarpa* Engl. & K. Krause [73]; on

Strychnos spinosa Lam. And [86] on *Gardenia erubescens* Stapf & Hutch. Local people have very rich ethnobotanical knowledge due to the diversity of ethnolinguistic groups. Yet, the knowledge differs from one ethnolinguistic group to another for food, energy, and pharmacopeia use in SSz. These differences within ethnolinguistic groups were due to respondents having different backgrounds. However, food, fodder, pharmacopeia, culture, and customs use are basic needs for locals living in BCz. They are crucial for farmers, traditional healers, and breeders of Bobo, Bwaba, Dioula and Dafing cultures.

All use patterns were treasured by men compared to women. The difference could be explained by the fact that female informants comprised fewer groups than male informants. Additionally, men were either farm owners, farmers and breeders or farmers and traditional healers. Also, custom and cultural activities were made by men. Women were mostly housemaids and sometimes traders. In Sz, elderly people placed a high value on *C. toka* in pharmacopeia, sacred and magic use than the adults. In contrast, adult informants from SSz cherished less *C toka* in most use categories (food, fodder, sacred, magic, energy, building). This could be the reason for the cultural erosion due to the rise of imported religions (Islam and Christianity) or the lack of knowledge of young people on *C. toka* use. In addition, young people may not inherit the knowledge from their parents. Besides, because the species is uncommon in most communal areas, young people may be unfamiliar with the species. Differences in plant part use were also highlighted across ethnolinguistic groups, ages, and sex. Study by Ref. [74] showed that men used *Bombax costatum* Pellegr. and Vuillet more than women. Leaves, roots, barks, and fruits were more valued by Bobo and Dafing cultures. In SSz, women tended to place more importance on seed use, whereas men placed more importance on leaves and roots. Because women spent more time with children, they were more aware of the species' seed uses.

4.3. Traditional perception of occurrence habitats, management practices and the attitudes of informants to maintain and conserve C. toka

Deciduous, semi-deciduous or evergreen to semi-deciduous tree *C. toka* [50,65] was abundant and spread in Sz compared to SSz. Results showed that the wild species were further found in sacred forests, rocky areas, farmlands, and PAs of Sz. This could be justified by the fact that Sz is well wetted than SSz. Hence, some interviewees of Sz believed that *Celtis toka* only appeared in old compounds (where ancestors lived before). However, this is hard to prove without a stronger investigation. In Saudi Arabia [50] stressed that the magic tree habitat was rocky, slope or valley bottom. Moreover, this was confirmed by several studies across Africa. In the Sahel, the species biotope is a valley [19]). Thus, *C. toka* is either settled in riparian areas, galleries forests, berg of water bodies, dense dry forests or savanna frameworks [16,87–89]. In the study sites, management such as sowing, seedling transplantation and assisted natural regeneration were all lacking. Similar findings were made on *Afzelia africana* Sm. where there is a complete lack of management practices [80]. No individuals were found planted next to houses. This could be explained by the huge size and the mystic aspect of the species. In most cases, the species were pruned either by breeders or farmers. Similar studies have been conducted on *Bombax costatum* Pellegr. and Vuillet [74] in Burkina Faso. Mystic, fetish, sacred, taboo, magic, or medico-magic species are the traditional strategy for the conservation of *C. toka*. However, the more a species was known as taboo, the more it was a luxury to the local population. Hence [90], highlighted taboo as a conservation strategy used by native people to preserve heavily threatened species. The term sacred tree has been highlighted by Ref. [91]. Sacred areas are where earth sacrifices are made and where the earth chiefs are buried [91]. Most people across the study areas have reported that the species was sacred. However, activities such as customs, culture, or rituals were taken under the species. For instance, under the majority of the fetich tree were tools such as hen feathers, canaries or pieces of canaries, cowries, coins, and eggs that reflected ritual activities. Moreover, according to Bobo elders, any problems were solved when rituals are done under *C. toka* tree. Sociolinguistic groups such as Bobo, Bozo, Bwaba, Dafing and Mossi thought that some of the species were mystics because they believed that they were haunted, and represent the presence of evil spirits, genies, and demons. Therefore, they possessed power beyond human conception. In addition, some people across the study areas have emphasized that the species was magic like it protects villages and their contents, gives worth, power, water, birth, reconciliation of couple, genuine love, and promotion in work. Additionally, according to the magical aspect, any plant part hung in a house sacks evil spirits, witchcraft, and witches. In Sz for instance, some fishermen (Bozo) thought that the presence of a plant part (bark or roots) in their pirogue protects them against ferocious water animals' attacks, particularly hippopotamus in rivers. Also, certain Bobo traditional healers believed that the decoction of the epiphyte found on *C. toka* provides worth and promotion to them. In SSz, local people from Kaminiankoro (a village named after the local name of *C. toka* (Kaminian)) believe that the species provides them with long life, protection, joy, and peace. Besides, according to some Mossi cultures, a death of an individual of *C. toka* raises the death of the chief of the village. As a result, local people (Bobo, Bozo, Mossi, traditional healers, hunters, elders etc.) highly hold the species as a fetish, mystic, sacred, magic, or taboo tree which were their approaches to sustainability and conservation. Endogenous biodiversity conservation strategy [17,92] underpins all of this. The term taboo was highlighted by on *Afzelia africana* Sm. by Ref. [80] in Burkina Faso. In contrast to our founding, there is no traditional conservation strategy on *Strychnos spinosa* Lam. in Benin [73].

5. Conclusion

The study provided important knowledge of local people on *C. toka* in Burkina Faso. Results revealed that the mystical species *C. toka* is a multipurpose tree used in eight use categories and mainly for food (27.89%), fodder (18.97%), medicine (14.92%), sacred

(5.24%), and magic (5.24%). *C. toka* is involved in the treatment of twenty-nine ailments. According to locals, the most common diseases treated by *C. toka* were vitamin deficiencies, malaria, cast, madness, eye ache, and yellow fever. Additionally, *C. toka*, generally colonized gallery forests, sacred forests protected areas and rocky areas. Local knowledge is very diverse and influenced by levels of sociodemographic factors. However, across the sociolinguistic groups studied, Bobo and Dafing had high levels of knowledge about the species. Pruning was the management practice. Thus, traditional sustainable use and conservation strategies were either mystical or taboo or sacred or fetich or medico-magic or magic characters of *C. toka*. Despite its usefulness, magical, fetish, sacred or taboo aspect, *C. toka* has been excessively cut and debarked. Special attention must therefore be given to it. Moreover, this reveals the need for conservation measures to ensure its long-term sustainability. Therefore, it would also be desirable to domesticate this resource. Henceforward, this study calls for further research on toxicity, biochemistry, and nutrition through laboratory tests to confirm its traditional uses in Burkina Faso. The promotion and vaporization of *C. toka* could provide significant socio-economic benefits to local communities.

Author contribution statement

Zaïnabou Dabré: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Issouf Zerbo: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Blandine Marie Ivette Nacoulma: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Dodiomon Soro: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Adjima Thiombiano: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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List of abbreviations

WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
NTFPs	Non-Timber Forest Products
IUCN	International Union for Conservation of Nature
LC	least concern
FAO	Food and Agriculture Organization of the United Nations
RF	Relative frequency of Use
FL	Fidelity Level
UD	Use Diversity
UE	Use Equitability
CZ	climate zones

Appendixes

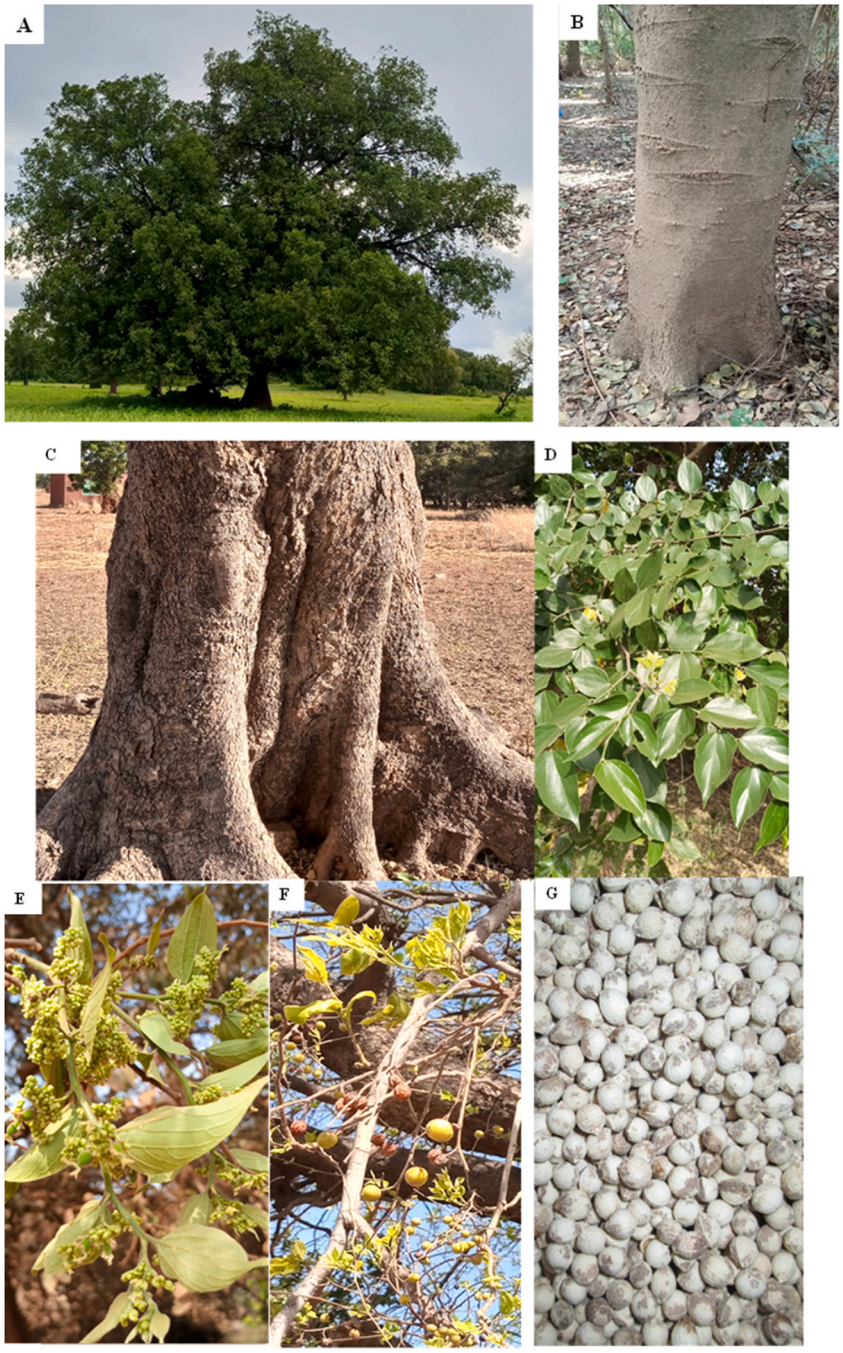

Fig. 2. Whole tree in agroforestry farmland (A), young (B) and old (C) trunks, Leaves (D), Flowers (E) fruits (F) and seeds (G) of *C. toka.* Seeds were harvested from ripened fruits between November 2021 and January 2022.
PicturesZ. DABRE, 2020 (B, D). 2021(A, G) and 2022 (C, E, F, G). .

Table A2
Different local names and meaning of *C. toka* in the study zones

CZ	Localities	Ethnolinguistic groups	Vernacular names	Meaning
Sz	Balé	Bwaba	Kankami, kankama, kankambri	Food tree, sacred species, magic species
		Dafing	Mambi, kamignan	Very useful tree, sweet stew tree, magic tree
		Bambara	Mambri	Useful tree, taboo tree, magic tree
		Toussain	Kamignan	Useful tree, sacred species, and magic tree
	Houet	Bobo	Kamignagua, kanka, Loumou, seideni, sondeyni, bamignan, kamignan, kamygnam	Sweet stew tree, good spiritual tree, sacred species, magic species, fetish, mistic tree
		Bambara	Guamignan, mambri, gamignan, kongnon, djo,	Useful tree, fetish tree, Magic tree, fodder tree, sacred species
		Marka	Yobo	Fetish, magic tree
		Bozo	Djo, djo la, yobo, gamignan	Fetish, Magic tree, sweet stew tree
		Bwaba	Amignan, kamignan, kamignan	Sweet stew tree, good spiritual tree, sacred species, magic species
		Dioula	Djo, mabri, kamignan, nongon na baa	Fetish, magic tree, sweet stew tree, fodder tree
		Foulga	Riiki	–
		Fulani	Kamignan	Very useful tree, fodder tree, sweet stew tree
		Maranssé	Farangua	Useful tree
		Miniankas	Mambri	Sweet stew tree
		Mossi	Farangua, rickou	Sweet stew tree, fodder
		Sambla	Kaa, gnimini, kamignan, fly	Senior brother of Adansonia digitata, useful tree
		Samo	Mambri	Sweet stew tree
		Sénoufo	Kamignan	Sweet stew tree
		Tièfo	Kamignan	Sweet stew tree
		Toussian	Mambri, mabri	Sweet stew tree, fodder tree
		Yarsé	Farangua	–
SSz	Bazèga	Mossi	Pargandé	Useful tree
	Boulgou	Bissa	Gobda, gobdo, saam, kada	Saam, gobda, gobdo, kada
		Fulani	Ganki	Fodder tree
	Ganzourgou	Mossi	Pargandé	Food tree, useful tree, fodder
	Gnagna	Gourmanché	Tidjerbou	Hunger hunter/famine hunter
	Gourma		O'ossanssambou, oti, sanssambou	Medicine tree (against itching)
	Kossi	Bobo	Kamignan, kamignan yiri	Useful tree, sacred species, and magic tree
		Dafing	Kamignan	Very useful tree, sweet stew tree, sacred tree
		Gourounsis	Douka, kamignan	Sweet stew tree
		Mossi	Dikou, kamignan	Sweet stew tree
	Kourwéogo	Mossi	Yibourougou, yibiligou	Fodder tree, sacred tree
	Mouhoun	Fulani	Ganignan, kamagnan	Very useful tree, fodder tree, sweet stew tree
		Dafing	Kamagnan	Very useful tree, sweet stew tree, magic tree
		Bwaba	Kamagnan, kamignan	Useful tree, fodder tree
		Dioula	Kamignan	Sweet stew tree, magic tree
		Mossi	Kalguem-tohéga, salguem-tohéga	Sweet stew tree
		Bobo	Kamignan	Sweet stew tree
	Nahouri	Gourounsis	Takara	Useful tree
	Nayala	Dafing	Kamigni, kamignin, kamignin ba	Very useful tree, sweet stew tree, sacred tree
		Fulani	Ganki, yibi, yibini	Very useful tree, fodder tree

Table A5
plant parts, diseases and recopies of *C. tpka* in Sz and SSz of Burkina Faso

Plant parts	Diseases	Recipes	Fidelity Level	
			Sz (n = 203)	SSz (n = 202)
Barks	Diabetes	The decoction of barks is taken as drink.	0.99	–
	Fungal infection (Disease that attacks new born babies anus)	The decoction of barks is used to wash the new-born baby anus and get him/her drink later.	0.99	–
	Old wound	The decoction of barks is used to wash the old wound and the powder of the barks is used to apply on the wound	**1.48**	–
	Backache	–	–	0.65
	Body ache	The decoction of barks is used to wash the body and drink.	–	0.65
	Eyes ache	The decoction of barks is used to wash the eyes	–	**1.3**
	General disease	The decoction of barks is used to bath and drink.	–	0.65
	Hemorrhoids	–	–	0.65
	Madness	–	–	0.65
	Malaria	–	–	0.65

(*continued on next page*)

Table A5 (*continued*)

Plant parts	Diseases	Recipes	Fidelity Level	
			Sz (n = 203)	SSz (n = 202)
	Cast (disease mystically transmitted by humans and evil spirits)	Powder of the barks added into charcoal breach and covered themselves with blanket to get its smoke.	–	**5.84**
	Tiredness	The decoction of the barks is taken as a drink	–	0.65
Flowers	Chest ache	Drink the powder of the flowers added into chilled water	0.99	–
	Malaria	–	**1.48**	–
Fruits	Old wound	The decoction of the fruits is served as a drink and powered fruits is applied on the old wound	0.49	–
	Measles and chickenpox	Powder fruits put into porridge is served as a drink	0.49	–
	Vitamin	lick either fresh or dried fruits	0.99	–
Seeds	Vitamin	Chew dried seeds		0.18
	Chest ache	Powder seeds added into chilled water and applied on the chest	**1.97**	–
	Diarrhea	Pounded seeds added to salt and licked	0.99	–
Leaves/leafy branches	Breast ache	Pounded leaves, pressed, and applied the juice on the breast of a new-born mother	–	0.18
	Yellow fever	The decoction of leaves is drunk as a drink	–	**2.6**
	Body ache	Sweet stew made with dried powder leaves added to shea butter, locust beans, salt, Maggie (Cube Jumbo), fish or meat and other vegetables	–	0.65
	Malaria	–	0.49	–
	Baby sicknesses	The decoction of the leaves/leafy branches is taken as a drink and later bath the baby with	0.49	–
	Eyes ache	The decoction of the leaves/leafy branches is used to wash the eyes	**1.48**	–
	Fungal infection	The decoction of the leaves/leafy branches is used to wash the new-born baby anus and get him/her drink it.	0.4	–
	Malaria	Powder dried leaves added to water, or its decoction is drunk and washed. Sweet stew made with the young powder leaves added to groundnut paste, locust beans, fish or meat, Maggie and other vegetables is taken as porridge only or taken with To. Otherwise, self-covered with the decoction is used	2.96	**8.44**
	Good appetite	Infusion of leaves/leafy branches added to Dolo (local beer made with red sorghum) or any other drink and drink	0.18	
	Old wound	Pressed fresh leaves, remove the juice, and apply it on it	0.4	**1.3**
	Measles and chickenpox	Stew cooked with fresh powder leaves added to shea butter is served as drink (2 or 3 times/day) until the patient get healed. Let over from the previous day stew is thrown away. Otherwise, decoction of leaves is drunk and washed.	0.99	–
	Vitamin	Sweet stew made with dried fresh (young) powder leaves added to peanut paste, locust beans, salt, Maggie, fish, or meat. Or sweet stew made with the young powder leaves added to locust beans, fish or meat and Maggie. Otherwise, sweet stew made with the young powder leaves added to *Adansonia digitata powder* leaves, locust beans, fish or meat and Maggie. Or Sweet stew made with dried powder leaves added to shea butter, locust beans, salt, Maggie, fish or meat, salt, and other vegetables. These sweet stews are taken either with To (traditional food made based on corn or millet flour in Burkina Faso) or other foods.	**10.84**	7.14
Roots	Diarrhea	Decoction of the leaves is taken as a drink.	–	**1.3**
	General disease	Decoction of the leaves is used to bath.	–	0.65
	Hemorrhoids	–	–	0.65
	Madness	–	–	**3.25**
	Malaria	–	–	0.65
	Ringworm	Roots burnt and added to shea butter and applied it into the ringworm; later make decoction and drink	–	**1.3**
	Tiredness	The decoction of roots is served as a drunk	–	0.65
	Backache	The decoction of *C. toka* roots added to other roots of plants is bathed.	**1.48**	–
	Fungal infection	The decoction of roots is used to wash the new-born baby anus and get him/her drink.	0.99	–
	Blood pressure	The decoction of the roots is drink as a drink	0.99	–
	Toothache	The decoction of roots is kept into the mouth for few minutes	**1.48**	–
	Measles and chickenpox	Dried powder roots are mixed with shea butter and applied on the body	0.99	–
	Old wound/Wound	Powder roots is applied on the wound of human and animals heals it.	0.49	1.62
Roots & Leaves/ leafy branches	Fever	Roots and leaves/leafy branches are boiled, drunk and having a shower with	–	**2.6**
Roots & barks	Ulcer	Dried powder roots and barks put into porridge and drink. Otherwise, the decoction is served as a drunk by the means of calabash	**1.97**	0.65
Any plant parts	Measles and chickenpox	The decoction of any plant parts of *C. toka* is purged.		0.18

Sz: Sudanian climatic zone, SSz: Sudano-Sahelian climatic zone, n: number of interviewees per climatic zones. Values in bold: fidelity levels that were shown to be more important.

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