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RESEARCH ARTICLE
CONTRIBUTION OF NON-WOOD FOREST PRODUCTS TO HOUSEHOLD FOOD SECURITY IN THE MOYEN-CHARI PROVINCE OF SOUTHERN CHAD

Waya Esaie[1], Pale Maïgari[2], Ibrahima Wanie Sago[2] and Adamou Ibrahima[3]

1. University of Sarh, Faculty of Agricultural and Environmental Sciences, Biology Laboratory, P.O. Box 105 Sarh, Chad.
2. University of Maroua, Faculty of Sciences, P.O. Box 46 Maroua, Cameroon.
3. University of Ngaoundéré, Faculty of Sciences, Biodiversity and Sustainable Development Laboratory, P.O. Box 454 Ngaoundéré, Cameroon.

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Abstract

This study highlighted the local woody species exploited for human consumption by the four cantons (Niellim, Balimba, Djoli and Kokaga). The general objective of this study is to know the contribution of Non-Timber Forest Products (NTFPs) in the food security of the four cantons of the Moyen-Chari Province of Chad. The study was carried out by ethnobotanical surveys based on the food species consumed by humans and the main threats to woody food species. The sampling method is random with 200 respondents including 50 per canton. The results show that there are 48 woody food species whose organs are used for human consumption and in the four cantons. The results show that there are 48 woody food species whose organs are used for human consumption in the four cantons. These species are richer in the Kokaga (35 species) and Balimba (35 species) cantons followed by the Djoli canton (31 species) and the Niellim canton (30 species). The pulps, leaves, seeds, flowers and fruits of Vitellaria paradoxa (49.32%), Detarium microcarpum (43.60%) and Parkia biglobosa (40.46%) are more consumed in the four cantons. In the Niellim canton, the five priority woody food species in order of preference are: Vitellaria paradoxa (15.25%), Detarium microcarpum (11.86%), Tamarindus indica (11.86%), Parkia biglobosa (11.30%) and Ziziphus abyssinica (6.21%). The priority woody species of Balimba canton are: Vitellaria paradoxa (14.95%), Parkia biglobosa (12.29%), Detarium microcarpum (10.63%), Vitex doniana (8.31%) and Ximenia americana (7.97%). As for the Djoli canton, these are Ziziphus abyssinica (11.04%), Balanites aegyptiaca (9.03%), Parkia biglobosa (8.70%), Detarium microcarpum (8.36%) and Ximenia americana (7.36%). And finally in the Kokaga canton, we have Detarium microcarpum (11.86%), Vitellaria paradoxa (15.25%), Parkia biglobosa (11.30%), Gardenia aqualla (6.54%) and Strychnos innocua (6.21%). In the four cantons studied, the flowers are not very edible. The fruits are more requested in human food in the Balimba, Kokaga and Djoli cantons than in the Niellim canton. The seeds and leaves are the most preferred in Djoli and Kokaga than in Niellim and Balimba. The dominant families in the four cantons are Fabaceae (44%), Moraceae (20%), Combrataceae (12%) and Rubiaceae (12%). The threats common to these four cantons are the exploitation and overexploitation of fruits and seeds, bush fires, ploughing and clearing of fields, and the low and very low regeneration of certain woody food species. This study provides a starting point for decision-making in the sustainable management of the lean season. The results of this study would help guide conservation and development programs for woody food species in the study area.

Corresponding Author:- Waya Esaie
Address:- University of Sarh, Faculty of Agricultural and Environmental Sciences, Biology Laboratory, P.O. Box 105 Sarh, Chad.

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Introduction:-

In sub-Saharan Africa, it is widely recognized that populations rely on natural resources, particularly forest resources, to ensure their survival (Dembélé et al., 2016). The importance of non-timber forest products (NTFPs) and their contribution to food security and poverty reduction (Loubelo, 2012; Badjaré et al., 2018) are generally underestimated because most of them do not appear in national economic statistics (FAO, 2010). NTFPs occupy an important place in the traditional livelihoods and culture of the populations of the Sahel. These resources occupy a prominent place in the daily lives of these populations thanks to the multiple uses to which they are put (FAO, 2011; Dembélé et al., 2016). These natural resources are of interest and a certain socio-economic balance for local populations and allow them to meet their basic needs (Guigma et al., 2012; Badjaré et al., 2018). For vulnerable farmers whose average annual income is low, spontaneous plant species constitute a food alternative (Guimbo et al., 2012). They constitute a survival food during lean periods, in drought years and a supplementary food during periods of abundant rain in the Sahel (Ouedraogo et al., 2013) and are also the subject of important commercial activities generating income for rural populations, particularly women and children who are heavily involved in the gathering and marketing of these products (Hama et al., 2010; Hama et al., 2019). These NTFPs can be harvested in the wild or are produced in forest plantations, in agroforestry parks or even in trees outside forests (Loubelo, 2012). Numerous studies have shown the importance of plant species in human food in Africa (Guigma et al., 2012; Dembélé et al., 2016; Ado et al., 2016; Ayena et al., 2016; Badjaré et al., 2018; Hama et al., 2019; Assogbadjo et al., 2021; Rousou, 2022). Among these plants are woody and herbaceous plants. Food woody species include all woody plants that provide leaves, flowers, fruits, seeds, pods, sap, bark or other parts used for human consumption (Thiombiano et al., 2014; Ado et al., 2016). Consumption depends on the periods and years. Humans often use these woody food species to meet their food needs, for service wood, fuel wood, livestock fodder and traditional medicine (Waya et al., 2023) or as a source of income (Djibo et al., 2020). For others, the exploitation of these non-timber forest products constitutes their crisis response strategies when drought leads to poor harvests. Diversification of livelihoods, particularly through non-timber forest products, is the main strategy used in Tanzania to anticipate climate variability (Djibo et al., 2020). Endogenous knowledge is an essential component of local biodiversity conservation (Pilgrim et al., 2007). It is necessary to understand the local knowledge of the rural population to detect any changes in the flora and to have a good understanding of the use of woody food species (Djibo et al., 2020). The general objective of this study is to understand the contribution of NTFPs to food security in the four cantons of the Moyen-Chari Province of Chad. The aim is to determine all the organs of the woody species exploited for consumption and their families and the threats to these woody species.

Materials and Methods:-

Study Site

The study sites are Kokaga Canton, Balimba Canton, Djoli Canton, and Niellim Canton. The four cantons are part of the Moyen-Chari province and located in the southern part of Chad (Figure 1). The area is characterized by a dry tropical climate and Sudanian bioclimatic, with an average annual precipitation of 1000 mm (the rainy season lasts approximately 6 months), an average annual temperature of 24.5°C, and relative humidity ranging from 32 to 85% depending on the month (ASECNA, 2018). The soil types are: erosion soils on acid rocks dominant on Mount Niellim, sesquioxides with ferruginous stains and concretions and cuirasses, and hydromorphic soils characteristic of the Djoli, Kokaga, Balimba, and Niellim cantons. The vegetation formations are shrub and wooded savannahs. Overall, the vegetation is of the Sudanese type, the density and distribution of which depend on the topography and the nature of the soil (PAPNM, 2010). The population of these cantons is mainly composed of Sar-Madjingaye, Mbaye, Daï, Arabe, Sara-Kaba, Tounia, Boua, Toumak, Niellim and Ndam.

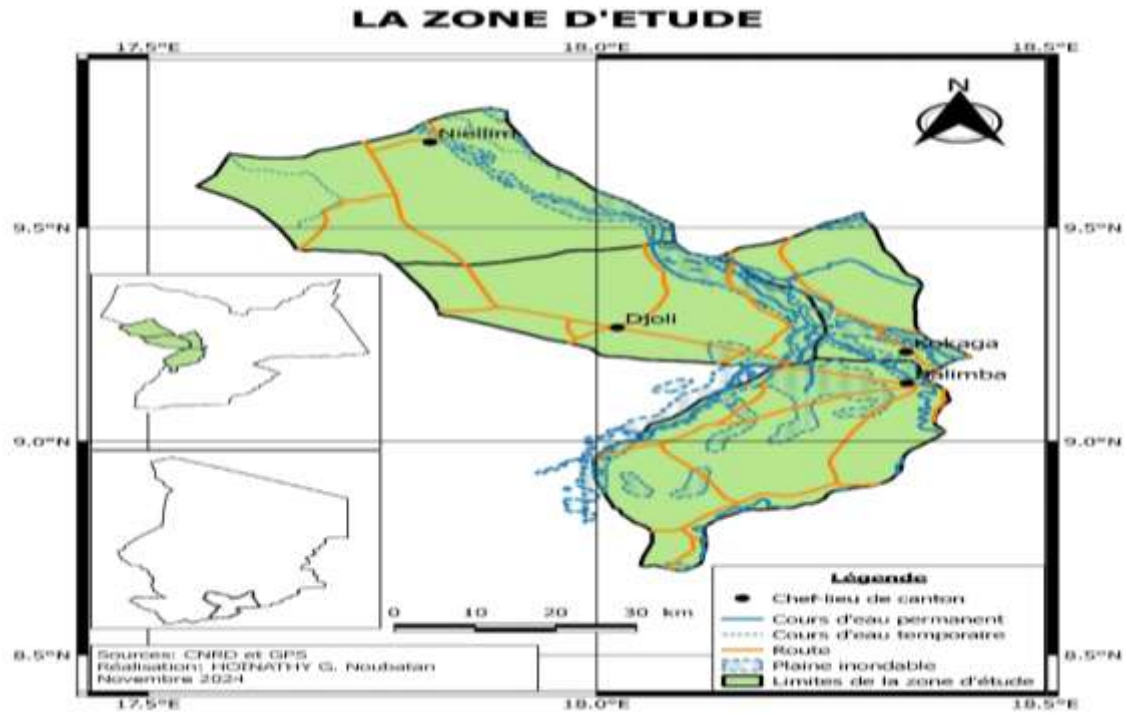

Figure 1:- Map of the study area.

Sampling and Data Collection Methods

The sampling method is a two-stratified method. The first consists of the four target cantons of Moyen-Chari, which are the cantons Niellim, Djoli, Kokaga and Balimba, and the second stratum is composed of 16 villages, including four villages per canton (Table 1). This method was used by Atakpama et al. (2012); Zabouh (2014) and Badjaré et al., 2018. These villages were chosen to cover all the ethnic groups present in each of the cantons and in relation to the intense human activities carried out on NTFPs and their position in relation to the Manda National Park. The data collection methods were mainly based on semi-structured interviews, focusing mainly on populations, traditional leaders and water and forestry agents at the level of the different cantons to collect information on the most consumed food species in their canton, the organs of the species used and the threats to the species. The questionnaire included closed questions (answered yes or no), open questions (answered deliberately according to one's point of view) and directed questions (some answers are proposed to the respondents). The sample consisted of 200 people, including 50 per canton (Table 1). Individual interviews were adopted, specifically face-to-face interviews, because they allow for the highest response rate to the greatest number of questions (Arouna, 2012). The choice was much more focused on women, since they are the ones who value NTFPs more, especially food. Individual interviews were facilitated by the help of interpreters who spoke local dialects well (Sara, Niellim, Boua, Arab and Tounia). The species cited during the survey were determined from their local names, then collected in the fields and identified by botanists from the University of Sarh, botanical lexicons and reference documents (Ligneux du sahel, 2008; Arbonnier, 2009; Flore illustrée du Tchad, 2019).

Table 1:- Sampled villages in the four cantons.

Canton	villages	Households	Households surveyed
Manda	Manda I	173	17
	Matta	53	10
	Taholo	56	10
	Mandjikaga	80	13
Kokaga	Maïnroum	100	16
	Dyba-sya	35	10
	Bainaka	40	12
	Ngangolo	36	12

Djoli	Djoli	120	16
	Sanguelé	53	13
	Doboro	36	10
	Doguigui	50	12
Niellim	Photoum	60	13
	Wain	36	10
	Niellim	82	16
	Falké	47	11
	TOTAL	**1056**	**200**

Threats to woody food and priority species

The methodology adopted to determine the threats to woody food and priority species was to rank each potential threat for each priority species in each canton using the method used by Ado and his colleagues in 2016, with the following points: 0 = not threatened; 1 = slightly threatened; 2 = threatened; 3 = highly threatened; 4 = The species' status is unknown.

Data Processing

The collected data were entered into Excel software. To list all NTFPs consumed in the four cantons, the organs of the woody species harvested, and calculate the percentage, we used SPSS Statistics 22 software. The order of importance of each species among the five priority species cited by each canton was expressed as a percentage and calculated by the ratio of each species' score to the total score, taking into account the responses of all respondents in order to rank the priority species. We performed a descriptive statistical analysis of the NTFP plant species.

Results and Discussion:-

Organs of Species Exploited for Food by Canton

The woody species whose organs are used for human consumption are composed of 48 woody food species in the four cantons (Table 2; Figure 2). These species are richer in the Kokaga (35 species) and Balimba (35 species) cantons followed by the Djoli canton (31 species) and the Niellim canton (30 species) (Table 2). Only 37.5% of these species (18 species) are common to the four cantons (Table 2). The pulps, leaves, seeds, flowers and fruits of Vitellaria paradoxa (49.32%), Detarium microcarpum (43.60%) and Parkia biglobosa (40.46%) are more consumed in the four cantons (Figure 2). The fruits of Vitellaria paradoxa which are very appreciated and consumed by the population of the study area. The flowers of Parkia biglobosa are sucked by children (waya et al., 2023), its powdered leaves are well consumed and its flowers and fruits (pulp) are used in the manufacture of sweet drinks (Thiombiano et al., 2012). These pulps are energetic when transformed into pastes and consumed alone or in association with millet flour (Thiombiano et al., 2012). Its seeds, especially fermented, are very popular condiments in sauces and are substitutes for flavors (Maggie) (waya et al., 2023). For Detarium microcarpum not only are its fruits edible, rich in vitamin C (Anonymous, 2008), but locally marketed (waya et al., 2023). Detarium microcarpum and Vitellaria paradoxa are regularly used to meet energy needs (Guigma et al., 2012). All these species are found throughout the cantons and are in their preferred area. Badjaré et al. (2018) in their research on "Ethnobotanical study of woody species of dry savannahs in Northern Togo: diversity, uses, importance and vulnerability", also found that among the most common useful woody species, there are Vitellaria paradoxa, Parkia biglobosa, Detarium microcarpum and Vitex doniana. The fruits and seeds of Ziziphus abyssinica are more appreciated in the Djoli canton (11.04%) than the Niellim canton (6.21%). The pods, flowers and fruits of Tamarindus indica are also very appreciated in the Niellim canton. Vitex doniana fruits are widely consumed in the Balimba canton (8.31%). The fruits, pods and seeds of Balanites aegyptiaca are in high demand in Djoli canton (9.03%), while in Kokaga canton, the fruits of Gardenia aqualla and the pulp and seeds of Strychnos innocua are appreciated respectively (6.54%) and (6.21%). In addition to their fresh consumption, these fruits can be dried, grilled, or used in food preparations (Rousou, 2022). In addition, they can be processed or treated for the production of other products, such as for oil extraction (Rousou, 2022). For example, shea oil, extracted by grinding or crushing the fruits, as suggested by ethnobotanical data. This first place ranking obtained by Vitellaria paradoxa has also been reported by many authors (Diop et al., 2005; Belem et al., 2008; Guigma et al., 2012; Dembélé et al., 2016). This position shows the importance of this woody species for the populations. Faye et al. (2010) cited by Dembélé et al. (2016) who noted that the fruits of Vitellaria paradoxa are widely consumed raw for their pulp by the populations in the Ségou region during the lean period which corresponds to the rainy season. This is confirmed by the population of the study area, during our survey. The exploitation of the organs of these non-timber forest products constitutes their response

strategies to a crisis when drought leads to poor harvests (Djibo et al., 2020). Each exploited part has a disadvantage on the survival of the species (Guigma et al., 2012). Overexploitation of vegetative organs (roots, leaves, flowers, bark, wood) leads to physiological disorders and a drop in productivity (Guigma et al., 2012). The use of seeds and flowers prevents the seminal regeneration of species (Taita, 2003; Guigma et al., 2012).

Table 2:- Woody species used in human food and products consumed in the four cantons.

SPECIES	CONSUMED ORGANS	Number of times species cited as a percentage (%) in the 04 cantons				
		NIELLIM	BALIMBA	DJOLI	KOKAGA	TOTAL(%)
Afzelia africana	Flowers	0,56	0	0	0,33	0,89
Amblygonocarpus andongensis	Fruits, Flowers, Seeds	0	0	0	0,33	0,33
Annona senegalensis	Leaves, Flowers, Fruits	0	3,32	0,67	0,33	4,32
Balanites aegyptiaca	Fruits, Pods, Seeds	2,82	0,66	9,03	1,63	14,15
Borassus aethiopum	Terminal bud, Sap, Seedling	3,39	0,66	0,67	0,65	5,38
Cassia sieberiana	Pods	0	0	0,33	0	0,33
Combretum collinum	Gum	0	0,33	0	0	0,33
Combretum glutinosum	Leaves	0	0,33	0	0	0,33
Cordia africana	Fruits, Seeds	0	0,33	0	0	0,33
Crossopteryx febrifuga	Leaves, Fruits	0	0,33	0,33	0	0,67
Daniellia oliveri	Seeds, Fruits	0	0,33	0	0	0,33
Detarium microcarpum	Pulps, Leaves	11,86	10,63	8,36	12,75	43,6
Dioscorea dumetorum	Fruits, Leaves	1,13	0,33	0,67	1,96	4,09
Diospyros mespiliformis	Leaves, Pulps	0,56	4,65	2,34	0,98	8,54
Euphorbia kamerunica	Saps	1,13	0	0	0	1,13
Ficus dekdekena	Bark	0	0	0	0,33	0,33
Ficus glumosa	Figs	2,82	1,33	2,34	2,29	8,78
Ficus ingens	Figs	0	0	2,01	1,96	3,97
Ficus platyphylla	Leaves, Figs	0	0,66	0	0,65	1,32
Ficus sycomorus	Bark, Leaves	0,56	1,99	2,34	1,63	6,53
Gardenia aqualla	Fruits	4,52	0	6,02	6,54	17,08
Grewia cissoides	Fruits	0	1,33	0	0	1,33
Grewia venusta	Fruits, Bark, Leaves	5,65	1,66	0,67	3,59	11,57
Hexalobus monopetalus	Fruits	1,13	5,98	1,67	4,58	13,36
Hymenocardia acida	Leaves, Fruits	1,13	1,66	0	2,29	5,08
Hyphaene thebaica	Almond	1,13	1	7,02	0,98	10,13
Khaya senegalensis	Inflorescence	0	1	0	0	1
Mimosa pigra	Fruits	0	1	1,67	0,33	3
Moringa oleifera	Leaves, Fruits, Seeds, Flowers	2,26	0	0,67	0,98	3,91
Parinari curatellifolia	Almond, Fruits	1,69	1,66	0	1,63	4,99
Parkia biglobosa	Leaves, Flowers, Fruits, Seeds	11,3	12,29	8,7	8,17	40,46
Pericopsis laxiflora	Flowers	0	0,33	0	0	0,33
Pterocarpus erinaceus	Flowers	0,56	1,66	0,33	1,96	4,52

Saba senegalensis	Pulps	0,56	0	0	0	0,56
Sarcocephalus latifolius	Pulps	0,56	0	0,33	0,65	1,55
Scadoxus multiflorus	Fruits, Leaves	1,13	0,66	2,68	0,65	5,12
Sclerocarya birrea	Almond, Pulps	0	0,33	1	0,33	1,66
Securidaca longipedunculata	Leaves, Flowers	0	0	0	0,65	0,65
Strychnos innocua	Pulp, Seeds	0	3,99	1,67	6,21	11,87
Strychnos spinosa	Leaves, Fruits, Seeds	1,69	0,33	0	3,27	5,3
Swartzia madagascariensis	Seeds	1,13	0	1,34	1,63	4,1
Tacca leontopetaloides	Flowers	1,13	0	0,67	0	1,8
Tamarindus indica	Pods, Flowers, Fruits	11,86	2,99	5,35	3,92	24,13
Terminalia laxiflora	Leaves	1,13	0,66	0,33	0	2,13
Vitellaria paradoxa	Pulp, Fruits, Seeds	15,25	14,95	7,02	12,09	49,32
Vitex doniana	Fruits	3,95	8,31	5,35	3,92	21,53
Ximenia americana	Fruits, Leaves	1,13	7,97	7,36	4,9	21,36
Ziziphus abyssinica	Pulp, Seeds	6,21	4,32	11,04	4,9	26,47
	Total	**100**	**100**	**100**	**100**	**4000**

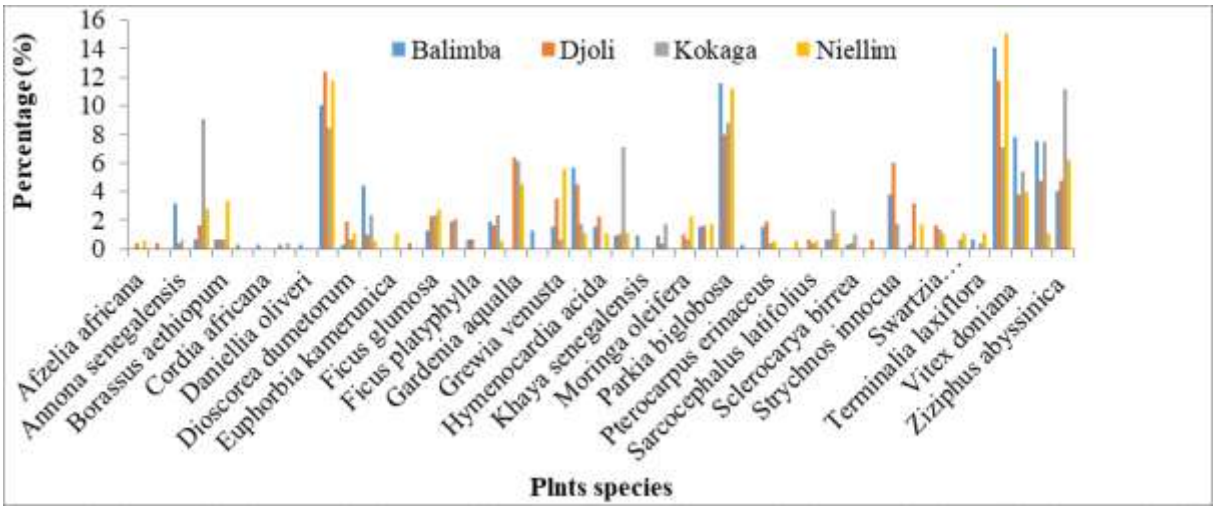

Figure 2:- Woody species used in human food in the 04 Cantons.

Priority woody food species in the four cantons

In the Niellim canton, the five priority woody food species in order of preference are: Vitellaria paradoxa (15.25%), Detarium microcarpum (11.86%), Tamarindus indica (11.86%), Parkia biglobosa (11.30%) and Ziziphus abyssinica (6.21%). The priority woody species in the Balimba canton are Vitellaria paradoxa (14.95%), Parkia biglobosa (12.29%), Detarium microcarpum (10.63%), Vitex doniana (8.31%) and Ximenia americana (7.97%). As for the Djoli canton, they are Ziziphus abyssinica (11.04%), Balanites aegyptiaca (9.03%), Parkia biglobosa (8.70%), Detarium microcarpum (8.36%) and Ximenia americana (7.36%). And finally in Kokaga canton, we have Detarium microcarpum (11.86%), Vitellaria paradoxa (15.25%), Parkia biglobosa (11.30%), Gardenia aqualla (6.54%) and Strychnos innocua (6.21%) (Table 3). There are woody food species that have more than one edible organ (Vitellaria paradoxa, Detarium microcarpum, Parkia biglobosa, Moringa oleifera, Borassus aethiopum etc.) while some have only one (Gardenia aqualla, Tacca leontopetaloides, Terminalia laxiflora, Vitex doniana). The number of organs consumed varies from one woody species to another but also from local knowledge (Djibo et al., 2020). In the four cantons studied, flowers are not very edible. Fruits are more requested in human food in the cantons of Balimba, Kokaga and Djoli than in the canton of Niellim on the one hand and seeds and leaves are more preferred in Djoli and

Kokaga than in Niellim and Balimba. Djibo and his colleagues in 2020 in their study, found that leaves, fruits, flowers and seeds are requested and edible in the study area. Dietary habits would play a determining role in the choice of preferred food woody species (Djibo et al., 2020). This is the case of Parkia biglobosa and Vitellaria paradoxa, an area known for its high consumption of these species during lean periods.

Table 3:- Classification of welding plants in order of priority.

Cantons	**Niellim**			**Balimba**			**Kokaga**			**Djoli**		
Rank	**Species**	**Citation numbers**	**%**	**Species**	**Citation numbers**	**%**	**Species**	**Citation numbers**	**%**	**Species**	**Citation numbers**	**%**
1ere	Vitellaria paradoxa	27	15,25	Vitellaria paradoxa	45	14,95	Detarium microcarpum	39	12,75	Ziziphus abyssinica	33	11,04
2e	Tamarindus indica	21	11,86	Parkia biglobosa	37	12,29	Vitellaria paradoxa	37	12,09	Balanites aegyptiaca	27	9,03
3e	Detarium microcarpum	21	11,86	Detarium microcarpum	32	10,63	Parkia biglobosa	25	8,17	Parkia biglobosa	26	8,70
4e	Parkia biglobosa	20	11,30	Vitex doniana	25	8,31	Gardenia aqualla	20	6,54	Detarium microcarpum	25	8,36
5e	Ziziphus abyssinica	11	6,21	Ximenia americana	24	7,97	Strychnos innocua	19	6,21	Ximenia americana	21	7,36

Families of species harvested for consumption in each canton

The dominant families in the four cantons are Fabaceae (44%), Moraceae (20%), Combrataceae (12%) and Rubiaceae (12%) (Table 4). Fabaceae and Moraceae are more cited in Kokaga canton (42.10%; 26.31%) than in Djoli (38.88%; 16.66%), Balimba (35%, 15%) and Niellim (28.57%; 9.52%) cantons, while Rubiaceae were more represented in Djoli (16.66%) and Kokaga (15.78%) cantons than Niellim (9.52%) and Balimba (5%) cantons. The Combrataceae family is more requested in Balimba canton (15%) than in the other cantons (Table 4). These results show that the woody food species whose organs are consumed by the populations surveyed and living in the study area are made up of 25 families, including 21 in the Niellim canton, 20, 18 and 19 families respectively in the Balimba, Djoli and Kokaga cantons. These families of woody food species are different from the families found (Ceasalpiniaceae, Anacardiaceae and Capparaceae) by Djibo et al. (2020) during their research on "Local perception on the state of spontaneous woody food species and their role: case of the rural communes of Tamou and Simiri in Niger". The difference in the families of woody food species between the four cantons could be explained by the mode of dissemination and the degree of adaptation of most of the species constituting these dominant families (Djibo et al., 2020), on the one hand, and the preferences of its populations or the availability of these families on the other hand.

Table 4:- Families of NTFPs of plant origin, exploited in the 04 cantons of the Province of Moyen-Chari.

Families	**Niellim**	**Balimba**	**Djoli**	**Kokaga**	**Total**
Amaryllidaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Anacardiaceae	0 (0%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Annonaceae	1 (4,76%)	2 (10%)	2 (11,11%)	2 (10,52%)	2 (8%)
Apocynaceae	1 (4,76%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)
Arecaceae	2 (9,52%)	2 (10%)	2 (11,11%)	2 (10,52%)	2 (8%)

Balanitaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Boraginaceae	0 (0%)	1 (5%)	0 (0%)	0 (0%)	1 (4%)
Chrysobalanaceae	1 (4,76%)	1 (5%)	0 (0%)	1 (5,26%)	1 (4%)
Combrataceae	1 (4,76%)	3 (15%)	1 (5,55%)	0 (0%)	3 (12%)
Dioscoreceae	2 (9,52%)	2 (10%)	2 (11,11%)	2 (10,52%)	2 (8%)
Euphorbiaceae	1 (4,76%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)
Fabaceae	6 (28,57%)	7 (35%)	7 (38,88%)	8 (42,10%)	11 (44%)
Lamiaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Loganiaceae	1 (4,76%)	2 (10%)	1 (5,55%)	2 (10,52%)	2 (8%)
Malvaceae	1 (4,76%)	2 (10%)	1 (5,55%)	1 (5,26%)	2 (8%)
Meliaceae	0 (0%)	1 (5%)	0 (0%)	0 (0%)	1 (4%)
Moraceae	2 (9,52%)	3 (15%)	3 (16,66%)	5 (26,31%)	5 (20%)
Moringaceae	1 (4,76%)	0 (0%)	1 (5,55%)	1 (5,26%)	1 (4%)
Phyllanthaceae	1 (4,76%)	1 (5%)	0 (0%)	1 (5,26%)	1 (4%)
Polygalaceae	0 (0%)	0 (0%)	0 (0%)	1 (5,26%)	1 (4%)
Rhamnaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Rubiaceae	2 (9,52%)	1 (5%)	3 (16,66%)	3 (15,78%)	3 (12%)
Sapotaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
Taccaceae	1 (4,76%)	0 (0%)	1 (5,55%)	0 (0%)	1 (4%)
Ximeniaceae	1 (4,76%)	1 (5%)	1 (5,55%)	1 (5,26%)	1 (4%)
TOTAL	**21**	**20**	**18**	**19**	**25**

Threats to Food and Priority Species in the Four Cantons

The analysis of the research results shows the main threats to the five priority food species in each canton of the study area (Table 5). The threats common to these four cantons are the exploitation and overexploitation of fruits and seeds, bush fires, ploughing and clearing of fields, and the low and very low regeneration of certain woody food species. In addition to threats common to the four cantons, in Niellim, there is the exploitation of flowers and fruits of Tamarindus indica and the exploitation of fruits and bark of Ziziphus abyssinica; in Balimba, there is the exploitation of Vitex doniana fruits and the exploitation of Ximenia americana leaves and fruits, in Djoli, there is the overexploitation of Balanites aegyptiaca fruits and seeds and the aging of Ximenia americana leaves and fruits and finally in Kokaga, there is the exploitation of Gardenia aqualla fruits and the exploitation of Strychnos innocua seeds (Table 5). Threats such as overexploitation, exploitation, fires and clearing are reported by Ado et al. (2016) but it is mainly aging for Balanites aegyptiaca. This local perception reflects the particular importance that populations attach to these woody food species. Indeed, Vitellaria paradoxa and Parkia biglobosa play a socio-economic role that is very appreciable by local populations (Guimbo et al., 2012). The exploitation of immature fruits was reported by the surveyed population and it is difficult to find Vitellaria paradoxa seeds to ensure regeneration. This observation is confirmed by the work of Soumana et al. (2010). Population growth and the increase in demand for plant products, some species are in decline in specific localities (Guigma et al., 2012). Soil depletion has a significant impact on these priority plants (Ado et al., 2016). The disappearance of these emblematic resources is justified by the overexploitation of their organs to satisfy human needs but also overgrazing. (Djibo et al., 2020).

Table 5:- Main threats to priority woody food species.

Scientific Names	**Main Threats**	**Niellim (%)**	**Balimba (%)**	**Djoli (%)**	**Kokaga (%)**
Vitellaria paradoxa	Overexploitation of fruits and seeds, bushfires, aging, plowing and clearing of fields	15,25	14,95	-	12,09
Tamarindus indica	Exploitation of flowers and fruits	11,86	-	-	-
Parkia biglobosa	Overexploitation of seeds, plowing and clearing of fields, poor regeneration	11,3	12,29	8,70	8,17

Detarium microscarpum	Very poor regeneration and exploitation of fruits	11,86	10,63	8,36	12,75
Ziziphus abyssinica	Exploitation of fruits and bark	6,21	-	11,04	-
Vitex doniana	Exploitation of fruits	-	8,31	-	-
Ximenia americana	Exploitation of leaves and fruits	-	7,97	7,36	-
Balinetes aegyptiaca	Overexploitation of fruits and seeds, aging	-	-	9,03	-
Gardenia aqualla	Exploitation of fruits	-	-	-	6,54
Strychnos innocua	Exploitation of seeds	-	-	-	6,21

Conclusion:-

This research, whose results complement previous studies on the exploitation, management, and use of woody food plants in general and in the Moyen-Chari province of southern Chad in particular, represents an essential contribution of non-timber forest products to household food security. The Niellim, Balimba, Djoli, and Kokaga cantons are rich in woody food species used not only as a dietary supplement but also to cope with the lean season through the consumption of various organs (leaves, flowers, fruits, pulp, pods, seeds, etc.). Some woody food species are overexploited, aging, and threatened with extinction (Vitellaria paradoxa, Parkia biglobosa, Ziziphus abyssinica and Balinetes aegyptiaca). To reduce the erosion of the biodiversity of these woody food species, restoration and conservation strategies are needed for the sustainable use of these priority species, which are highly valued by the population. In short, all species provide the substances (carbohydrates, proteins, lipids, vitamins and mineral salts) necessary for life. It remains to be verified that this qualitative contribution is also quantitative to ensure the nutritional balance of man.

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