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Floristic diversity and fruit species potential in cocoa agroecosystems in the department of Daloa, Côte d'Ivoire

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Abstract

Agroforestry systems with cocoa trees are full of important woody resources, including fruit species that provide various products for human needs. Despite their importance, unfortunately, these systems are experiencing a progressive reduction in fruit species under the combined effect of climate change and anthropic pressures. The sustainability of fruit trees in cocoa agro-ecosystems necessarily requires knowledge of their floristic diversity, hence the interest in evaluating the potential of fruit species in these ecological environments. The methods of surface surveys of 50m x 50m (2500 m^2) and itinerant was adopted for the inventories in 8 cocoa farms in 4 localities of the department of Daloa and a survey carried out among farmers provided information on fruit species. A total of 63 fruit species, divided into 48 genera belonging to 31 families were inventoried. The families Rutaceae, Annonaceae, Fabaceae, Myrtaceae, Anacardiaceae are the best represented. The most frequent and abundant species are *Citrus limon, Citrus sinensis, Cola nitida, Elaeis guineensis, Irvingia gabonensis, Mangifera indica, Persea americana, Psidium guajava, Spondias mombin, Tamarindus indica, Ricinodendron heudelotii* and *Xylopia aethiopica*. The fruit flora inventoried is characterized by a dominance of shrubs (49.20%) and trees (42.86%). The results highlight different fruit species in cocoa farms despite anthropic pressures which conservation strategies must take into account in the trade-off between cocoa production and other associated plants.

Keywords: Cocoa agroecosystems, Daloa, fruit species, Côte d'Ivoire, West Africa

I. Introduction

In tropical Africa, cocoa agroecosystems are of the agroforestry type in which farmers introduce fruit species that grow together with cocoa plants and other spontaneous woody plants that are necessary both to provide shade for young cocoa trees and for their uses (Jagoret et al., 2008; Deheuvels, 2011). Studies conducted in Côte d'Ivoire (Adou & N'Guessan, 2006) and elsewhere in Africa (Jagoret *et al*., 2011) in cocoa agroecosystems have revealed that these systems, which are carried out under tree cover, abound in a significant diversity of fruit species that provide various products for human needs. Despite the interest of rural communities in plant products from these trees, there is a gradual disappearance of this plant

diversity in agricultural plots due to anthropogenic pressures (Boko *et al*., 2021). The rapid changes in the social and cultural behaviors of local populations and the degradation of traditional agroecosystems due to anthropogenic pressures including unsustainable agricultural practices (Koulibaly *et al*., 2010) and climate change are the causes. Given this observation, we can ask ourselves, what is the real potential for fruit species in cocoa agroecosystems today, under the combined effect of climate change and anthropogenic pressures? In other words, do cocoa farms, which used to conserve various plant resources, in their current state still have a diversity of fruit species that is essential for farmers during the lean season? Answering these questions requires knowledge of the diversity of fruit species conserved in cocoa plantations. In the peripheral areas of the Daloa department, cocoa farms are quite widespread to meet the needs of rural communities. They appear to be suitable environments for diagnosing the potential for spontaneous and non-spontaneous fruit species in cocoa production systems. Moreover, to the best of our knowledge, very little specific work dealing with the fruit resources of these agrosystems has been carried out in this large agricultural region of Côte d'Ivoire (N'Guessan *et al*., 2014).

It is within this framework that this study aims to provide information on the potential for fruit species in cocoa agroecosystems in the Daloa department.

II. Materials and Methods

II.1. Material

II.1.1. Study area

Located between 6°27′00" North latitude and 5°56'00" West longitude, the department of Daloa is 141 km from Yamoussoukro. It is bounded by the localities of Vavoua, Zuénoula and Bouaflé (North), Gonaté (East), Issia (South) and Guézon (West). It is located in the Guinean domain, characterized by an equatorial climatic regime with two rainy seasons and two dry seasons (Eldin, 1971). Monthly rainfall varies between 1300 mm and 1800 mm. The average annual temperature is 25.6°C. The Daloa area belongs to the mesophilic sector with a vegetation composed of dense semi-deciduous forests, degraded forests and mesophilic savannahs (Guillaumet & Adjanohoun, 1971). It is conducive to cash crops such as cocoa, coffee, rubber and cashew trees and food crops such as yams, cassava, eggplant and tomatoes. However, today, strong demographic pressure has led to the progressive degradation of existing natural formations to the benefit of perennial crops (Barima *et al*., 2016). The study was conducted in cocoa farms in four sited in the department of Daloa: Bribouo, Toroguhé, Zakoua and Zepréguhé. Their choice was motivated by their proximity for good monitoring of the work.

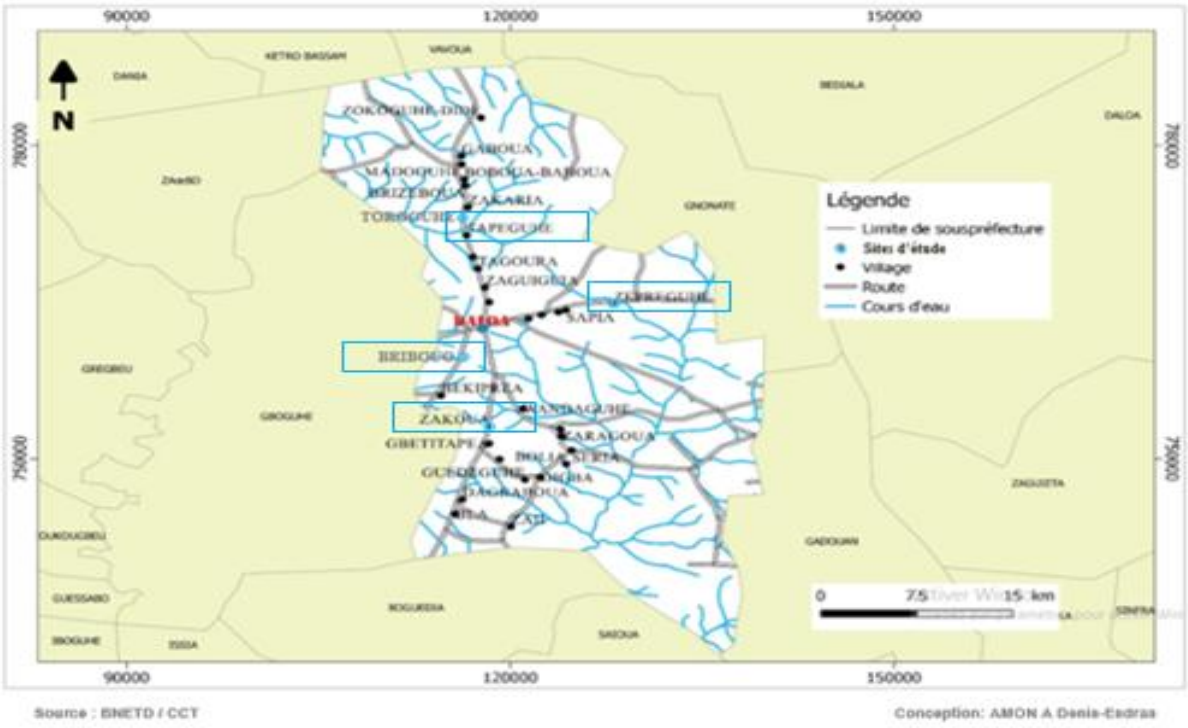

Figure 1: Location of study sites in the department of Daloa

II.2.1. Data collection

Floristic inventories were carried out using an approach combining two methods. One, based on surface surveys in 16 cocoa production systems in 4 villages or sites of the Daloa department: Bribouo (06°52'09.88N and 0630'20.45"W), Toroguhé (06°56'41.01"N and 06°27'49.77"W), Zakoua (06°48'06.24N and 06°27'07.58"W) and Zépréguhé (06°54'09.27"N and 06°21'28.84"W). It consisted of making an inventory of the richness and floristic composition of spontaneous and non-spontaneous fruit species in a 2 500 m^2 plot (50m x 50m) delimited in each cocoa agroecosystems. This arrangement was repeated twice in the selected cocoa agroecosystems. A total of 32 surveys were conducted in all cocoa farms. The other was an itinerant inventory that consisted of walking through these 16 selected cocoa cocoa agroecosystemss in all directions to identify spontaneous and non-spontaneous fruit species encountered. In addition to these inventories, an ethnobotanical survey of farmers was conducted. Farmers over the age of 45 were selected with the help of the village chief. Thirty-six experienced farmers with knowledge of fruit plants were selected. The surveys were conducted through semi-structured interviews with the farmers and laborers based on a questionnaire designed for this purpose. Information on the socio-demographic characteristics of the informants (age, gender, education level, ethnicity, experience) was collected. The questions asked were mainly about fruit species, farmers' knowledge of these fruit plants and their uses. The identification of fruit plants was done either *in situ* or with the help of the Herbarium of the Centre National de Floristique (CNF) in Abidjan, and the main morphological types of fruit species in the selected cocoa farmswere determined (Aké-Assi, 1984, 2002).

II.2.2. Data processing

The data processing and the list of inventoried species as well as their taxonomy were compiled with the Microsoft Office 2016 Excel spreadsheet. The floristic diversity essential for the characterization of the fruit species encountered in the different cocoa agroecosystems studied was by the specific richness (S), the specific frequency (Fi), the Shannon and Weaver index (H'), the Pielou index (E), the beta diversity index (ß), the density and the rarefaction index (Ri). The Shannon and Weaver index (H') is given by the relation following:

$$H' = -\sum (ni/N)*\ln(ni/N)$$

with H' - Shanonn-Weaver index, ni - number of individuals of the species, N - total number of individuals of all species considered.

The higher the value of the index H', the higher the diversity.L'indice d'équitabilité de Piélouest calculé selon la formule suivante:

$$E = H'/\ln S$$

with E - Piélou Equitability Index, S - total number of species found and H' - Shannon Index.

It varies from 0 to 1 and is maximal when species have identical abundances in the stand and minimal when a single species dominates the whole stand.

The specific frequency of a species (Fi) expresses the presence or absence of the species and is given by the following formula:

$$Fi = \frac{\text{Number of surveys in which the species is present}}{\text{Total number of surveys}} \times 100$$

The beta diversity index (ß) is used to evaluate the floristic similarity between the different cocoa agroecosystems in the study sites. It is given by the following formula:

$$\beta = \frac{2C}{2C + S1 + S2}$$

C - number of species common to the different cocoa agroecosystems, S1 and S2 are respectively the number of species common to cocoa agroecosystems1 and 2. The index ß varies from 0 when there are no common species between the two cocoa agroecosystems, to 1 when all species found in cocoa farm 1 also exist in cocoa farm 2.

The density of a fruit species is the number of individuals of this species per hectare. It is evaluated by the formula:

$$D = n/S$$

with D - density (stems/ha), n - number of stems present on the area under consideration and S - area under consideration (ha).

The rarity index (Ri) or species rarity-weight richness is used to determine the abundance and rarity of a plant species (Piba *et al*., 2015). It is calculated as follows:

$$Ri = (1 - \frac{ni}{N}) \times 100$$

with ni - number of plots where species i is found and N - total number of plots placed in the environment.
Species with Ri is between 50 and 80% are abundant in the environment. Species with Ri ≤ 50% are very frequent and abundant in the environment studied. The species with Ri > 80% are rare and those with Ri = l 00% are very rare.

II.2.3. Statistical analysis

The data generated were used to develop the various graphs. One-way statistical analysis (ANOVA) was performed using STATISTICA software version 7.1. When differences were significant, the means were separated by Duncan's test at the 5% significance level.

III. Results

III.1. Socio-demographic characteristics of informants

The cocoa agroecosystems in the 4 sites studied are mostly managed by men. The surveys mobilized 36 male informants (100% of those surveyed), who were experienced and over 45 years of age, and who own or manage cocoa plantations (Table 1). These surveys mobilized 3 ethnic groups among the informants, dominated by the Bété ethnic group (86.11%) against 11.11% of foreign nationals. The latter are Mossi, managers of cocoa plantations. The most representative age group among the informants is the elderly (65 years and over) with 58.33%. This is followed by the age group between 55 and 65 years with 11 informants, or 30.56%. The adult informants (45-55 years) with 11.11% were the largest minority.

Table 1: Socio-demographic characteristics of respondents by site

Sites / Cocoa farms	Number of respondents	Parameters		Number of individuals	Frequencies (%)
Bribouo	9	Genre	Male	36	100
		Age	≤ 45 ≤ 55 ans	4	11.11
Toroguhé	9		> 55 ≤ 65 ans	11	30.56
			> 65 ans	21	58.33
Zakoua	9	Education level	Illiterate	29	80.5
			Primary	6	16.67
Zepreguhé	9		Secondary	1	2.78
		Ethnic groups	Mossi	4	11.11
Total	36		Baoulé	1	2.78
			Beté	31	86.11

The farmers are heavily dominated by illiterates. This group is represented by 80.55% of the workforce with 28 people out of the 45 surveyed. Only 6 people, or 16.67%, have an elementary school education. Only one respondent had a secondary school education (2.78%). None of the informants we met had a higher education level.

III.2. Composition and richness of fruit trees in cocoa farms

The fruit flora inventoried in the cocoa agroecosystems of the department of Daloa is rich in 63 species, divided into 48 genera belonging to 31 families (Table 2). The families Rutaceae (10% of taxa), Annonaceae, Fabaceae and Myrtaceae (8% of taxa each), Anacardiaceae (6% of taxa) are best

represented (Figure 2). Next are the families Clusiaceae, Rubiaceae and Sterculiaceae (5% of taxa each), Apocyaceae, Euphorbiaceae, Mimosaceae, Moraceae, Palmae and Sapindaceae (3% of taxa each). The remaining seventeen families grouped as "Others " with one species each (27% of taxa) are the least represented. These include Araceae, Bixceae, Caricaceae, Irvingiaceae, Zygophylaceae, among others.

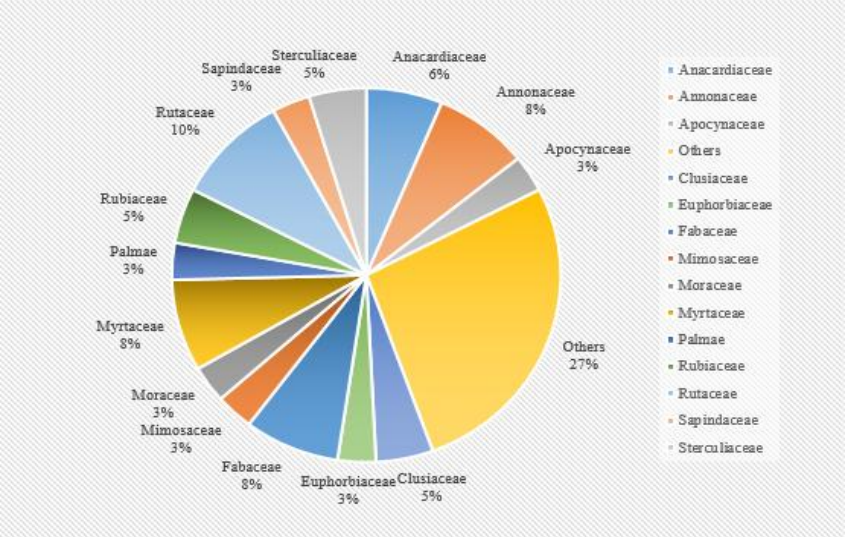

Figure 2: Proportion of families of cocoa fruit taxa in Daloa

The genera *Citrus* (6 species), *Annona*, *Eugenia* (3 species each), *Cola*, *Blighia*, *Datarium*, *Garcinia*, *Pakia* and *Xylopia* with 2 species each, are better represented. All other genera contain one species each (Table 2). The cocoa agroecosystems of Briboua (44 species, 36 genera and 26 families) is richest in fruit species, followed by those of Zepréguhé (33 species, 30 genera and 21 families), Zakoua (28 species, 23 genera and 18 families) and Toroguhé (22 species, 19 genera and 17 families). Among the cohort of spontaneous and non-spontaneous fruit species inventoried, 10 species are found only in cocoa agroecosystems of Bribouo. These include *Adansonia digitata*, *Aframomum elliotii*, *Bixa orellena*, *Dialium guinense*, *Gossypium barbadense*, *Pentadesma butyracea* and *Vitellaria paradoxa*. On the other hand, *Carica papaya*, *Citrus sinensis*, *Elaeis guineensis* and *Persea americana* were found in all the cocoa agroecosystemsstudied (Table 2).

Table 2: Diversity of introduced and spontaneous fruit species in cocoa farms in Daloa

Families, species& Genra	Morp. types	Br	To	Za	Ze	Fi (%)	Ri (%)
Anacardiaceae							
Anacardium occidentalis L.	shrub	+		+	+	28	72
Mangifera indica L.	tree	+		+	+	72	28
Pseudospondias microcarpa (A. Rich.) Engl.	tree		+	+		6	94
Spondias mombin L.	tree	+	+			41	59
Annonaceae							
Annona senegalensis Pers	shrub		+			3	97
Annona muricata L.	shrub	+			+	25	75
Annona squarnosa L.	shrub		+			3	97
Xylopia aethiopica (Dunal) A. Rich.	tree	+		+	+	44	56
Xylopia villosa Chipp	tree		+		+	6	94

Apocynaceae							
Carissa edulis Vahl	shrub			+	+	6	94
Picralina nitida (Stapf) Th. & H. Dur.	tree	+			+	9	91
Araceae							
Cocos nucifera L.	Palm	+	+			19	81
Arecaceae							
Elaeis guineensis Jacq.	Palm	+	+	+	+	56	44
Asteraceae							
Vernonia colorata (Willd.) Drake	shrub	+		+	+	16	84
Bixaceae							
Bixa orellena L.	shrub	+				3	97
Bombacaceae							
Adansonia digitata L.	tree	+				3	97
Borringstonaceae							
Petersianthus macrocarpus (P. Beauv.) Liben	tree				+	3	97
Bromeliaceae							
Ananas comosus L.	xerophytic	+			+	22	78
Caricaceae							
Carica papaya L.	shrub	+	+	+	+	34	66
Clusiaceae							
Garcinia afzelii Engl.	shrub	+	+	+		16	84
Garcinia kola Heckel	shrub	+		+	+	38	63
Pentadesma butyracea Sabine	tree	+				3	97
Combretaceae							
Terminalia catappa L.	tree	+	+		+	13	88
Euphorbiaceae							
Bridelia ferruginea Benth.	shrub	+	+			6	94
Ricinodendron heudelotii (Baill.) Pierre ex Pax	tree	+		+	+	38	63
Fabaceae							
Amphimas pterocarpoides Harms	tree				+	3	97
Detarium microcarpum Guill et Perr.	shrub		+	+		6	94
Detarium senegalensis J. f. Gmel.	shrub	+				6	94
Dialium guinense Willd.	shrub	+				3	97
Pterocarpus santalinoides L'Hérit. ex DC.	tree				+	3	97
Irvingiaceae							
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	tree	+	+		+	69	31
Lauraceae							
Persea americana Mill.	tree	+	+	+	+	97	3
Malvaceae							
Gossypium barbadense L. var. barbadense	shrub	+				6	94
Meliaceae							
Carapa procera DC. De Wilde	shrub	+		+	+	31	69

Mimosaceae							
Parkia bicolor A. Chev.	tree	+				3	97
Parkia biglobosa (Jacq.) Benth.	tree	+			+	9	91
Moraceae							
Myrianthus arboreus P. (Beauv.)	tree		+			3	97
Treculia africana Decne	tree	+		+		6	94
Myrtaceae							
Eugenia jambos L.	shrub	+		+		13	88
Eugenia malaccensis L.	shrub		+		+	16	84
*Eugenia owariensis*P. Beauv.	shrub	+		+	+	9	91
Psidium guajava L.	shrub	+		+	+	78	22
Tarrietia utilis (Sprague) Sprague	shrub			+		3	97
Palmae							
Borassus aethiopum Mart.	Palm	+			+	6	94
Pheonix recrinata Jacq.	Palm		+			3	97
Rubiaceae							
Coffea canephora A. Froehner	shrub	+				16	84
Gardenia erubescens Stapf. & Hutch.	shrub		+			3	97
Morinda lucida Benth.	shrub	+		+		16	84
Rutaceae							
Citrus aurantium L.	shrub		+		+	16	84
Citrus grandis Osbeck	shrub	+				9	91
Citrus limon Burn. f.	shrub	+		+	+	66	34
Citrus maxima (Burm.) Merr.	tree	+				13	88
Citrus reticulata Blanco	shrub	+		+		9	91
Citrus sinensis (L.) Osbeck	shrub	+	+	+	+	78	22
Sapindaceae							
Blighia sapida K. D. Koenig	tree		+		+	9	91
Blighia welwitschi (Hiern) Rodlk.	tree	+	+			9	91
Sapotaceae							
Vitellaria paradoxa C. F. Gaerthner	tree	+				6	94
Sterculiaceae							
Cola caricifolia (G. Don) K. Schum.	tree	+				3	97
Cola nitida (Vent.) Schott & Endl.	tree	+		+	+	72	28
Tamarindus indica L.	tree	+		+	+	63	38
Verbenaceae							
Vitex doniana Sw.	tree				+	3	97
Zingiberaceae							
Aframomum elliotii (Bak.) K. Schum. H.	herb			+		3	97
Zygophyllaceae							
Balanites aegyptiaca (L.) Delile	shrub			+	+	16	84

Meaning: morp - morphological, Bro - Bribouo, To - Toroguhe, Za - Zakoua, Ze - Zepreguhé, Fi - Frequency, Ri - rarefaction index

In addition, the results indicate 5 morphological types among the 63 fruit species inventoried: 49% are shrubs, 42% are trees, 6% are palms and 2% are herbaceous and xerophytes respectively (Figure 3).

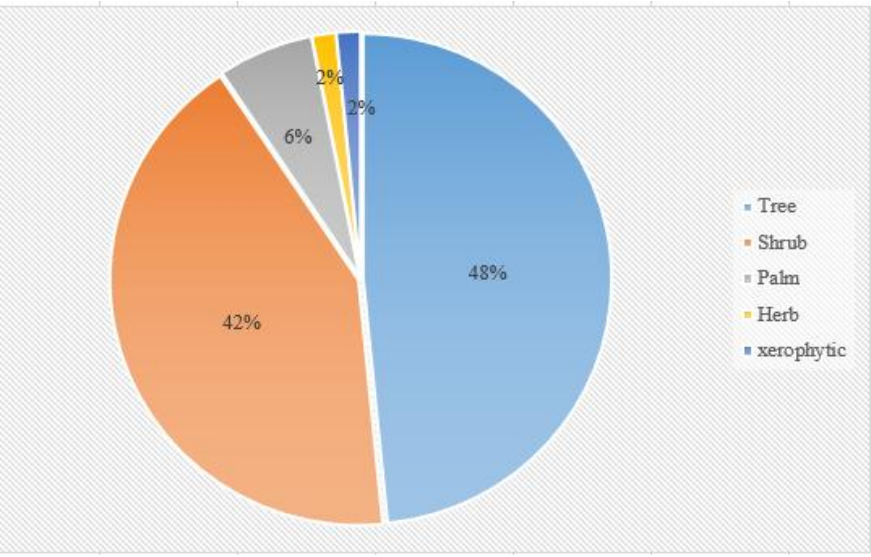

Figure 3: Morphological types fruit species inventoried incocoa agroecosystems in Daloa

III.3. Frequency of species

The most frequent species inventoried in cocoa production systems in the Daloa department were *Psidium guajava* (78%), *Citrus sinensis* (78%), *Cola nitida* (72%), *Mangifera indica* (72%), *Irvingia gabonensis* (69%), C. limon (66%), *Tamarindus indica* (63%) and *Elaeis guineensis* (56%) Table 2. In Briboua cocoa farms, the most frequent species are *M. indica* (100%)(Figure 4A), *C. sinensis* (Figure 4B), *C. nitida, Persea americana* (87.50% each), *Elaeis guineensis, I. gabonensis, P. guajava* (75% each), *Garcinia kola, Spondias mombin* (62.50% each), *Ricinodendron heudelotii, Xylopia aethiopica* (50% each) and *T. indica* (37.50%). At Toroguhe, *P. americana, S. mombin* and *I. gabonensis* were present in 88%, 63% and 60% of the records respectively. In Zakoua, *Citrus limon* (87.50%), *P. americana, P. guajava* (75% each), *C. nitida, M. indica, Tamarindus indica* (62.50% each) and *C. sinensis* (50%) are more frequent. In Zepreguehé, *Citrus limon, C. sinensis, I. gabonensis, Mangifera indica, Persea americana* and *P. guajava* present in 100% of the surveys. *E. guineensis* (50%). Each are more frequencies. The results also show that from the spectrum of these inventoried fruit species, the most frequent and abundant with rarefaction indices lower than 50% (Table 2) are in order of importance *P. americana* (3%), *C. sinensis, P. guajava* (22% each), *C. nitida, M. indica* (28% each), *I. gabonensis* (31%), C. limon (34%), *T. indica* (38%), *Eguineensis* (44%). The most important spontaneous fruit species are *X. aethiopica* (56%), *S. mombin* (59%), *R. heudelotii* (63%) and *Carapa procera* (69%).

Figure 4: *Mangifera indica* (A) and *Citrus sinensis* (B) plants found in cocoa agroecosystems

III.4. Floristic diversity

Table 3 presents the diversity parameters of cocoa agroecosystems by location surveyed. The Shannon index is high for all the cocoa farms surveyed (3.15±0.29). It decreases to reach the lowest value in the Toroguhé cocoa agroecosystems (2.86±0.05). There is a significant difference between the number of fruit species in the different cocoa farms (F= 5.52 and P = 0.012) in the four sites of the Daloa department (Table 3). The Pielou equitability index does not follow the same trend as the Shannon index. It varies on average from 0.90±0.08 to 0.92±0.04 (Table 3). However, the variation is small at the locality level in terms of fruit species present. However, the index is lower in Zepreguhé (0.90±0.08). The results indicate no significant difference between the number of fruit species in the different cocoa agroecosystems (F= 0.093 and P = 0.962). It is 0.92±0.05 in all cocoa agroecosystems.

Table 3: Diversity of fruit species in different cocoa agroecosystems in the study sites

Sites / Cocoa farms	Number of plots	Diversity parameters		
		Specific richness (S)	Shannon (H')	Piélou (E)
Briboua	4	44	3,48±0,16a	0,92±0,04a
Toroguhé	4	22	2,86±0,05a	0,92±0,01a
Zakoua	4	28	3,09±0,27ab	0,92±0,08a
Zepreguhé	4	33	3,17± 0,29b	0,90±0,08a
Moyenne			3,15±0,29	0,92±0,05

On the same column, the values followed by the same letter are not significant at the 5% threshold

III.5. Similarity between cocoa agroecosystems in the sites

The similarity indices are generally low, reflecting a fairly significant difference between the cocoa groecosystems of the sites. However, the cocoa agroecosystems in Zakoua and Zepreguhé are the most similar, while those in Toroguhé and Zakoua are the most dissimilar (Table 4).

Table 4: Similarity between the different cocoa farms in the surveyed sites

Sites	Bribouo	Toroguhé	Zakoua	Zepreguhé
Bribouo	****			
Toroguhé	2,23	****		
Zakoua	0,37	0,21	****	
Zepreguhé	0,36	0,26	0,53	****

III.6. Density of fruit species in cocoa farms

The proportion of spontaneous fruit species is 46.03% of the total number of fruit trees inventoried, while non-spontaneous fruit species, introduced after the cocoa agroecosystems was cultivated, represent 53.97%. Table 5 presents the densities of these spontaneous and non-spontaneous fruit species surveyed. For all cocoa agroecosystems in the four sites surveyed, the number of non-spontaneous or introduced fruit species is higher than the number of spontaneous fruit species. There was a significant difference between the number of spontaneous fruit species on one side (F= 4.58 and P = 0.023) and the number of non-spontaneous fruit species in the different cocoa agroecosystems surveyed on the other side of the four sites (F= 14.67 and P = 0.0002). The proportion of fruit species in terms of density within cocoa agroecosystems is 194±60.61 stems/ha in Bribouo, followed by Zepreguhé(110±15.49 stems/ha), Zakoua (70±10.58 stems/ha) and Toroguhé (42±10.58 stems/ha) (Table 5). There was a significant difference in the number of fruit species in cocoa agroecosystems in the study sites (F= 16.94 and P = 0.0001).

Table 5: Density of fruit species inventoried in cocoa agroecosystems in Daloa

Sites	Spontaneous fruit species	Non-spontaneous fruit species	Fruit species / Cacoa farms
Bribouo	37 ± 17,08a	157 ± 52,90a	194± 60,61a
Toroguhé	11 ± 6,13a	31 ± 5,03ab	42 ± 10,58ab
Zakoua	14 ± 5,16a	56 ± 10,83b	70 ± 10,58b
Zepréguhé	12 ± 6b	96 ± 18,76c	110± 15,49c
Moyenne	14 ± 14,78	85 ± 55,45	104 ± 65,80

On the same column, the values followed by the same letter are not significant at the 5% threshold

IV. Discussion

The surveys were conducted predominantly among men because of the local community's land ownership pattern for agricultural activities. This partly explains the high representation of elderly people (65 years and older) among the informants. According to the informants, access to information on plant resources generally requires experienced people.

They also showed a high rate of illiteracy among informants in the four sites in the Daloa department. This high rate can be detrimental to the management and safeguarding of fruit resources in the plots (Begossi *et al*., 2002).

In the department of Daloa, cocoa agrosystems are rich in 63 species, divided into 48 genera belonging to 31 families. This floristic richness is lower than the 70 species and 84 fruit species found by Jagoret *et al*. (2014a) in cocoa farms in Bokito and Ngomedzap, Central Cameroon. However, it is similar to the 64 species inventoried in Zima, Cameroon by these same authors. This difference could be explained by cultivation practices. Indeed, human pressure plays a role in the loss of species and therefore of fruit trees.

The predominant families are the Rutaceae (20% of taxa), Annonaceae and Myrtaceae (17% of taxa each), Fabaceae (16% of taxa), Anacardiaceae (13% of taxa). The dominance of the Annonaceae and Fabaceae families in cocoa agroforestry systems has been highlighted by several authors including Temgoua *et al*. (2018) in Cameroon.

Among the species inventoried, we also note a dominance of trees and shrubs. These results corroborate those of Djihounouck *et al*. (2019).

The Shannon index is high in the cocoa agroforestry systems studied and varies from one site to another. It is above 3 for 95%, especially in Briboua, Zepreguhé and Zakoua and lower in Toroguhé. This reflects the high diversity and good distribution of fruit species in Briboua, Zepreguhé and Zakoua, but also the greater stability of the agrosystems in these villages compared to Toroguhé (Akpo *et al*., 2003).

The fruit flora is not well balanced, as evidenced by their relatively high equitability values, which are close to each other when considering each site's average agrosystem value.

The density of fruit species (104 stems/ha) is lower than the 225.5 trees/ha found in Bokito in the agroforestry cocoa production systems of Central Cameroon (Jagoret *et al*., 2011). This difference in fruit species density could be explained by the knowledge of the endogenous species of the ethnic groups encountered. Indeed, the Bété and Baoulé ethnic groups only introduce into their plots those species whose usefulness they know very well.

The fruit species *Persea americana, Mangifera indica* and *Elaeis guineensis* are the mostfrequent and important species because of their rarefaction index value of less than 50%. These results confirm the work of Sonwa *et al*. (2007) and Jagoret (2014a) in Cameroon.

Conclusion

The present study allowed for an evaluation of fruit species in cocoa agrosystems in the department of Daloa. The fruit flora inventoried in the agrosystemsstudied is rich in 63 species, divided into 48 genera belonging to 31 families. This specific richness is characterized by a dominance of trees and shrubs. The preponderance of woody species such as *Citrus sinensis, Cola nitida, Mangifera indica, Persea americana, Psidium guajava, Irvingia gabonensis, Citrus limon, Tamarindus indica, Elaeis guineensis, Xylopia aethiopica, Spondias mombin, Ricinodendron heudelotii*, and *Elaeis guineensis* testifies to their important place in the socio-economic life of rural communities. The study also corroborated the idea that, despite anthropic pressures, cocoa agrosystems abound in significant plant diversity, especially fruit diversity. Thus, improvement strategies must take into account these data in the search for the best compromise between cocoa production and other services provided by the associated trees.

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