ISSN: 2310–3469 RNPS: 2347
*Revista Cubana de Ciencias Forestales. 2019; mayo-agosto 7(2)**:** 212-224*

Translated from the original in spanish

Diversity of arboreal species in scenarios of urban agriculture in the municipality of Pinar del Río

Diversidad de especies arbóreas en escenarios de la agricultura urbana en el municipio de Pinar del Río

Lisandra Hernández Guanche[1]

Yoerlandy Santana Baños[2]

Armando acosta Hernández[3]

Armando del Busto Concepción[4]

[1]Universidad de Pinar del Río "Hermanos Saíz Montes de Oca". E-mail: lisandra.guanche@upr.edu.cu, yoerlandy@upr.edu.cu, armando.acosta@upr.edu.cu, armando@upr.edu.cu

Received: December 20th, 2018.
Approved: Aprril 7th, 2019.

ABSTRACT

The research was carried out in the organoponics system of "Vial Colón" belonging to the municipality of Pinar del Río, with the objective of determining the diversity of arboreal species associated with these scenarios. Inventories were carried out in the different organoponics to determine the number of individuals per species. Its taxonomic identification was made, as well as its absolute frequency and abundance calculations in each sample. A total of 37 arboreal species belonging to 26 botanical families were obtained. The most represented family was the Fabaceae. The species with the highest abundance were *Persea americana* Mill. and *Moringa oleifera* Lam., while the frequency of appearance yielded values higher than 70% in *Azadirachta indica* A. Juss., P. *americana*, M. o*leifera*, *Mangifera indica* L. and *Cocos Nucifera* L.

Keywords: families; forestry; fruit tree; organoponics.

RESUMEN

La investigación se llevó a cabo en el sistema de organopónicos del "Vial Colón", en el municipio Pinar del Río, con el objetivo de determinar la diversidad de especies arbóreas asociadas a estos escenarios. Se realizaron inventarios en los diferentes organopónicos para cuantificar los individuos por especie. Se realizó su identificación taxonómica, así como la de los valores de frecuencia absoluta y abundancia en cada muestreo. Se obtuvo un total de 37 especies arbóreas pertenecientes a 26 familias botánicas; la familia más representada fue la Fabaceae. Las especies con mayor abundancia fueron *Persea americana* Mill. y *Moringa oleifera* Lam., mientras que la

frecuencia de aparición arrojó valores superiores al 70 % en *Azadirachta indica* A. Juss., *P. americana, M. oleifera*, *Mangifera indica* L. y *Cocos nucifera* L.

Palabras clave: familias; forestales; frutales; organopónicos.

INTRODUCTION

Biodiversity is defined as any variation of the hereditary base at all levels of organization, from genes in a local population or species, to species that form all or part of a local community, and finally in the same communities that form the living part of the world's multiple ecosystems (Wilson, 1988).

From a biological point of view, the presence of trees benefits production systems in aspects such as maintaining nutrient cycling and increasing species diversification (Navia *et al.,* 2003).

Vázquez (2011) states that the auxiliary diversity fomented is constituted by the plants that are sown in live barriers and others that accompany crops and offer certain ecological services, such as favoring natural regulators, pollinators and other beneficial organisms. These components of biodiversity can also be used for other functions in the agroecosystem and are sometimes planned and managed to favour their effects.

Several authors have studied tree vegetation in different environments (Sordo, 2009; Sosa, 2013; Rodríguez *et al.,* 2018). The concept of cultivation in urban agriculture has been modified to different species of fruit trees, timber, ornamentals and others that already existed in those places and are served as crops with different purposes, with a tendency towards plant diversification (Vázquez and Fernández, 2007).

In general, there is a trend towards plant diversification in these urban systems, mainly of shrubs and trees with different purposes, which contributes to increasing and conserving biodiversity and generating diverse productions (Vázquez et al., 2005).

Vargas et al. (2016) pointed out that studies carried out on suburban farms, especially in the eastern region of Cuba, focus on very specific aspects of the productive component and suggest developing studies that consider different diversification indicators that serve as a basis for improving productivity, the Decision-making process and the design of these systems.

Mesa *et al.,* (2009) state that it is of great interest to study the existing biodiversity, since they contain a great diversity of native or introduced crop species, in perfect state of adaptation to the conditions of the territory.

In this context, the objective of this research was to determine the diversity of tree species in the scenarios of urban agriculture in the municipality of Pinar del Río.

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MATERIALS AND METHODS

Description of research scenarios

The research was carried out in the organoponic system of the "Vial Colón", belonging to the municipality of Pinar del Río, located in the "Hermanos Cruz" district. Seven organoponics were randomly selected; the study period covered the months of January 2016 and November 2018 (Table 1).

Table 1. - Names, coordinates and productive purposes of the seven selected organoponics.

No	Organopónicos	Ubicación geográfica	Producción
1	Ingeniería #1	22°26'06.4"N 83°40'24.4"W	Hortalizas
2	Materiales	22°25'45.0"N 83°40'30.5"W	Hortalizas
3	Camiones	22°25'42.2"N 83°40'30.7"W	Hortalizas
4	La Conchita	22°25'46.8"N 83°40'35.7"W	Hortalizas
5	El Vial	22°25'28.7"N 83°41'05.9"W	Hortalizas
6	Tropiflora	22°25'21.3"N 83°41'11.8"W	Flores y ornamentales
7	Erea # 1	22°25'11.5"N 83°41'16.4"W	Hortalizas

Methodology for carrying out the inventory of tree species

A floristic inventory was carried out from the counting and identification, up to the family and species level, of the tree plants present in the organoponics selected for the study. The identified species were also classified by their use, using the methodology proposed by Godínez *et al.,* (2006). These studies classify the species into timber, melliferous, medicinal and other uses; within the latter include ornamental, eatable and protecting soil and water. With the organoponic inventory, the Absolute Frequency (AF) was determined, using the equation described in Chablé *et al.,* (2015), adjusted by the authors for the study conditions.

$$FA\ (\%) = \frac{\text{Número de organopónicos donde se presenta cada especie}}{\text{Total de organopónicos inventariados}} * 100$$

Indexes used for the assessment of diversity in organoponics

Information on the number of species and individuals present in each organoponic was calculated using the Shannon-Wiener diversity index for equity, the Simpson dominance index and the Margalef species richness index.

Data on species composition and abundance were processed with the BiodiversityPRO program.

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RESULTS AND DISCUSSION

Composition and abundance of identified tree species

The floristic composition of the studied area resulted in 37 plant species distributed in 26 botanical families, composed mostly of spontaneous vegetation, species with productive purposes and others as living barriers or for phytosanitary uses, evidencing the degree of diversity reached in these scenarios.

Fabaceae was the family best represented with four species, followed by *Malvaceae, Moraceae, Sapotaceae, Euphorbiaceae, Lamiaceae, Arecaceae and Annonaceae,* all represented by two species; the rest of the families were constituted by a single species, expressing these results a greater abundance of individuals per species than number of species per family. Similar results were obtained by Leyva and Lores, (2012) in studies conducted to measure new agrobiodiversity indices in 15 agroecosystems, identifying *Fabaceae* as the most represented family (Table 2).

Table 2. - List of tree species identified in organoponics, as well as their category of uses

No.	Familia	Nombre Científico	Nombre Vulgar	Usos
1	*Euphorbiaceae*	*Acalypha hispida* Burm.	rabo de gato	MD, OU
2	*Annonaceae*	*Annona cherimola* Mill.	chirimoya	ME, OU
3	*Annonaceae*	*Annona muricata* L.	guanábana	ME, OU
4	*Arecaceae*	*Areca catecu* L.	areca	OU
5	*Moraceae*	*Artocarpus altilis* (Parkinson) Fosberg	árbol del pan	ME, OU
6	*Meliaceae*	*Azadirachta indica* A. Juss.	nim	ME, OU
7	*Bixaceae*	*Bixa orellana* L.	bija	ME, MD, OU
8	*Nictaginaceae*	*Bougainvillea spectabilis* Willd.	zarza americana	OU
9	*Burseraceae*	*Bursera simaruba* (L.) Sarg.	almácigo	MR, ME, MD, OU
10	*Caricaceae*	*Carica papaya* L.	fruta bomba	ME, MD, OU
11	*Sapotaceae*	*Chrysophyllum cainito* L.	caimito	ME, OU
12	*Rutaceae*	*Citrus limon* (L.)Burm. f.	limón	MR, ME, MD OU
13	*Arecaceae*	*Cocos nucifera* L.	coco	MD OU
14	*Euphorbiaceae*	*Codiaeum varegatum* (L.) A. Juss.	croto	MD, OU
15	*Boraginaceae*	*Cordia dentata* L.	ateje	MR, MD, OU
16	*Fabaceae*	*Delonix regia* (Bojer ex Hook.) Raf.	framboyán	MR, ME, MD, OU
17	*Moraceae*	*Ficus elastica* Rxb. ex Hornem.	ficus	ME, MD, OU
18	*Fabaceae*	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	piñón	MR, ME, MD, OU

19	*Sterculiaceae*	*Guazuma ulmifolia* Lam.	guácima	MR, ME, MD, OU
20	*Malvaceae*	*Hibiscus elatus* Sw.	majagua	MR, ME, MD, OU
21	*Malvaceae*	*Hibiscus rosa-sinensis* L.	Marpacífico	ME, OU
22	*Malpiguiaceae*	*Malpighia emarginata* DC.	acerola	ME, MD, OU
23	*Anacardiaceae*	*Mangifera indica* L.	mango	MR, ME, MD, OU
24	*Rubiaceae*	*Morinda citrifolia* L.	nonis	ME, MD, OU
25	*Moringaceae*	*Moringa oleifera* Lam.	moringa	MR, ME, MD, OU
26	*Lauraceae*	*Persea americana* Mill.	aguacate	ME, MD, OU
27	*Myrtaceae*	*Pisidium guajava* L.	guayaba	MR, ME, MD, OU
28	*Lamiaceae*	*Gmelina arborea* (Roxb)	álamo blanco	MR
29	*Sapotaceae*	*Pouteria campechiana* (Kunth) Baehni	canistel	ME, MD, OU
30	*Passifloraceae*	*Passiflora edulis* Sims	maracuyá	ME, MD, OU
31	*Cucurbitaceae*	*Melothria sp.*	pepinillo	ME, OU
32	*Myrtaceae*	Syzyguium malaccese (L.)	pera de malaca	ME, OU
33	*Fabaceae*	*Samanea saman* (Jacq.) Merr.	algarrobo	MR, ME, MD, OU
34	*Bignoniaceae*	*Spathodea campanulta* P. Beauv	tulipán americano	MR, ME, MD, OU
35	*Fabaceae*	*Tamarindus indica* L.	tamarindo	ME, MD, OU
36	*Combretacea*	*Terminalia catappa* L.	almendra	ME, MD, OU
37	*Lamiaceae*	*Vitex parviflora* A. Juss	roble vitex	MR, ME, MD, OU

Legend: MR -wood, ME -meliferous, MD -medicinal, OU -other uses

It should be noted that within the species identified, 81 % are melliferous, 70 % are for medicinal use and 37 % are for wood. Sordo (2009) identified 111 species from 39 families, with the purpose of determining the available wealth in each territory, forming four groups for the objectives of different subprograms of urban agriculture (forestal), coffee and cocoa; flowers and ornamental plants and beekeeping. These results suggest that the species described in the organoponics could be included in these programs, taking advantage of their strengths to pursue successful strategies.

The greatest abundance of individuals by species was inventoried *in P. americana* (37 individuals) and *M. oleifera* (31 individuals) (Figure 1), while 19 species showed abundance less than five individuals, among them are found: *T. indica, P. campechiana, P. alba, H. elatus, D. regia, C dentata, C. cainito, C. papaya, B. simaruba, A. altilis*; this indicates that the fruit species are among the most used in the arboreal component of these production systems, as a way to increase biodiversity.

According to Matienzo (2010), in urban agriculture there are experiences in the use of various species such *as Persea americana, Mangifera indica, Psidium guajava, Cocos nucifera, Azadirachta indica,* among others.

Ortiz and Vera (2001), in studies carried out on biodiversity in urban agricultural gardens, identified as species with greater abundance *Persea americana, Mangifera indica, Psidium guajava, Cocos nucifera*, among others.

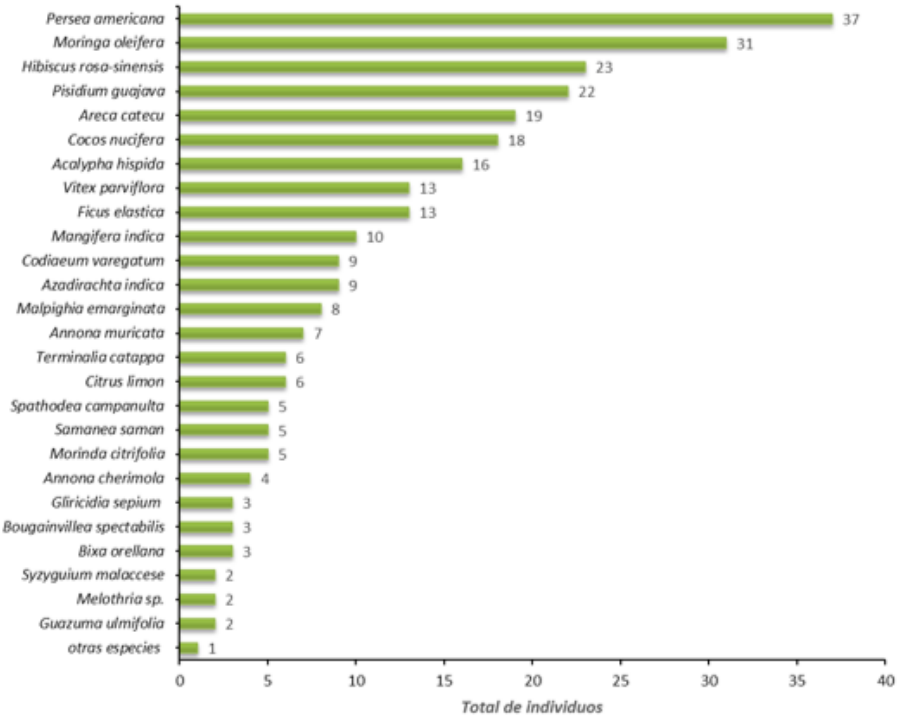

Fig. 1. - abundance graph for identified tree species

The identified species had variation for the absolute frequency in the organopónicos, being verified that 13,2 % of the species possess values of frequency superior to 70 %, where were included the species *A. indica and P. americana* with 85,7 % and *C. nucifera, M. oleífera* and *M. indica* reached 71,4 %. It should be noted that 21.1 % of the species had occurrence frequencies between 30 and 70 %, while more than 65 % showed values below 30 % (Table 3).

Table 3. - List of species and their frequency in the organoponics studied

Especies	1	2	3	4	5	6	7	FA **(%)**
Acalypha hispida	0	0	0	0	0	0	16	14.3
Annona cherimola	3	0	0	0	0	0	1	28.6
Annona muricata	1	0	1	0	1	4	0	57.1
Areca catechu	0	0	0	0	0	19	0	14.3
Cocos nucifera	4	1	2	10	1	0	0	71.4
Artocarpus altilis	0	0	0	0	0	0	1	14.3
Azadirachta indica	1	2	2	1	3	0	7	85.7
Bixa orellana	1	1	0	1	0	0	0	42.9
Delonix regia	0	1	0	0	0	0	0	14.3
Gliricidia sepium	3	0	0	0	0	0	0	14.3
Guazuma ulmifolia	0	0	0	0	2	0	0	14.3
Hibiscus elatus	0	0	0	0	1	0	0	14.3
Hibiscus rosa-sinensis	0	0	0	0	0	23	0	14.3
Malpighia emarginata	2	2	3	0	1	0	0	57.1
Mangifera indica	1	0	0	1	3	2	3	71.4

Morinda citrifolia	2	3	0	0	0	0	0	28.6
Syzyguium malaccese	0	0	0	1	0	0	1	28.6
Spathodea campanulta	2	2	1	0	0	2	0	75.1
Terminalia catappa	0	0	1	4	0	1	0	42.9
Bougainvillea spectabilis	0	0	0	0	0	3	0	14.3
Bursera simaruba	0	0	0	1	0	0	0	14.3
Carica papaya	0	1	0	0	0	0	0	14.3
Chrysophyllum cainito	0	0	0	0	1	0	0	14.3
Citrus limon	2	0	0	0	3	0	1	42.9
Codiaeum varegatum	0	0	0	0	0	9	0	14.3
Cordia dentata	0	1	0	0	0	0	0	14.3
Ficus elastica	0	0	0	0	9	4	0	28.6
Moringa oleifera	10	5	5	5	6	0	0	71.4
Persea americana	5	4	9	0	1	1	17	85.7
Pisidium guajava	3	2	0	1	16	0	0	57.1
Gmelina arborea	0	0	0	0	1	0	0	14.3
Pouteria campechiana	1	0	0	0	0	0	0	14.3
Passiflora edulis	0	1	0	0	0	0	0	14.3
Melothria sp.	1	0	1	0	0	0	0	28.6
Samanea saman	3	0	0	0	1	1	0	42.9
Tamarindus indica	0	1	0	0	0	0	0	14.3
Vitex parviflora	0	0	0	0	0	12	1	28.6

Biodiversity indices in the organoponics studied

En la tabla 4, se puede apreciar que la mayor abundancia corresponde al organopónico 6 (81 individuos), seguido por el 1, 5 y 7, con valores superiores a 40 individuos. En relación con la riqueza, se encontró mayor número de especies en los organopónicos 1, 2 y 5, a pesar de que el índice de Margalef fue ligeramente superior para el 2, 3 y 4, en los cuales se evidencia mayor proporción de especies con relación a su abundancia.

También se destaca que los índices de equidad (Simpson 1/D) fueron superiores en los organopónicos 1 y 2 respecto al 5, lo que evidencia que el número de especies no es un indicativo de mayor diversidad, ya que esta medida está asociada a la similitud en la distribución de dichas especies o viceversa; si existe un alto índice de dominancia de especies, la diversidad es menor. Dicho resultado se atribuye a que en el organopónico 5, la especie *P. guajava* presentó una cantidad de individuos (16) dominante sobre el resto de las especies representada.

Tabla 4. - Índices de biodiversidad para los organopónicos estudiados.

Índices de diversidad	**Organopónicos**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Total de individuos	45	27	25	25	**50**	**81**	48
Riqueza	**17**	**14**	9	9	**15**	12	9
Shannon H' Log Base 10.	**1,12**	**1,07**	0,81	0,76	**0,95**	0,86	0,69
Simpson Diversity (1/D)	**12,86**	**15,26**	5,88	4,92	**6,77**	5,97	4,03
Margaleff M Base 10.	21,78	**25,15**	**25,75**	**25,75**	21,19	18,86	21,41

In figure #2, a dendrogram of similarity among the organoponics is shown, for the composition of found species. It can be seen that there is more than 50 % similarity for organoponics 2, 3 and 1, giving a higher degree of relationship between 2 and 3, especially because they prevail fruit trees as a strategy for food diversification, due to their productive purpose. However, organoponic 6 showed less coincidence of species, due to the fact that 30.7 % of those associated with it are ornamental and are not represented in the other organoponics because of those included in the study, only this one is dedicated to the production of flowers, which suggests a greater preference for ornamental plants (Figure 2).

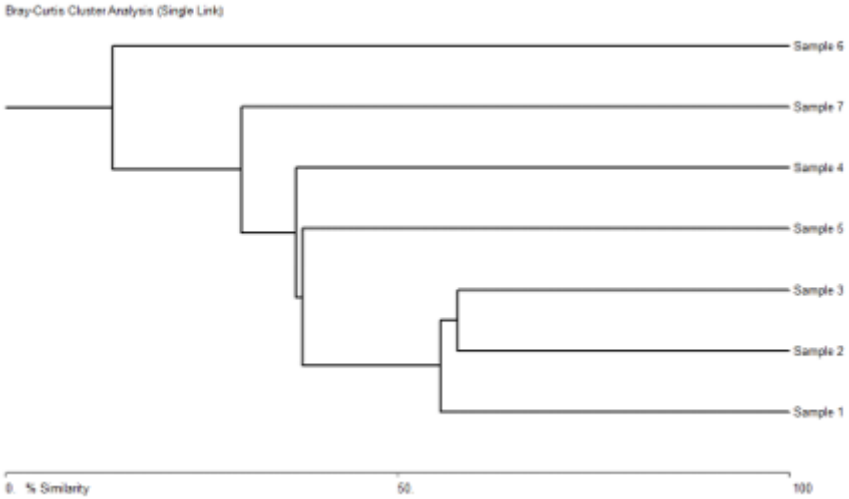

Fig. 2. - Dendrogram of similarity between organoponics

The tree diversity present in the organoponics of Pinar del Río includes 37 species belonging to 26 botanical families, with a greater representation of *Fabaceae.* The most abundant species are *P*. americana and *M. oleifera*, while the absolute frequency exceeds 70 % in *A. indica, P. americana, M. oleifera, M. indica* and *C. nucifera*. Organoponics 1, 2 and 3 have greater similarity in species composition, while the greatest abundance is found in 6.

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