INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 5, p. 29-38, 2016
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Practice of home gardens (HG) in the suburban area between Cotonou and Ouidah in southern Benin

Adjahossou Baï Sêdami[*1], Adjahossou Vidédji Naéssé[2], Djego Julien[3], Adjahossou Dossou Firmin[3,4]

[1]*Department of the Environnement's Engineering, Polytechnique School of Abomey-Calavi, Benin*

[2]*Faculty of Science and Techniques, Polytechique University of Abomey, Benin*

[3] *Faculty of Agricultural Sciences, University of Abomey-Calavi, Benin*

Article published on November 25, 2016

Key words: Home garden, Suburban, Agrosystem, Southern Benin

Abstract

In the suburban area between the cities of Cotonou and Ouidah in Benin, home gardens are sources of food crops and fruit products for families. They also include medicinal plants that form the vital core of the remedies available in the household and ornamental plants. The samply survey deals with 46 homegardens and 31 are selected for the study. The objective of this study is to the presence or absence of homegarden in this suburban area. Data concerned the size, species composition, the phytogeographic distribution of home gardens, the different uses of plants. The collection of information was carried out by individual structured interviews with households. The diversity indices such as Shannon-Wiener, Jaccard helped to categorize these home gardens located on the coastal strip and clarify their biological wealth. The size of these gardens is between 55 m² to 2150 m² and the sample can be divided into three groups: small < 80 m²; ≤ 200 m² medium ≤ 500 m²; large off> 500 m². The average percentage of species by home garden is 55.86% are grown for their nutritional values, 24,69%, for their medicinal values, however 20% are ornamental, ceremonial or used wooden shelter. There is a strong dominance (60%) to wide geographical distribution of species. These agricultural systems also contribute to preserve the environment. This study has permitted to identify strengths and constraints related to the creation of home gardens in this area.

***Corresponding Author:** Adjahossou Baï Sêdami ✉ sedajas@yahoo.fr

Introduction

Home gardens (HG) is practiced in many parts of the world including South East Asia, Latin America (Pulido *et al*., 2008), India (Das and Das, 2005), Africa (Aworinde and Erinoso, 2013), Europe (Gaston *et al*., 2005). These agricultural systems characterized by several complex layers (Fernandes and Nair, 1986; Coomes and Ban, 2004), home to several biological types (Michon, 1983; Mohan, 2004) and promote optimal and efficient use of solar energy, minerals, and moisture from the ground (Michon, 1983). Faced with the rapid environmental degradation, these gardens are a reservoir of genetic resources that contribute to the preservation of ancient cultivars neglected in modern agriculture which is oriented towards productivity and guided by market forces.

The home gardens occupy small areas around the household and contribute to the improvement of life conditions in the Household (Wezel and Ohl, 2005; Kumar 2006; Bernholt *et al*., 2009). In Kerala in India, practitioners of HG consider food products from their home gardens as being healthier and having better taste compared to those acquired in local trade (Mohan, 2004). Regarding the satisfaction of health needs, FAO (1998) estimates that in developing countries 80% of the population rely on traditional medicine based on plants with 70 to 90% from the forests or wild vegetation. But the increasingly strong pressure exerted by a growing population, not only reduces their availability but also contributes to the extinction of some species (Rao and Rao, 2006). The cultivation of medicinal plants in the home gardens merely contributes to this process of extinction (Rao *et al*., 2004). Ornamental plants are usually grown around huts and along the paths in the area (Peyre *et al*., 2006). In urban areas, the utilitarian and social role of HG decreases as the aesthetic and ritual functions increase with the partial replacement of food crops by ornamental plants (Wiersum, 2006). The HG, considered as sustainable agricultural ecosystem models are sometimes strongly oriented towards the cultivation of a small number of species with significant market value (Chandrashekara and Baiju, 2010; Balooni *et al*., 2014).

In Benin, the agricultural production system is sometimes mentioned in the Atacora department northeast of the country, but it is not apparent in other regions, especially in the suburban area of Cotonou, which is not considered an agricultural area. However, observations of vegetation around the city of Cotonou revealed clues to the presence of HG. The exploratory survey results that followed this observation, justified the present study entitled "The Practice of home gardens in the suburban area between Cotonou and Ouidah " In Benin, the largest urbanization rate concerns Cotonou and land speculation has made obscure the need to create and manage green spaces. This speculation has also promoted the installation of low-income people in the surrounding areas, support the creation of HG. Little work has been done on the richness and floristic composition of the HG that could contribute to meeting the food and health needs of the population. This study aims to verify the presence or absence of home gardens in this suburban area and to determine their size, diversity, composition and features in order to preserve phytodiversity.

Study zone

The study area between the city of Cotonou and Ouidah in southern Benin, is a low-lying coastal plain (3-4 m). The floors are made of yellow sand and the water table is less than 2 m deep there. The Sudano-Guinean climate is characterized by two alternating rainy seasons of two dry seasons of unequal duration. The height of water collected during the year varies between 950 and 1150 mm. The average temperature is 27 ° C from 24 ° C to 30 ° C during the rainy season and from 23 ° to 33 ° C in dry seasons. These soil and climatic conditions favor the presence of lush vegetation all along the year.

Material and methods

During the exploratory survey in the suburban area of Cotonou and Ouidah, especially in the localities of Cocodji, Coccotomey and Pahou, 46 Homegardens were visited and 31 were carefully selected for investigation.

Data collection was conducted through participatory research method of unstructured interviews, semi-structured group and individual structured interviews. The main parameters studied are: the structure and floristic composition of home gardens, the usefulness of species, the area occupied by the species, the classification of home gardens by the number of species found. The data collected were coded and subjected to various treatments such as descriptive statistics and correlation test, the hierarchical classification. This classification was used to group the different species in relation to significant parameters. To compare the HG, the diversity index of Shannon and dissimilarity index of Jaccard were calculated to assess the specific diversity of the study area. So to understand the relationships between different gardens, Jaccard's similarity index (I_J) is calculated by this formula:

$$I_J = 100 \times \frac{c}{a+b-c}$$

where a and b denote the number of species of environments a and b and c the number of species common to both environments.

Also the index of Shannon H has précised the structure of populations.

$$H = - \sum_{i=1}^{s} (Ni/N) \log_2 (NNi/N)$$

Ni = number of individuals of the species (i)

N = total number of individuals of the group Ni / N = relative frequency of individuals of the species (i)

Results

Description of HG

HG size varies from 55 m² to 2150 m² with an average of 272 m². Figure 1 shows the frequency polygon representing the distribution areas of the HG.

Table 1. Frequencies (%) some main species in homegardens following their use.

Species	Food plants (%)	Medicinal plants (%)	Ritual plants (%)
Carica papaya	44.44	8.5	
Mangifera indica	44.44	2,13	
Elaeis guineensis	42.22		
Musa sinensis	42.22	2,13	
Ocimum gratissimum	40	12.76	
Cymbopogon citratus	33.33	14.89	
Coco nucifera	31.11	2,12	
Moringa oleifera	28.88	4,25	
Vernonia amydalina	28. 88	8.5	
Laurus nobilis	24.44		
Persea americana	22.22		
Manihot esculenta	20	2,13	
Citrus limon		23.40	
Newbouldia laevis		14. 89	58.33
Jatropha multifida		14.89	
Aloe buettneri		8.5	
Cassia occidentalis		8.5	
Crateva religiosa		8.5	
Croton zambesicus		8.5	25
Draceana arborea			75
Jatropha curcas		4,26	16.6

This polygon is trimodal, but for 93.55% of gardens, areas are between 55 m² and 400 m² and the 2150 m² value appears to be exceptional.

For 50% of explored households, HG occupy about 40% of the total area. Figure 2 shows a highly significant correlation between the number of species and area of the HG. Furthermore, analysis of multiple regression between the number of species, the HG area and number of uses indicates an adjusted coefficient of determination R^2 equals to 0.75 ($p = 0.000$).

This coefficient is highly significant at 0.05 and shows that the number of species present in these gardens is linked both to the area available and the uses made by households.

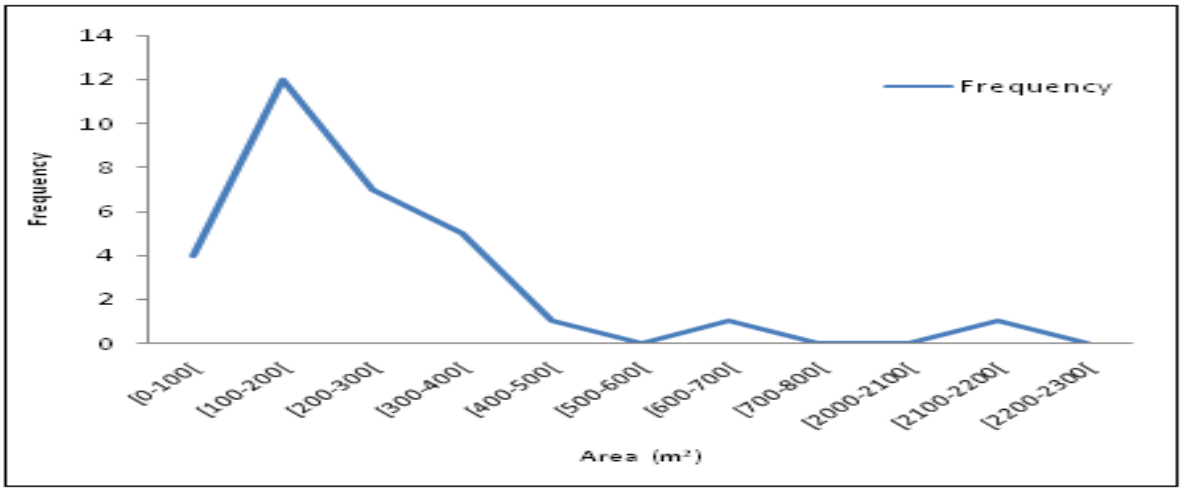

Fig. 1. Frequency polygon of the distribution area of the home gardens.

The 103 species listed in the 31 HG belong to 86 genres and 50 families. The most represented families are Euphorbiaceae (18%) and Fabaceae (12%), Rutaceae (12%), Caesalpiniaceae (10%), Malvaceae (10%), Moraceae (10%), Apocynaceae (8%), Poaceae (8%), Anacardiaceae (6%), Mimosaceae (6%).

On average, there are 13 species by HG. Figure 3 shows the proportions of plant parts used in all the HG. Fruit are the most frequently used (59%), followed by leaves (45%). However roots and bark are respectively 5% and 1%.

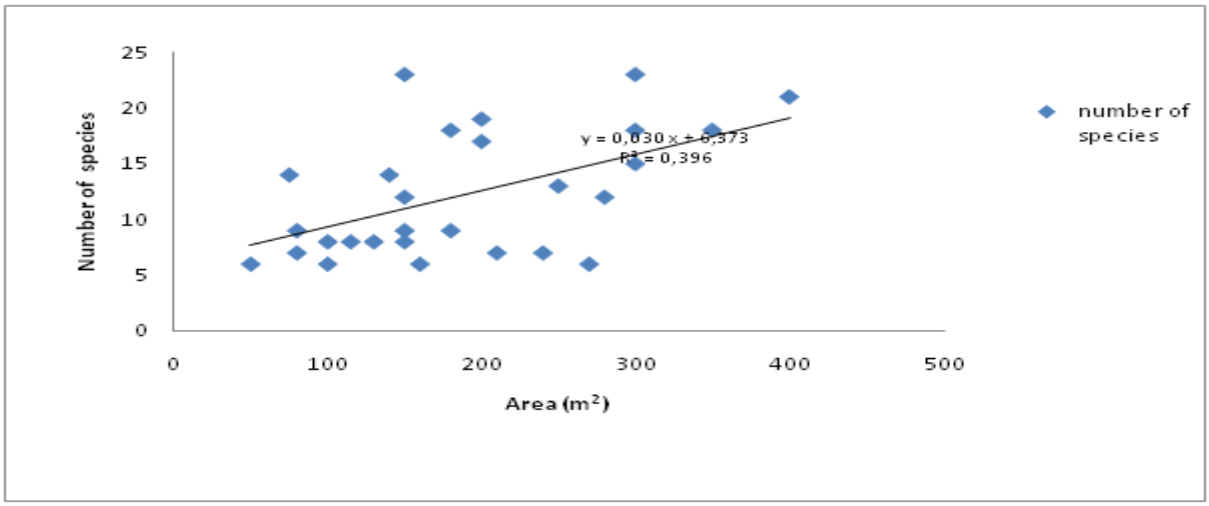

Fig. 2. Correlation between the number of species and area of the homegardens.

The fruits of 33 species are used in 28 HG. Per household, on average five (5) species of fruit trees. The most common species are: *Carica papaya* (67.85%), Musa *sinensis* (53.57%), *Mangifera indica* (53.57%), *Elaeis guineensis* (53.57%), *Coco nucifera* (50%), *Citrus limon* (39.28%), *Persea americana* (32.14%), *Citrus sinensis* (25%), *Annona senegalensis* (25%), *Cola nitida* (17,85%), *Ananas communis* (14.3%).The leaves of 50 species *Ocimum gratissimum* (56.66%), *Cymbopogon citratus* (50%), *Manihot esculenta* (60%).

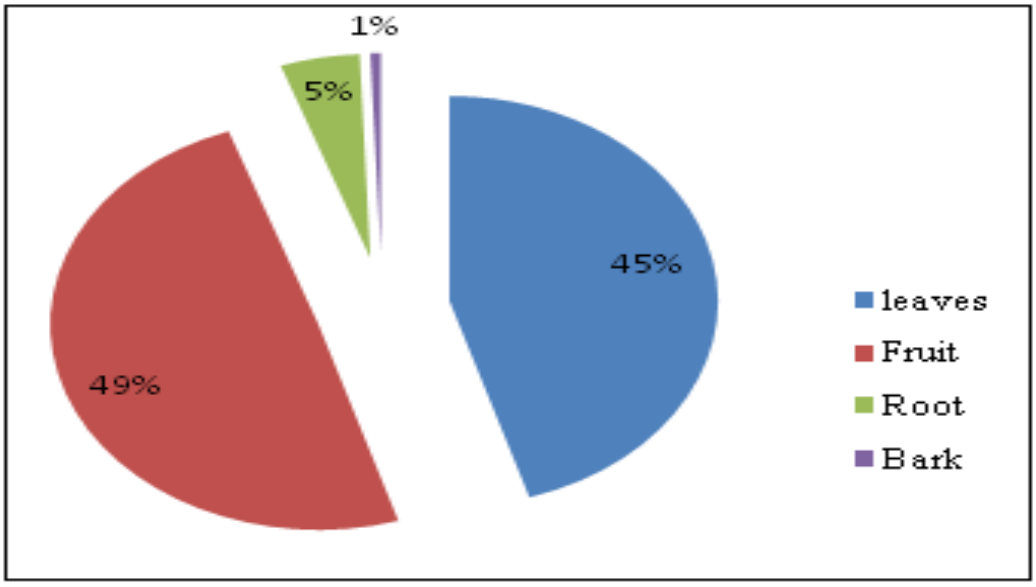

Fig. 3. Percent of homegardens where the differents parts of plants are used.

The other nine species are *Newbouldia laevis, Elaeis guineensis, Caesapulnea pulcherrima, Discorea* sp., *Securinega virosa, Vernonia amydalyna, Petivera alliacea, Cassia alata, Colocassia esculenta* are found in 12 HG. It should be noted that the roots and barks of the species are not commonly used. *Manihot esculenta* is frequently used.

The other nine species namely *Newbouldia laevis, Elaeis guineensis, Caesapulinea pulcherrima, Discorea* sp., *Securinega virosa, Vernonia amydalyna, Petivera alliacea, Cassia alata, Colocassia esculenta* are found in 12 HG. Bark species as *Fagara xanthoxyloides* and *Mangifera indica* are harvested and concern only 6% of HG.

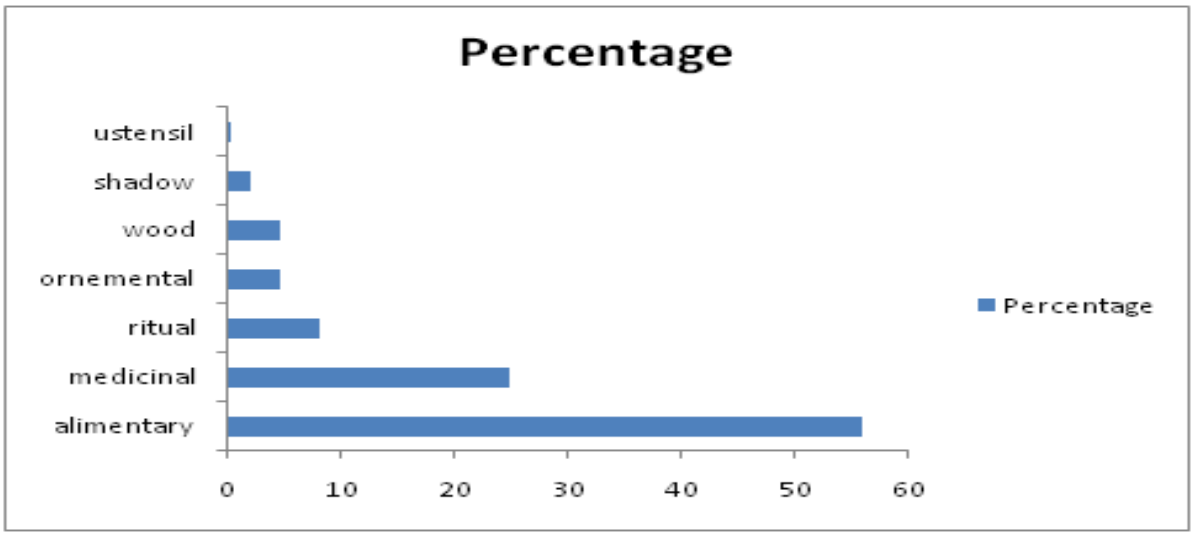

Fig. 4. Importance of species inventoried in the home gardens.

Figure 4 summarizes the percentage of usage of species inventoried in the HG. The plants are used for various purposes: food, medicinal, ornamental, ritual, timber, shade, ustensil, color. Food crops are dominant 55.84% against 24.69% for medicinal plants. The ritual plants, ornamental and wood account respectively for 8%; 4.7%; 4.7%. Plants for shade (1.85%) and the plants used to make utensils (0.30%) are almost insignificant.

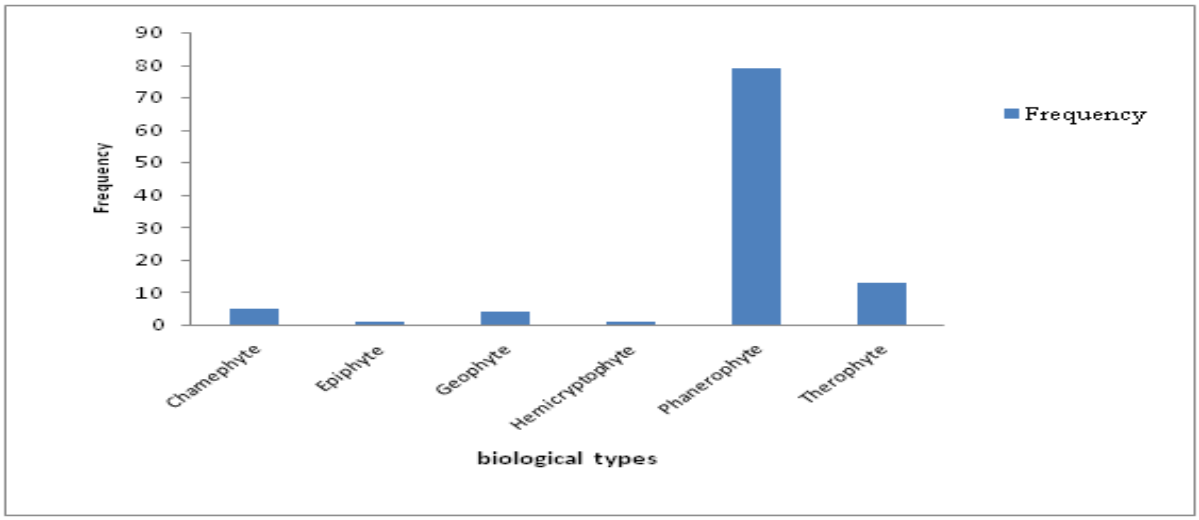

Fig. 5. Biological spectrum of homegarden.

46 species are used as food plants. On average, eight species are used as food plant in each HG. 47 species are used as medicinal plants, At least three medicinal species are used per household. The 12 most frequently used for ritual ceremonies species. The main food, medicinal, ritual plants are found in table 1. It should be noted that the high cost of living leads households near the city of Cotonou to give importance for both food plants and medicinal. But in rural areas, households give more importance to food plants to have some food autonomy and can pick medicinal plants in the bush or in undeveloped plots.

Floristic composition of HG

Figure 5 shows the floristic composition of HG identified in the study area.

The gardens contain almost 76% of phanerophytes followed therophytes (13%). The chamaephytes, geophytes, hemicryptophytes and epiphytes represent 4.9% respectively; 3.9%; 0.9% and 0.9%. Almost all biological types are represented with a dominance of phanerophytes which is a characteristic of tropical areas.

Figure 6 shows the phytogeographical distribution of agroecosystems. There is a dominance of wide geographical distribution species (60%) followed by a small proportion of species of element Guinean-Congolese base (10%) followed by Western Guinean-Congolese species (8%).

Multivariate analysis

The hierarchical classification " agglomerative Cluster Analysis " has grouped HG according to their floristic composition. Based on Ward's algorithm, the dendrogram constructed to classify these gardens based on their similarity makes clear, for R^2 = 42%, three groups (Figure 7). So the first category consists of 11 HG for 7 species and about an average area of 147 m² per household. These species have over 17 uses. This category primarily includes households that are most distant from the city of Cotonou. The second category is composed only of two HG J4, J8, which are respectively 6 and 7 species and an area of between 100 and 210 m² with 11-13 uses. The third cluster consists of 18 closest gardens in the city of Cotonou. They each have an average of 17 species, an area of 260 m²; these species occur in 25 uses. Finally, the 29 species of the HG of 2150 m² enter 32 different uses.

The correspondence analysis also allowed discriminating three groups of home gardens according to floristic composition (Figure 8). HG are negatively correlated with respect to the axis 1. This similarity is probably due to the fact that these gardens are manmade. Relative to the axis 2, we have two categories of home gardens. Some less diverse are negatively correlated and are located in the same area in Pahou, other positively correlated are located in the area between Cocodji and Pahou. Note that the HG 4, 8, 3, 12 and 22 are positively as well as negatively isolated with respect to this axis. It is noteworthy that the J4 and J8 home gardens have a certain similarity (Figure 5 and Figure 6).The similarity between the HG within a cluster suggests promiscuity among households in the suburban zone of Cotonou and therefore influences their floristic composition.

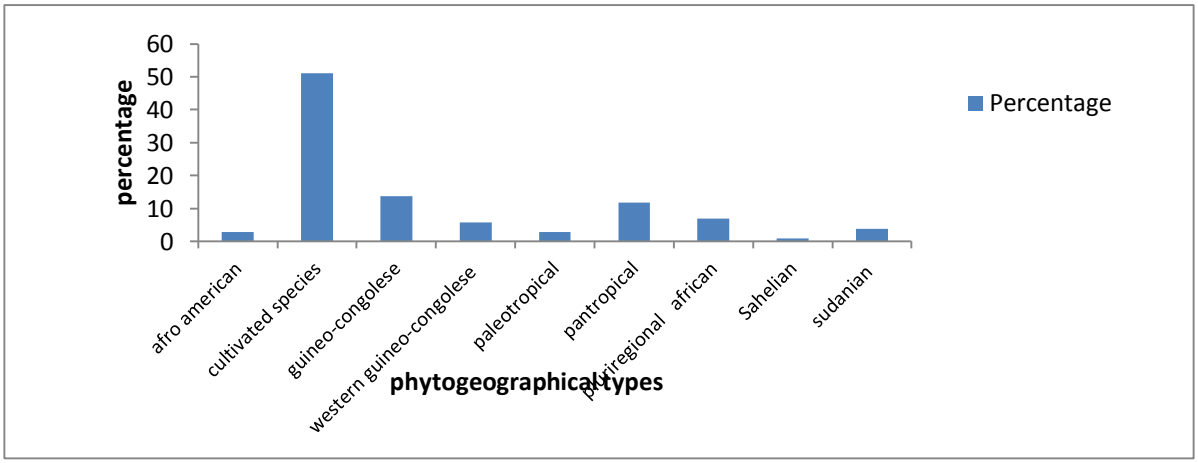

Fig. 6. Phytogeographical distribution of home gardens in suburban zone.

Calculation of indices of Jaccard and Shannon

Jaccard indices between the three classes are 7.77%, 21.65% and 12.90%.This confirms that the three categories of home garden are very distinct and that there is no similarity between home gardens.

As for Shannon indices are weak H 1 = 1.85, H2= 0.84 and H3 = 1.3 for the 3 classes. Ecologically, these areas are then generally undiversified and induce a strong specialization of species of these gardens.

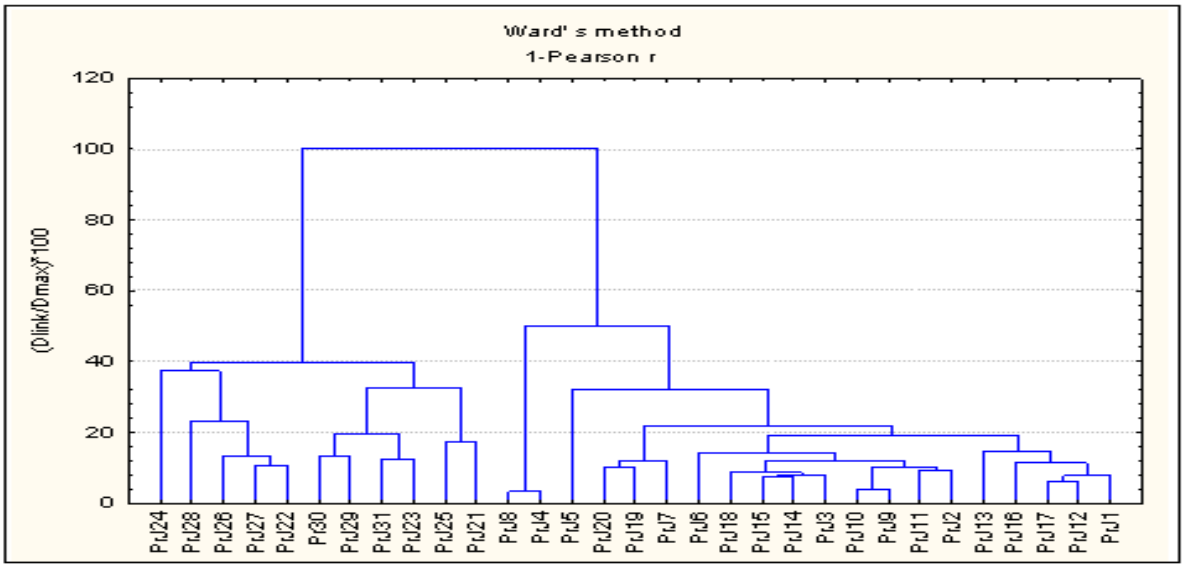

Fig. 7. Hierarchical classification of homegardens in suburban zone.

Discussion

Over the past two decades, numerous publications and the mobilization of various NGOs have contributed to a certain awareness of the need to preserve the environment in order to increase the chances of survival of the planet Earth. In this context, the protection of biodiversity appears to be a major concern, subject to large reforestation projects require huge financial resources. But without community involvement in the design and execution, the results of these projects are inconclusive. However, as shown in this study, technical and financial support from the practice of home gardens could make better use of human and financial resources invested in these projects. Indeed, the presence of 56 % of species contributing to the improvement of diet and 25% of medicinal species in the studied HG shows that over 80% of plants are devoted to satisfaction of basic needs.

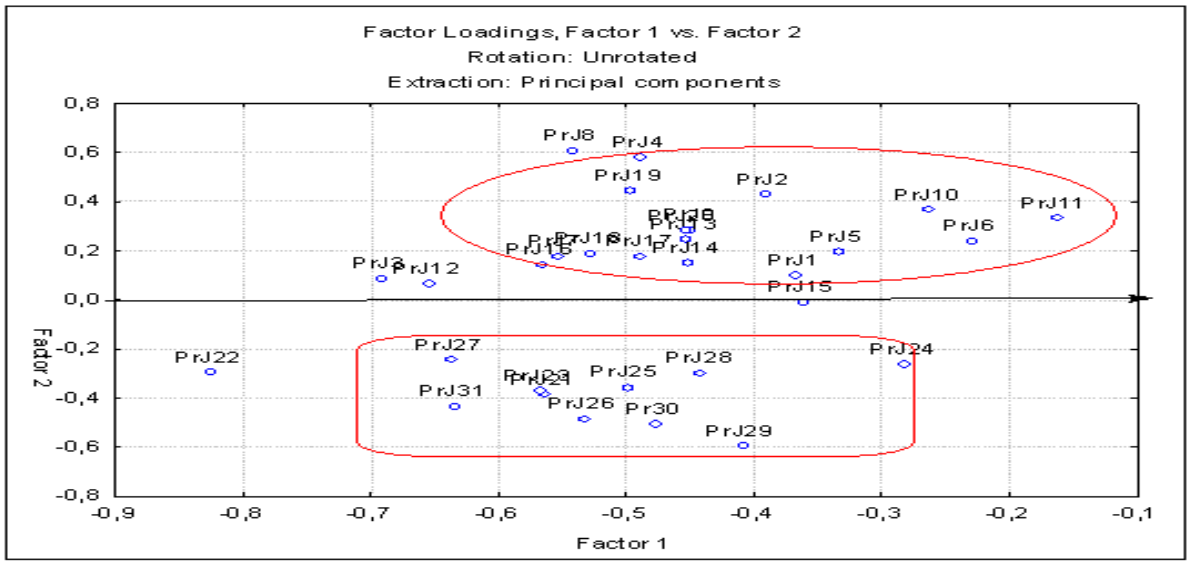

Fig. 8. Representation of homegardens on factorial plan in suburban zone.

This is confirmed by many authors where HG covers a significant proportion of domestic needs (Pulido and *al.,* 2008; Kala, 2010; Aworinder and Erinoso, 2013). The HG is both an effective conservation method of agricultural plant biodiversity and a diversified production system. Also some species of these agricultural systems, such as papaya (*Carica papaya*), oil palm (*Elaeis guineensis*) that play both food and medicinal functions predominate. The HG are both effective centers of conservation of agricultural biodiversity and vegetable storehouses of products necessary for the welfare of households. The 103 species inventoried in thirty gardens, with 17 species on average by HG confirm the floristic richness of this anthropogenic vegetation; each species with multiple functions, the HG constitutes a shrine of food and health security. Wezel and Bender (2003) also listed 103 species in 93 Cuban HG on having18 to 24 species on average per home garden.

Furthermore, the formations studied in Benin and Cuba also share about thirty species. This could be explained by the similarity of the climatic conditions of the two regions in the tropics. But it could also suggest a partial similarity of life styles between the inhabitants of these two regions of the world located on two continents, but that history unites in a certain way. However, the floristic composition of the HG on several factors like the size of gardens, land ownership, age of head of household, gender, arduous factor, (Perrault-Archambault and Coomes, 2008), this comparison approach is to be tempered. The results obtained in this study (Fig. 2) have shown that the average number of species per HG varies depending on the size of the HG. But although many authors confirm these results (Das and Das, 2005; Mayra *et al*., 2009; Zimik *et al*., 2012; Aworinde and Erinoso, 2013) observed that the size of HG and the number of species does not seem related.

Also the rich flora of the HG should to some extent reflect that of the supporting environment. Thus, in 17 home gardens surveyed in Brazil, 410 species have been recorded with the predominance of ornamental species followed by food and medicinal species (Mayra and *al.*, 2009). What is different the results of our study which, to deal with the high cost of living in suburban areas, most species are food and medicine. Life is more expensive in the area that the procurement of basic foodstuffs is so unevenly distributed that travel costs increases costs. The composition of home gardens therefore also depends on the needs of the owners (Mohan, 2004). The ecological analysis of the results shows a low floristic individualization of the element base Guineo-Congolese, these agricultural systems for the benefit of species wide geographical distribution, indicates a strong anthropogenic character. This beyond the soil and climatic conditions confirms the preponderance of human influence on the floristic composition of HG. If necessity of satisfaction of human needs is the primary cause of the existence of the HG, this factor could also be a threat to some species if the needs associated with them change. The bodies of the sampling method sometimes pose a threat to the conservation of biodiversity (Batawila, 2007).

Conclusion

The results have shown that home gardens of the study area are an important biodiversity reserve, reserve rationally used to meet at least partially the people's basic needs. However, this biodiversity reserve between Cotonou and Ouidah, two growing cities is highly threatened in the medium term by the current subdivision practices in Benin, the boundaries and dimensions of the plots of the most visited homes are subject to change. Indeed, for administrative slowness reasons, the official attribution of these areas sometimes occurs decades after the installation of populations. This official act is sanctioned by an area reduction of 20 to 50% at the expense of sites reserved for home gardens. These agricultural systems while relieving the population on the socio-economic plan allows them to preserve the environment are threatened.

It is urgent then that the different state structures, non-governmental organizations (NGOs) contribute to the design and promotion of subdivision systems favourable to the practice of home gardens in urban and suburban environments. Finally, the national agricultural research systems could inspire themselves from the floristic composition of home gardens to dedicate themselves to plant species whose promotion would be more advantageous to the everyday concerns of families.

Acknowledgment

The authors sincerely thank the foundation International Foundation for Sciences (IFS) to finance these research works and the Laboratory of Applied Ecology (LEA) in University of Abomey-Calavi (Benin) for its support.

References

Aworinde DO, Erinoso SM. 2013. Relationship between species composition and homegarden size in Odedalga of Ogun state Nigeria. Bayero Journal of Pure and Applied Sciences **6(2),** 10 -18.

Balooni K, Gangopadhyay KB, Mohan B. 2014. Governance for private green spaces in a growing Indian city. Landscape and Urban Planning **123,** 21-29.

Batawila K, Akpavi S, Wala K, Kanda MR. Vodouhe R, Akpagana K. 2007. Diversité et gestion des légumes de cueillette au Togo**.** African Journal of Food, Agriculture Nutrition and Development **7(3),** 21 pages.

Bernholt H, Kehlenbeck K, Gebauer J, Buerkert A. 2009. Plant species richness and diversity in urban and peri-urban gardens of Niamey, Niger. Agroforestery System **77,** 159-179.

Chandrashekara UM, Baiju EC. 2010. Changing pattern of species composition and species utilization in home gardens of Kerala, India. Tropical Ecology **51,** 221-233.

Coomes OT, Ban N. 2004. Cultivated plant species diversity in home gardens of an Amazonian Peasant Village in Northeastern Peru. Economic Botany **58,** 420-434.

Fernandez ECM, Nair PKR. 1986. An evaluation of the structure and function of tropical homegardens. Agroforest System **21,** 279-310.

Das T, Das AK. 2005. Inventorying plant biodiversity in home gardens: A case study in Barak Valley, Assam, North East India. Current science **89,** 155-163.

Eyzaguirre PB. 2003. Agrobiodiversity conservation and development in Vietnamese home gardens. Agriculture, Ecosystems & Environment **97,** 317-344.

FAO. 1998. The state of food and agriculture. Economic and social development Department.

Fernandes ECM, Nair PKR. 1986. An evaluation of the structure and function of tropical home gardens. Agricultural Systems **21,** 279-310.

Gaston KJ, Warren PH, Thompson K, Smith RM. 2005. Urban domestic gardens (IV): the extent of the resource and its associated features. Biodiversity and Conservation **14,** 3327–3349.

Kala CP. 2010. Home Gardens and Management of Key Species in the Pachmarhi Biosphere Reserve of India. Journal of Biodiversity **1,** 111-117.

Michon G. 1983. Village-forest-gardens in west Java. Proceedings of a consultative Meetings held in Nairobi, 8 to 15 April 1981. In: Plant research and agroforestry, Ed. P. Huxley. ICRAF Nairobi, 13-24 p.

Mohan S. 2004. An easement of the ecological and socioeconomic benefits provided by home gardens: a case study of Kerala, India. A dissertation presented to the graduate school of the University of Florida, 120 p.

Perrault-Archambault M, Coomes OT. 2008. Distribution of Agrobiodiversity in Home Gardens along the Corrientes River, Peruvian Amazon. Economic Botany 62,109–126.

Peyre A, Guidal A, Wiere F. 2006. Homegarden dynamics in Kerala India. In: Tropical homegardens. A time-tested example of sustainable agroforestry, Ed. Kumar BM, Nair PKR. Springer Science, Dordrecht, 87-103 p.

Pulido MT, Pagaza-CalderónEM, Martínez-Ballesté A, Maldonado-Almanza B, Saynes A, Pacheco RM. 2008. Home gardens as an alternative for sustainability: Challenges and perspectives in Latin America. Research Signpost 37/661 (2), Fort P.O., Trivandrum-695 023, Kerala, India Current Topics in Ethnobotany: Editors: Ulysses Paulino de Albuquerque and Marcelo Alves Ramos, 22 p.

Rao MR, Rajeswara Rao BR. 2006. Medicinal plants in Tropical Home gardens. In: Tropical homegardens: A time-tested example of sustainable agroforestry, Ed. Kumar BM, Nair P.K.R. Springer Science, Dordrecht, 205-232 p.

Rao MR, Palada, Becker BN. 2004. Medecinal and aromatic plants in agroforestry systems **61,** 107-122.

Wezel A, Bender S. 2003. Plants species diversity of homegardens of Cuba and its significance for household food supply. Agroforestery system **57,** 39-49.

Wezel A, Ohl J. 2005. Home garden plant diversity in relation to remoteness from Urban centers: a case study from the peruvian amazon region. In: Tropical home gardens : A time-tested example of sustainable agroforestry, Ed. Kumar B.M. and Nair P.K.R. Springer Science, Dordrecht, 143-158 p.

Wiersum KF. 2006. Diversity and change in home garden cultivation in Indonesia. In: Tropical homegardens: A time-tested example of sustainable agroforestry, Ed. Kumar B.M. and Nair P.K.R. Springer Science, Dordrecht, 13-24 p.

Zimik L, Saikia P, Khan ML 2012. Comparative Study on Home gardens of Assam and Arunachal Pradesh in Terms of Species Diversity and Plant Utilization Pattern. Research Journal of Agricultural Sciences **3,** 611-618.