Original Research Article

Usage and characterization of plant species in the composition of urban hedgerows in Brazil

.

ABSTRACT

The aim of the study was to conduct a qualitative and quantitative survey of hedgerows in a study area in the Imbiribeira neighborhood, Recife-PE, Brazil. After the delimitation of the study area, the number of properties with hedgerows was registered. The application of the questionnaire was directed to people residing, working or owning real estate that contained hedgerows with the following functions: embellishment, privacy, delimitation and coating. The number of blocks sampled, blocks with hedgerows, sampled hedgerows, hedgerows by block, properties with hedgerows, hedgerows by property and private companies and residences with hedgerows were noted. The interviewee was questioned about reasons for implantation and difficulties faced, the presence of animals, reasons for plant selection, the composition of plant species and phytosanitary conditions. In the study area 30 blocks were sampled, the presence of hedgerows was observed in 18 of them. Of these 18 blocks 73 hedgerows were surveyed, with an average of 2.43 hedgerows per block. The presence of hedgerows in 27 properties was verified. Landscape beautification is one of the main reasons for implantation and maintenance of the hedgerows. Of those interviewed, 30.77% stated that the work required for implantation and maintenance was a negative aspect of planting hedgerows. The presence of arthropods was verified in all studied hedgerows. General aesthetics was the reason the majority of interviewees chose their particular plant species. Seventeen plant species and 11 families were observed. The species *Ixora coccinea* L. var. *compacta* Hort. was the most commonly found species. Hedgerows for the purpose of embellishment represent 83.56% of the hedges found. The phytosanitary status and the presence of flaws in the hedgerows in the study area presented a certain relation. Although hedgerows are widely used in urban and rural areas, studies on their composition, structure, ecological importance and relevance to biodiversity conservation are scarce.

Keywords: Hedgerows, Urban forests, Landscaping, Phytosanitary, Ecological benefits.

1. INTRODUCTION

Most Brazilian people live in urban and semi-urban areas, where houses are surrounded by brick walls, iron grids, or electric fences with almost no free terrain. It is possible to take advantage of the structure and fences of the wall by transforming them into green fences (fences that are formed by plants). Increasing greenery improves well-being and makes the environment more natural and enjoyable.

The conversion of green area into a developed area is one of the major reasons for the destruction of natural habitats in urban cities around the world. There is no environment

more altered than the urban environment due to subsequent construction that paves over and dissects green spaces. Development limits access to green areas in the urban environment.

Urban forest corresponds to all vegetation covered public or a private space located in the urban perimeter. Urban trees and green spaces can be classified as urban forest [1]. Urban forests are important for human sustainability, not only in environmental, economic, and industrial terms, but also spiritually, historically, and aesthetically because of their direct and indirect provided benefits [2]. Urban forests provide biophysical, physical, psychic, ecological, political, and social-economic benefits. These benefits include adding aesthetic value and recreational opportunities that improve health and well-being and raises property values in the neighborhoods [3].

The plants that compose the urban forests not only embellish the landscape, but play an important role in reducing the environmental impact of urban settlements. Several ecological benefits can be obtained from urban forests, such as micro-climatic improvement, humidity, reduction of insulation, mitigation of atmospheric and acoustic pollution, and protection of soil and fauna [3].

The improvement of the climate is due to the provided shade and modification of the airflow by evapotranspiration. Shade reduces the amount of radiant energy absorbed, stored and radiated by concrete surfaces. Urban forests can also serve as a community attraction [4].

There are many reasons to plant hedgerows. How hedgerows are handled and the diversity and types of plant species present will result in hedgerows with different functions and can affect the diversity of fauna species that can be found in these hedgerows, as well as in their phytosanitary conditions.

Hedgerows constitute an important part of our landscape and can be an ideal border for gardens. They have many benefits: such as reducing noise; providing shelter, food supply and natural habitats for animals such as insects, birds and mammals; pest control because they provide habitat for natural predators; provide privacy; security, thorny species provide obstacles for anyone trying to overcome them, and they are visually attractive. Hedgerows also act as green corridors for the movement of insect populations and increase the connection between the different parts of the hedges [5,6]. Hedgerows provide a favourable environment for various birds for nesting, providing shelter against predators, and homes for insect food sources.

In some European countries, the implantation of hedgerows is widely used as a strategy for the conservation and preservation of wild animals, aiming to make anthropic environments more accessible to animals [6].

Hedgerows can play an important role in the moth diversity and conservation in productive areas, where their benefits are influenced by their number of individuals, richness of species and management [7].

Hedgerows with a rich diversity of species can reduce their susceptibility to pests and diseases. Plant diversity is one of the most important components of the urban ecosystem because it provides several ecological benefits and contributes directly to the quality of life and well-being of the population [8]. The diversity of species can contribute to the conservation of local biodiversity by preserving native species in urban environments and providing natural habitats for local animal species [9]. One way to achieve a greater diversity of invertebrates in hedgerows is to increase the floristic diversity, this increases potential

hosts for a variety of invertebrates. A rich diversity of trees and shrubs species may also provide a longer flowering period. This is particularly beneficial for animals that eat pollen and nectar and for the animals that use pollinators as a food source.

The types and functions of hedgerows can generally be determined according to the predominant plant species. The distribution of hedgerow types depends on a combination of environmental and cultural factors. In an urban environment, hedgerows have the primary function of embellishment, privacy, delimitation, and coating. Hedgerow species most commonly planted for embellishment often have ornate or uniquely aromatic flowers, beautiful aesthetics, or unique colouring.

Species that form a crown or a dense vegetative part can be characterized as delimitation or privacy hedgerows. Hedgerows used to delimitate areas usually have the purpose of providing privacy to one side of the hedgerow or both.

The delimitation function (green fence) can be both physical and symbolic. A physical barrier could completely prevent or make it difficult to overpass the hedgerow.

The symbolic limit or barrier, such as a row of small shrubs around a garden, may not exert any major impediment to overtake. A symbolic limit can serve primarily as a walking guide, encouraging people to stay in the pedestrian area. These types of hedgerows are generally small and have ornamental appearance.

The presence of climbing species generally indicates hedgerows of the coating type, since they alone would not exert the function of a hedge. Hedgerows consisting of climbing plant species always use underlying support to form the structure. Some of the advantages of the green-walls (hedgerows with coating species) are the thermal insulation and reduction of solar rays directly on the constructions providing a reduction of energy expenses for cooling of the environment, aside from psychological and aesthetic benefits [10].

The aim of this work was to conduct a qualitative and quantitative survey of urban hedgerows in a study area in the Imbiribeira neighborhood, located in the city of Recife-PE, Brazil. The study used a survey evaluating the properties containing hedgerows. The goal of the survey was to record the rationale for selecting the species, the relevance of the hedgerows to the local fauna, the plant species found and the group of species they belong, the types of hedgerows mentioned (Coating, Embellishment, Privacy and Delimitation) and the phytosanitary conditions of the hedgerows.

2. MATERIAL AND METHODS

2.1 Study area

The coast of Pernambuco is generally flat and low, in several places lower than sea level. It is considered a "green region" because of the variety of ecosystems, such as the Atlantic Rain Forest, Restingas, Estuaries with extensive Mangroves, Coral Reefs, Islands, and plains covered by coconut trees.

The city of Recife has an approximate area of 218,435 km² and a population of 1,537,704 inhabitants. The city represents about 7.2% of the metropolitan area and concentrates 42% of the inhabitants of the region. Its urban area extends throughout the municipal territory and its population grows beyond the limits of the municipality.

2.2 Sample area

This study was carried out in an area of Imbiribeira, Recife, PE, Brazil. The neighborhood of Imbiribeira has 0.14km² of a predominantly residential area, with commerce in its main streets. It presents a landscape characterized by the Atlantic Forest Biome, tropical climate, and average annual temperature of 21° C, with an average rainfall of 1400mm/year.

2.3 Survey

The survey was conducted in an area of 30 city blocks (37.024 hectares) consisting mostly of residential properties and a small park.

After the delimitation of the study area, the number of properties with hedgerows was registered. The application of the questionnaire was directed to people residing, working, or owning real estate that contained hedgerows with the following functions: embellishment, privacy, delimitation and coating.

The method for conducting the interview was based on qualitative and quantitative research with a semi-structured questionnaire, which combined open and closed questions, where the person inquired has the possibility to discuss the proposed topic.

2.4 Properties characterization

The number of blocks sampled, blocks with hedgerows, sampled hedgerows, hedgerows by block, properties with hedgerows, hedgerows by property and private companies and residences with hedgerows were noted.

2.5 Potentialities and limitations

In order to understand the reasons that led people to opt for a hedgerow instead of other types of fences or construction materials, the interviewees were asked the reasoning for hedgerow implantation on the property, and of any problems or difficulties encountered getting the plants established.

2.6 Local Fauna relevance

To assess the relevance of the hedgerows to the local fauna, the interviewees were asked which taxonomic groups (mammals, birds, amphibians, reptiles and arthropods) are frequently found in the hedgerows, regardless of the purpose (food, shelter, pollination, nesting, breeding, rest, etc.).

2.7 Plant species aspects

The plant species that compose the hedgerows were registered and the interviewees were asked the reasons why they chose the species to compose it.

The species that comprised the hedgerows were classified according to their origin in native and exotic. The species used were classified into groups of plant species: arboreal, shrub, herbaceous and climbing plants. From the survey of the species, the frequency of observation was observed.

2.8 Types of Hedgerows

The hedgerows were classified according to their function in four types: Coating, when it covered another type offence to give a more ecological connotation (grid, wall, etc.); Embellishment, species with showy flowers or with differentiated aesthetic aiming an ornamental and aesthetic beauty of the environment; Privacy, when it is intended to prevent the display of one or both sides of the hedgerow; Delimitation, when it has the function of guiding people's path, delimiting gardens, or of hindering or preventing the passage through them.

2.9 Phytosanitary conditions

A phytosanitary evaluation was performed by the analysis of the visual aspect of the hedge, classifying them in: healthy plants; and sick plants. The sick plants were classified according to their sickness level as low, medium and high.

Regarding the integrity, the hedgerows were classified as: with flaws, when the hedgerow presented discontinuities along its extension caused by flaws in its structure and; without flaws when the hedgerow had no discontinuities along its length.

3. RESULTS AND DISCUSSION

3.1 Properties characterization

In the study area of the neighborhood of Imbiribeira, 30 blocks were sampled, where the presence of hedgerows was observed in 18 of them (Table 1). In these, 73 hedgerows were surveyed with an average of 2.43 hedgerows per block. The presence of hedgerows was verified in 27 properties, with an average of 2.70 hedgerows per property, of which 18 (66.67 %) are residential and 9 (33.33 %) belong to private companies.

Although considering the low number of properties with hedgerows, the number of hedgerows surveyed in the area was above the expectations. Opening the possibility to consider that this system is valued in the area.

Table 1. Hedgerows found in the study area in the neighborhood of Imbiribeira, Recife, PE, Brazil

Analyzed variables	Data
Sampled blocks	30
Blocks with hedgerows	18
Blocks without hedgerows	12
Sampled hedgerows	73
Hedgerows by blocks	2.43
Properties with hedgerows	27
Hedgerows by property	2.7
Private companies with hedgerows	9
Residences with hedgerows	18

3.2 Potentialities and limitations

All the interviewees stated that landscape beauty is one of the main reasons for the implantation and maintenance of the hedgerows (Fig. 1).

Another reason for their implantation was the physical and mental well-being, indicated by 92.31 % of the interviewees of the study area. There is growing recognition access to green

areas has a beneficial effect on public well-being [11]. Several researches have provided scientific evidence showing the benefits urban green areas have on resident's health [12].

The climatic comfort generated due to the presence of the hedgerows was constantly mentioned by the interviewees as one of the main reasons, being indicated by 84.62 % of them.

The other reasons stated by the interviewees were the delimitation of passages or gardens (23.08 %), avoiding graffiti on walls (vandalism) (15.38 %) and to favour natural predators of urban pests such as lizards and spiders (15.38 %).

Hedgerows provide a number of benefits to the environment around them, but they can become an issue when not properly maintained and can present many problems.

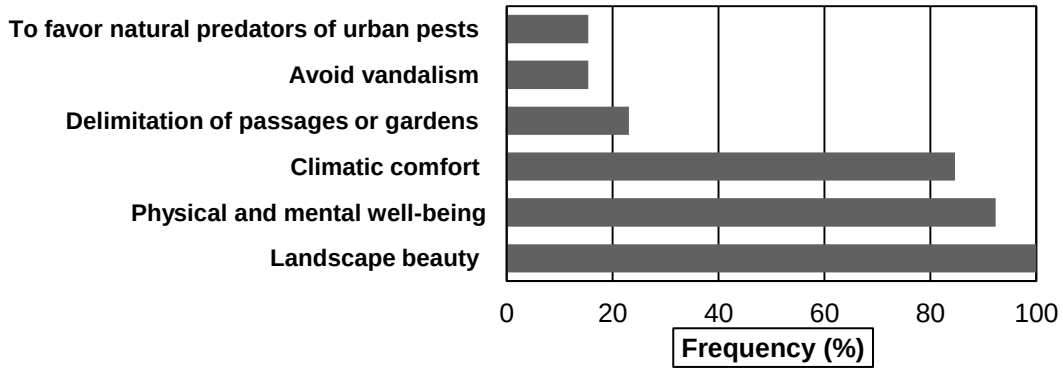

Fig. 1. Reasons for implantation and maintenance of hedgerows in urban areas

Although there are difficulties in the maintenance of hedgerows, these were not pointed out by the majority of the interviewees. Among the difficulties encountered in the use of hedgerows is the work required in implantation and maintenance, indicated by 30.77 % of the interviewees in the study area (Fig. 2). Another problem such as issues with encroachment on neighboring properties was reported by 23.08% of the interviewees. Also, high maintenance costs were pointed out by 15.38%. The environmental pest promotion, generation of pruning residues and necessity of defensive products to control phytosanitary problems were pointed equally by 7.69 % of them.

A small percentage of interviewees mentioned difficulties in maintaining their hedgerows. Of those who mentioned difficulties, none stated the challenges were enough to force them to remove their hedgerows.

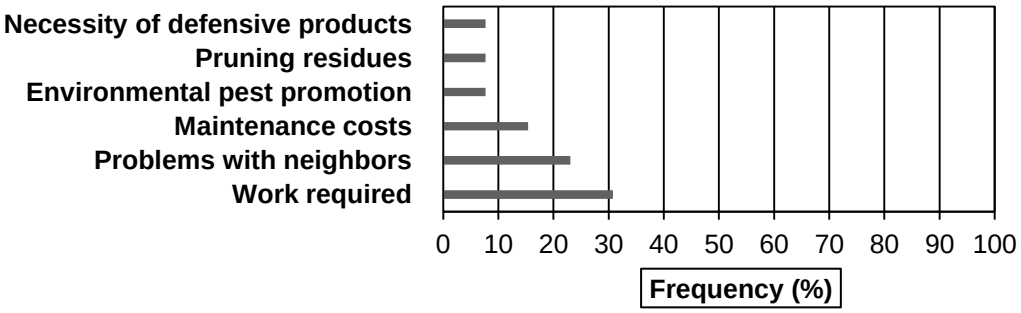

Fig. 2. Difficulties faced in the use of hedgerows in urban areas

3.3 Local Fauna relevance

As for the presence of fauna, it was verified the presence of arthropods in all studied hedgerows (Fig. 3). Insects such as ants, bees, ladybugs, butterflies, and moths were the most mentioned by the interviewees as being the main residents of their hedgerows. Spiders were also mentioned by all the interviewees in the study area.

The effects of time and frequency of pruning can determine the presence of populations of some arthropod species [13]. Some populations of insects can show a higher growth in hedgerows that are not pruned, while others can be more abundant in pruned hedgerows. Arthropod population can also be affected depending on the season pruning is performed. Due to this fact, the authors recommend that not all individual plants composing a hedgerow should be pruned at the same time.

A study about the importance of hedgerows, composed by different plant species, in the density and diversity of spiders showed that spiders can present preferences for specific plant species in different seasons, as well as a preference for hedgerows instead of another agroforestry system [14].

Most studies about the presence of invertebrate populations in hedgerows have focused on Coleoptera and Lepdoptera [15,16] and Lepdoptera [17]. However, studies on the presence of insect populations of various orders, such as Hymenoptera [15], Homoptera [15], Heteroptera [15,18,19] and Diptera [15] and arthropods such as molluscan [18] and spiders' species can also be observed [20]. Other studies have also reported the presence of amphibians such as frogs and salamanders, reptiles [21] and mammals such as bats and hedgehogs among others. Hedgerows with species that bloom all year round are potentially favourable to pollinating species such as bees.

The presence of birds was recorded by 88.24 % of the interviewees from the study area. Birds were the most mentioned by the interviewees. It was also mentioned the presence of nests in some hedgerows studied. Many birds make use of hedgerows by nesting in them, using them as a food source, and as a shelter. The usefulness of the hedgerow to the birds depends on the floristic composition. Homogeneous hedgerows have lower bird diversity than heterogeneous hedgerows because they present more diversity of flowers and fruits.

Reptiles were mentioned by 76.47 % of the interviewee. Lizards were the only kind of reptiles mentioned by the interviewees frequenting or residing in the hedgerows of the study area.

The mammals mentioned in the study area were mice and opossums which used the hedgerows for feeding and rest.

Amphibians and mollusks were both mentioned by only 18.18 % of the interviewees in the study area, and they were not considered as frequent fauna in their hedgerows.

A study carried out in Abreu e Lima/PE, Brazil, reported the importance of hedgerows for the local fauna. Several species of animals use the resources of hedgerows as a source of food (flowers and fruits). Among the animals found in the study are wild rabbits, sloths, agoutis, armadillos, capybaras, marmosets and anteaters [22].

The frequency and diversity of the animals found show that hedgerows help support local wildlife. Hedgerows are being used as a source of food, refuge, nesting, reproduction, and fallow creating important habitat for wildlife.

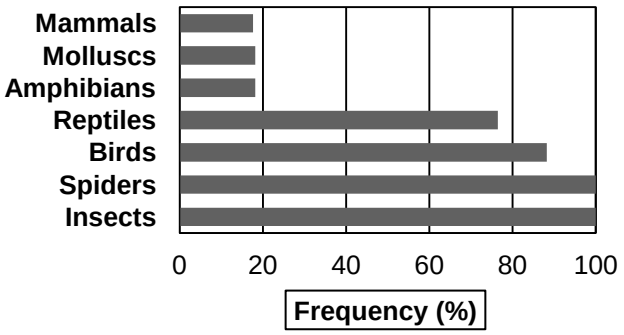

Fig. 3. **Main faunistic groups observed by the interviewees in the hedgerows in urban areas**

3.4 Plant species aspects

3.4.1 Species choices reasons

In the study area general aesthetics were pointed out by the majority of the interviewees as the main reason for choosing the plant species composing the hedgerows. 100% of arboreal and herbaceous types, 40% of shrubs, and 33.3% of climbing species were chosen for this reason (Fig. 4).

The aesthetic characteristics, pointed out by the majority of the interviewees as the main reason for choosing the plant species composing the hedgerows, can be analyzed from the particularities of the parts of a certain species (leaves, flowers, bark, trunk and fruits) and the species as a whole.

The interviewees who chose to plant hedgerows consisting of herbaceous varieties did so for general plant aesthetics. Those who chose hedgerows consisting of flowering varieties did so for the coloring of the flowers and contrast with the environment.

The presence of flowers was mentioned as one of the main reasons for the plant species selection. The shrubs were the most representative group, with 43.08 % of frequency. Climbing species had a low frequency of choice for this reason. This reason was not pointed out for choosing the arboreal species. This, due to the fact that the only species found

belonging to this group was *Ficus Benjamina*, which has no noticeable flowers and has no ornamental value.

The prior knowledge of the species was mentioned as the reason for choosing 100 % of the arboreal species. This option was almost equally pointed out by interviewees who had herbaceous and climbing species, with 50.00% and 41.67%, respectively. Due to the bigger variety of shrubs, this option was pointed out by only 32.31%. Interviewees who had hedgerows composed by the *Ixora* gender, *Duranta repens* var. *aurea* Hort. and climbing fig (*Ficus pumila* L.) were the ones who pointed out this reason the most.

Plant size was mentioned as the reason for choosing 100% or the arboreal species. Whilst, in hedgerows composed of climbing plants, the size was not considered by the interviewees due to their ability to adjust to the size of the support. The plant size refers to the height preference of desired by the owner, which may be high to prevent visibility of one or both sides of the hedge, or, low height to allow the visualization of one or both sides of the hedge.

The capacity to cover walls was mentioned as a reason for the selection of 88.33 % of the climbing plants, where, this characteristic is more present.

Other less mentioned reasons for choosing species, with lower frequency, were plants with pleasant aroma, in hedgerows with shrubs and climbing species, resilient plants, and hedgerows with shrubs.

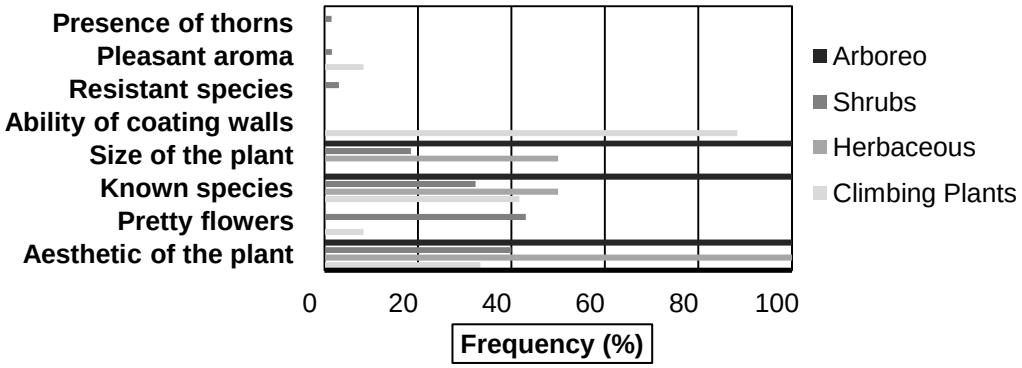

Fig. 4. Motifs of choice of plant species by group of plant species found composing hedgerows in urban areas

3.4.2 Plant species

Seventeen plant species and eleven families were observed. The species *Ixora coccinea* L. var. *compacta* Hort. was the most found species in the study area in the Imbiribeira neighborhood, representing a frequency of 48.78% of the found species (Tab. 2).

The *ixora* sp., the most found species in the study area, is a shrub species, dense, multi-branched evergreen, which height can reach more than 3m. It has attractive flowering, it is widely used in landscaping, especially in tropical gardens. There are different varieties with inflorescences in shades of red, orange, yellow and pink. It is widely cultivated for ornamental purposes.

The species *Ficus pumila* L. represented the second highest frequency of found species in the study area, with 14.62% of frequency. This species is one of the climbing species most used in landscaping. The climbing fig is a species of climbing plant with leaves in branches with adventitious roots that get attached to walls. The species has the ability to coat supports like walls, which makes it ideal for hiding construction defects or avoiding constant paintings. A study about green walls in residential real estate observed that most were composed by *Ficus pumila* [10].

The species *Duranta repens* var. *aurea* Hort. presented a frequency of 6.10% among found species in the study area. The species is also widely used in the formation of hedgerows in urban environments, as well as species of the genus *Ixora*. The *Duranta repens* species is a fast-growing shrub, which can reach a height up to 3 m. It is a popular ornamental plant used in hedges in tropical and subtropical parts of the world because of its showy flowers and fruits. Its dense lateral branches allow the formation of wide and dense hedges. Its young leaves have a golden-yellow color, which gives it good characteristics for its use as an ornamental plant.

Other species were also found with smaller frequencies: *Sansevieira trifasciata* var. *laurentii* (De Wild.), *Cantharantus roseus* (L.) G. Don, *Tabernaemontana laeta* Mart. With a 2.44% frequency and *Euphorbia milii* var. *splendens* Des Moulins, *Ficus benjamina* L., *Jasminum officinale* L., *Podocarpus macrophyllus* (Thunb.) Sweet, *Heliconia bihai* L., *Polyscias guilfoylei* Bailey, *Jasminum sambac* (L.) Aiton and *Plumbago auriculata* Lam. with a 1.22% frequency.

A study of the potential of shrub species selected some species with ornamental potential in the Brazilian semi-arid region, among them *Rosa sinensis* L., *Ixora coccinea, Ixora chinensis*, *Tabernaemontana la*eta and *Duranta repens* [23].

The two families with the highest numbers of individuals found in the study area was Rubiaceae, representing 62.20% of the species, all belonging to the *Ixora* genus, and Moraceae with 15.84%.

The Rubiaceae family was also the one with the highest number of species, represented by four species, followed by the Moraceae, Apocynaceae and Oleaceae families, being all represented by two species. The two species of the Moraceae family were represented by the *Ficus* genus and the Oleaceae family was represented by two species of the *Jasminum* genus.

An interesting aspect is a relationship between native and exotic species. The frequency of exotic species found in the study area corresponded to 90.24% (represented by 14 species), while only 9.76% (represented by 3 species) were native to the area. More than 80% of plant species in Brazilian cities are exotic flora. This is due to the lack of knowledge of native species and the colonial origin of Brazil which introduced several species from other countries to plant our streets and squares since the beginning of colonization. This predominance of exotic origin species over species of native origin was also reported in a study about ornamental species in the Brazilian semi-arid region [23]. The preference for exotic species in the urban forest composition, both due to rapid growth and aesthetic reasons, is one of the main consequences of urbanization and may increase biotic homogenization in urban cities.

Table 2. Species that compose hedgerows in the study area in the neighborhood of Imbiribeira, Recife, PE, Brazil

Scientific Name	Family	Origin	Group of	F (%)

			Species	
Ixora coccínea L. var. *compacta* Hort.	Rubiaceae	Exotic	Shrubs	48.78
Ficus pumila L.	Moraceae	Exotic	Climbing Plant	14.62
Ixora coccinea var. *lutea* (Hutch.) Corner	Rubiaceae	Exotic	Shrubs	10.98
Duranta repens var. *aurea* Hort.	Verbenaceae	Native	Shrubs	6.10
Sansevieria trifasciata var. *laurentii* (De Wild.)	Asparagaceae	Exotic	Herbaceous	2.44
Cantharantus roseus (L.) G. Don	Apocynaceae	Exotic	Shrubs	2.44
Tabernaemontana laeta Mart.	Apocynaceae	Native	Shrubs	2.44
Euphorbia milii var. *splendens* Des Moulins	Euphorbiaceae	Exotic	Shrubs	1.22
Ficus benjamina L.	Moraceae	Exotic	Arboreal	1.22
Jasminum officinale L.	Oleaceae	Exotic	Climbing Plant	1.22
Podocarpus macrophyllus (Thunb.) Sweet	Podocarpaceae	Exotic	Shrubs	1.22
Heliconia bihai L.	Heliconiaceae	Native	Shrubs	1.22
Polyscias guilfoylei L. H. Bailey	Araliaceae	Exotic	Shrubs	1.22
Ixora macrothyrsa Teijsm. & Binn.	Rubiaceae	Exotic	Shrubs	1.22
Ixora chinensis Lam.	Rubiaceae	Exotic	Shrubs	1.22
Jasminum sambac (L.) Aiton	Oleaceae	Exotic	Shrubs	1.22
Plumbago auriculata Lam.	Plumbaginaceae	Exotic	Shrubs	1.22

3.5 Types of Hedgerows

Hedgerows of embellishment were the most found, representing 83.56% of the hedges of the study area (Fig. 5). Delimitation hedgerows were the second most found, representing 54.79% of them. Coating and privacy hedgerows were found in 23.29% and 9.59% respectively of the cases in the Imbiribeira neighborhood.

Coating hedgerows composed of both shrub and tree species consist of the implantation of hedgerows near walls and grates, also known as green walls, with the function of covering these materials even if these plants do not use them as support. This implantation is mainly done to beautify the environment and hide construction defects.

It can be inferred that many of the hedgerows in urban areas can represent more than one type or function, and that embellishment is their primary purpose.

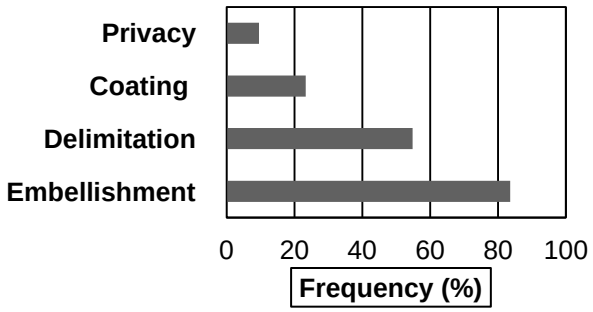

Fig. 5. Frequency of the different types of hedgerows in urban areas

The shrub species represented a higher frequency in the composition of hedgerows, with a frequency of 80.49% (Fig. 6). These species were the only ones composing all types of hedges in the study area of the neighborhood of Imbiribeira.

The peculiar shape of shrubs, with their different branches appearing at the ground, allows the formation of vegetation groups where the plants lose their individuality, forming associations, which can be very useful in the formation of hedgerows. This group of plants has great plasticity with regard to different colors, shapes, and volumes, some resembling small trees.

Climbing plants represented 15.89% of the hedgerows, followed by herbaceous and tree species, with 2.44% and 1.22%, respectively. The tree species presented a lower frequency among the vegetation groups in the study area of the Imbiribeira neighborhood. In all cases of tree species hedgerows, the same purpose was found, which is to embellish, delimit, and generate privacy to one or both sides of the hedgerow.

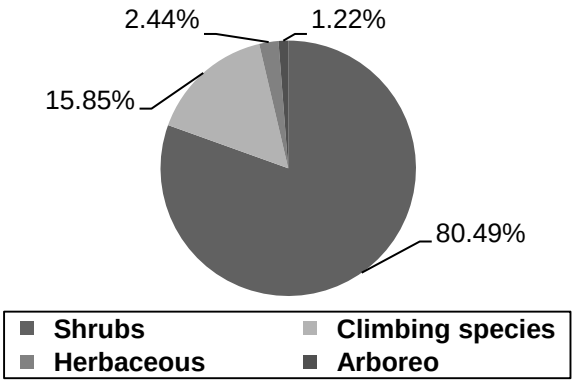

Fig. 6. Frequency of the groups of plants composing hedgerows in urban areas

The hedgerows with the privacy function had more representatives from the shrubs group, with a 75% frequency (Fig.7) and equal representatives from the arboreal and climbing species.

Coating hedgerows were most represented by the climbing species, as expected. Shrubs were also found to share this kind of function.

Hedgerows with delimitation function were mostly composed by shrubs, with a frequency of 92.50%. Another group found with this function, but with a lower frequency, was the herbaceous and arboreal. This is probably because the shrub plants can grow wider and denser hedgerows than herbaceous ones, making the ultrapassation harder to happen. Hedgerows composed by arboreal species can grow wider than the desired size.

Embellishment hedgerows were represented mostly by shrub species, with a 78.69% frequency, followed by climbing species (16.39%), herbaceous (3.28%), and arboreal (1.64%).

In general, the preference for shrub plants in most of the types of hedgerows, could be observed.

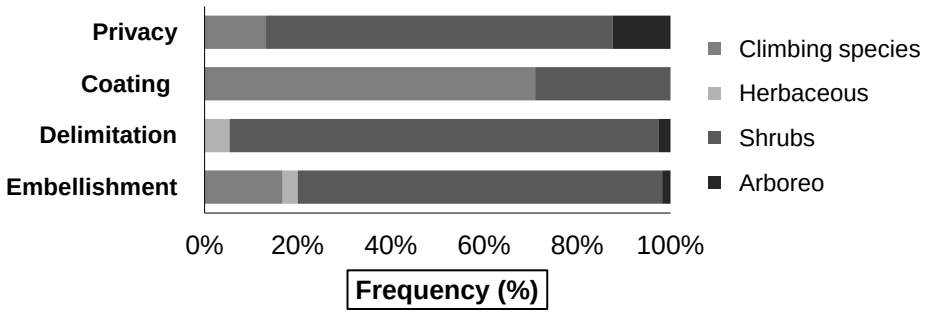

Fig. 7. Representation of each group of plants within the different types of hedgerows in urban areas

Analyzing the relationship between the plant groups and the hedgerow types, it was possible to observe that the climbing species, in their totality, had the coating function (Fig. 8). Most of the interviewees also pointed out the use of this group to beautify the environment (83.33%) and a few to provide privacy (8.33%). Due to the necessity of support, this group was not found for delimitation purposes.

Hedgerows composed of herbaceous species were used to equally delimit and beautify the environment in all cases of the study area. This group was not found coating or exercising the privacy function.

Most of the shrubs were found exercising the embellishment function, with a 73.85% frequency, flowed by the delimitation function (56.92%). This, due to the wide diversity of flowers and shapes of this group and its capacity to grow wider hedgerows. The functions less mentioned by the interviewee were privacy and coating, with 9.23% and 7.69%, respectively.

Arboreal species were equally mentioned exercising the embellishment, delimitation and privacy functions.

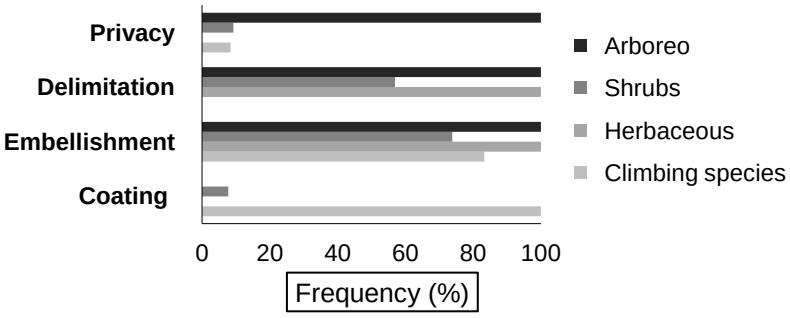

Fig. 8. Frequency of the plant groups that composed the different types of hedgerows in urban areas

3.6 Phytosanitary conditions

The phytosanitary status and the presence of flaws in the hedgerows of the study area presented a certain relation. According to the data, the presence of flaws intensified as the phytosanitary quality of hedgerows decreased. Only 15.38% of the hedgerows considered healthy presented flaws in their structure (Fig. 9). While, flaws were found in 100% of hedgerows with low phytosanitary quality (SH).

The uniformity of the plants composing the hedgerow is of great importance. Since a single dead plant or a plant with flaws in its structure can impair the hedgerows objective such as privacy (making it possible the visualization of one or both sides of the hedgerow) or security (making it possible to someone overpass the hedgerow that was meant for protection) or take away from the visual beauty.

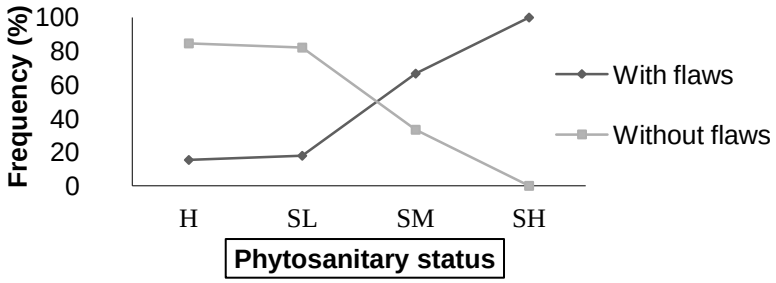

Fig. 9. Relation between phytosanitary status and the integrity of hedgerows urban areas. Where: H corresponds to healthy plants; SL corresponds to sick plants of low intensity; SM, sick plants of medium intensity; and SH, sick plants with high intensity

4. CONCLUSION

A considerable amount of relatively well conserved hedgerows of varying sizes could be witnessed. Landscape beauty is the main reason considered for the implantation and the conduction of hedgerows. Although there are difficulties in the management of hedgerows, most of the interviewees do not consider maintenance enough of a problem for them to consider taking out the plants. According to the majority of the interviewees general aesthetics of the species and the presence of flowers were the main reasons for choosing the species of hedgerows. The most found species comprising hedgerows in the present study were the *Ixora coccinea* L. var. *compact* Hort., *Ficus pumila* L., *Ixora coccinea* var. *lutea* (Hutch.) Corner and *Duranta repens* var. *aurea* Hort. The variety of shapes, flowers, and colors of shrub species and their ability to form beautiful hedgerows can be considered the main reasons why they are used in the composition of hedgerows. Uniformity of the plants composing the hedgerow is of great importance, since a flaw in a single plant can impair the objective and the visual aspect of the hedgerow. Although hedgerows are widely used in urban and rural areas, studies on their composition, structure, ecological importance and relevance to biodiversity conservation are scarce.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Biondi D. Floresta urbana: conceitos e terminologias. Curitiba:2015.
2. Seth MK. 2004. Trees and their economic importance. Bot Rev. 2004;69(4):321-376.
3. Biondi D, Althaus M. Árvores de rua Curitiba: cultivo e manejo. Curitiba: FUPEF; 2005.
4. McPherson EG, Simpson GR. A comparison of municipal forest benefits and costs in Modesto and Santa Monica. Urban For Urban Gree. 2002;1:61-74.
5. Burel F. 1996. Hedgerows and their role in agricultural landscapes. Cr Rev Plant Sci. 1996;15:169-190.
6. Baudry J, Bunce RGH, Burel F. Hedgerows: An international perspective on their origin, function and management. J Environ Manage. 2000;60:7-22.
7. Tobar LDE, Ibrahim M. ¿Las cercas vivas ayudan a la conservación de la diversidad de mariposas en paisajes agropecuarios? Rev Biol Trop. 2010;58(1):447-463. Spanish.
8. Scopelliti M, Carrus G, Adinolfi C, Suarez G, Colangelo G, Lafortezza R, et al. Staying in touch with nature and well-being in different income groups: the experience of urban parks in Bogotá**.** Landscape Urban Plan. 2016;148:139-148.
9. Ikin K, Le Roux DS, Rayner L, Villaseñor NR, Eyles K, Gibbons P, et al. Key lessons for achieving biodiversity-sensitive cities and towns. Ecol Manag Restor. 2015;16:206-214.
10. Valesan M, Fedrizzi B, Sattler MA. Vantagens e desvantagens da utilização de peles-verdes em edificações residenciais em Porto Alegre segundo seus moradores. Ambiente Construído. 2010;10(3):55-67. Portuguese.
11. Lafortezza R, Davies C, Sanesi G, Konijnendijk CC. Green Infrastructure as a tool to support spatial planning in European urban regions. iForest. 2013;6:102-108.
12. Song C, Ikei H, Kokayashi M, Miura T, Li Q, Kagawa T, et al. Effects of viewing forest landscape on middle-aged hypertensive men. Urban For Urban Gree. 2017;21:247-252.
13. Marshall EJP, Maudsley MJ, West TM, Rowcliffe HR. Effects of management on the biodiversity of English hedgerows. In: Barr CJ, Petit, editors. Hedgerows of the World: Their Ecological Functions in Different Landscapes. Iale: International Association of Landscape Ecology; 2001.
14. Wu Y, Cai Q, Lin C, Chen Y, Li Y, Cheng X. Responses of ground-dwelling spiders to four hedgerow species on sloped agricultural fields in Southwest China. Prog Nat Sci. 2009;19(3):337-346.
15. Joyce KA, Jepson PC, Doncaster CP, Holland JM. Arthropod distribution patterns and dispersal processes within the hedgerow. In: Cooper A, Power J, editors. Species Dispersal and Land Use Processes. Coleraine: International Association for Landscape Ecology; 1997.
16. Alvarez T, Frampton GK, Goulson D. The role of hedgerows in the recolonisation of arable fields by epigeal Collembola. Pedobiologia. 2000;44(3-4):516-526.
17. Ouin A, Burel F. Influence of herbaceous elements on butterfly diversity in hedgerow agricultural landscapes. Agr Ecosyst Environ. 2002;93:45-53.
18. Maudsley MJ. 2000. A review of the ecology and conservation of hedgerow invertebrates in Britain. J Environ Manage. 2000;60:65-76.
19. Moreby SJ, Southway S. The importance of hedgerow field boundaries to densities of beneficial invertebrates in cereals. In: Barr C, Petit S, editors. Hedgerows of the World: Their ecological functions in different landscapes. Iale: International Association of Landscape Ecology; 2001.
20. Maudsley MJ, Seeley B, Lewis O. Spatial distribution patterns of predatory arthropods within an English hedgerow in early winter in relation to habitat variables. Agr Ecosyst Environ. 2002;89:77-89.
21. Reading CJ, Jofré GM. Habitat selection and range size of grass snakes Natrix natrix in an agricultural landscape in southern England. Amphibia-Reptilia. 2009;30:379-388.

626 22. Lima MSC. Potencial de Uso das Espécies que Compõem Cercas Vivas na Comunidade
627 Rural de Pitanga, Município de Abreu e Lima, Pernambuco. Mestrado em Biologia Vegetal
628 Departamento de Biologia. Recife: Universidade Federal de Pernambuco; 2008.
629 23. Menezes HEA. Seleção de espécies arbustivas potenciais para o paisagismo no semi-
630 árido brasileiro. Monografia, Centro de Saúde e Tecnologia Rural. Patos: Universidade
631 Federal de Campina Grande; 2009.
632