Use and <mark>characterization</mark> of plant species in the composition of urban hedgerows

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, presence of animals, reasons of plant selection, 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. <mark>*compacta*</mark> 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.

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 walls structure and fences 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.

25 The conversion of green area into developed area is one of the major reasons for
26 destruction of natural habitats in urban cities around the world. There is no environment
27 more altered than the urban environment due to subsequent construction that paves over
28 and dissects green spaces. Development limits access to green areas in the urban
29 environment.
30
31 Urban forest corresponds to all vegetation covered public or a private space located in the
32 urban perimeter. Urban trees and green spaces can be classified as urban forest [1]. Urban
33 forests are important for human sustainability, not only in environmental, economic, and
34 industrial terms, but also spiritually, historically, and aesthetically because of their direct and
35 indirect provided benefits [2]. Urban forests provide biophysical, physical, psychic,
36 ecological, political, and social-economic benefits. These benefits include adding aesthetic
37 value and recreational opportunities that improve health and well-being and raises property
38 values in the neighborhoods [3].
39
40 The plants that compose the urban forests not only embellish the landscape, but play an
41 important role in reducing the environmental impact of urban settlements. Several ecological
42 benefits can be obtained from urban forests, such as micro-climatic improvement, humidity,
43 reduction of insulation, mitigation of atmospheric and acoustic pollution, and protection of
44 soil and fauna [3]. The improvement of the climate is due to the provided shade and
45 modification of the airflow by evapotranspiration. Shade reduces the amount of radiant
46 energy absorbed, stored and radiated by concrete surfaces. Urban forests can also serve as
47 a community attraction [4]. There are many reasons to plant hedgerows. How hedgerows
48 are handled and the diversity and types of plant species present will result in hedgerows with
49 different functions and can affect the diversity of fauna species that can be found in these
50 hedgerows, as well as in their phytosanitary conditions.
51
52 Hedgerows constitute an important part of our landscape, and can be an ideal border for
53 gardens. They have many benefits: such as reducing noise; providing shelter, food supply
54 and natural habitats for animals such as insects, birds and mammals; pest control because
55 they provide habitat for natural predators; provide privacy; security, thorny species provide
56 obstacles for anyone trying to overcome them, and they are visually attractive. Hedgerows
57 also act as green corridors for the movement of insect populations and increase the
58 connection between the different parts of the hedges [5,6]. Hedgerows provide a favorable
59 environment for various birds for nesting, providing shelter against predators, and homes for
60 insect food sources.In some European countries, the implantation of hedgerows is widely
61 used as a strategy for the conservation and preservation of wild animals, aiming to make
62 anthropic environments more accessible to animals [6].
63
64 Hedgerows can play an important role in the moth diversity and conservation in productive
65 areas, where their benefits are influenced by their number of individuals, richness of species
66 and management [7]. Hedgerows with a rich diversity of species can reduce their
67 susceptibility to pests and diseases. Plant diversity is one of the most important components
68 of the urban ecosystem because it provides several ecological benefits and contributes
69 directly to the quality of life and well-being of the population [8]. The diversity of species can
70 contribute to the conservation of local biodiversity by preserving native species in urban
71 environments and providing natural habitats for local animal species [9]. One way to achieve
72 a greater diversity of invertebrates in hedgerows is to increase the floristic diversity, this
73 increases potential hosts for a variety of invertebrates. A rich diversity of trees and shrubs
74 species may also provide a longer flowering period. This is particularly beneficial for animals
75 that eat pollen and nectar and for the animals that use pollinators as a food source.
76

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 coloring. 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 an 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 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 the 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 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 of fence 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).
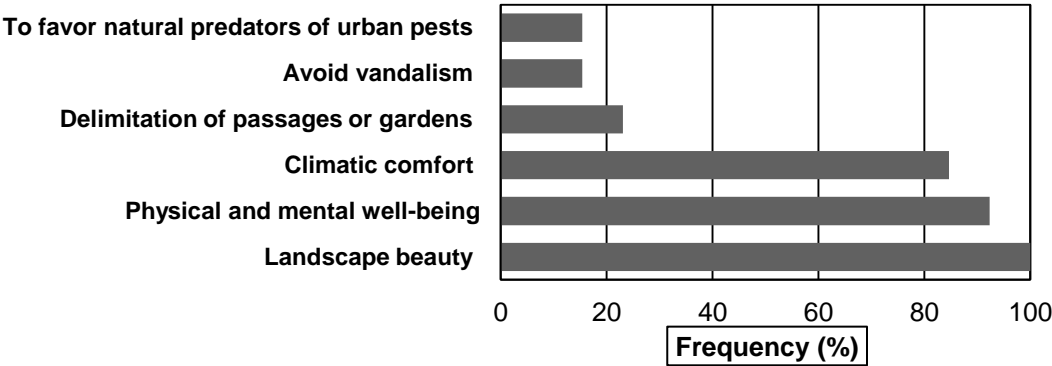
Another reason for their implantation was the physical and mental well-being, indicated by 92.31 % of the interviewees of the study area. There is growing recognition access to green areas has a beneficial effect on public well-being [11]. Several researches have provided scientific evidence showing 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.

224 The other reasons stated by the interviewees were the delimitation of passages or gardens
225 (23.08 %), avoiding graffiti on walls (vandalism) (15.38 %) and to favor natural predators of
226 urban pests such as lizards and spiders (15.38 %).
227
228 Hedgerows provide a number of benefits to the environment around them, but they can
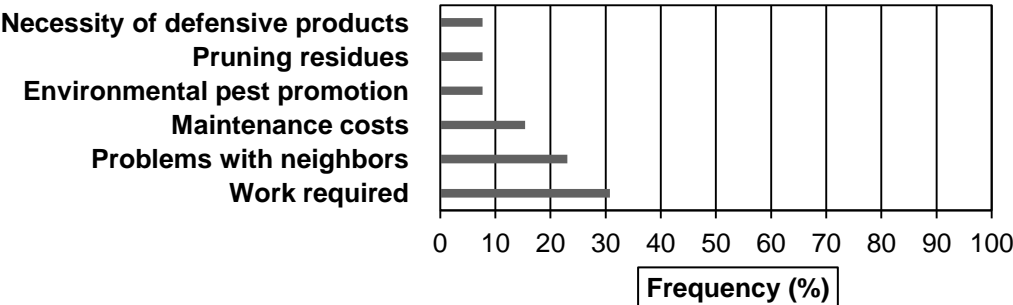229 become an issue when not properly maintained and can present many problems.
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231

232
233
234 **Fig. 1. Reasons for implantation and maintenance of hedgerows in urban areas**
235
236 Although there are difficulties in the maintenance of hedgerows, these were not pointed out
237 by the majority of the interviewees. Among the difficulties encountered in the use of
238 hedgerows is the work required in implantation and maintenance, indicated by 30.77 % of
239 the interviewees in the study area (Fig. 2). Other problem such as issues with encroachment
240 on neighboring properties was reported by 23.08% of the interviewees. Also, high
241 maintenance costs were pointed out by 15.38%. The environmental pest promotion,
242 generation of pruning residues and necessity of defensive products to control phytosanitary
243 problems were pointed equally by 7.69 % of them.
244
245 A small percentage of interviewees mentioned difficulties maintaining their hedgerows. Of
246 those who mentioned difficulties none stated the challenges were enough to force them to
247 remove their hedgerows.
248
249

250
251
252 **Fig. 2. Difficulties faced in the use of hedgerows in urban areas**
253
254 **3.3 Local Fauna relevance**

255

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

260

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

267

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

272

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

281

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

288

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

292

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

295

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

298

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

303

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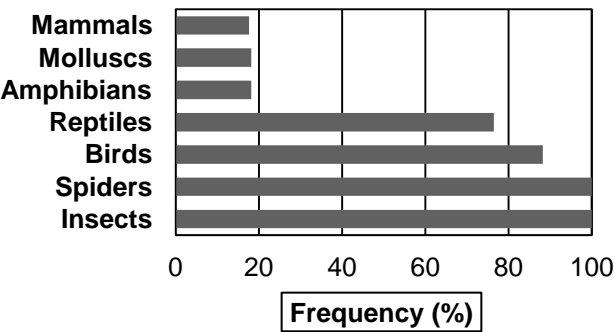306 fallow creating an important habitat for wildlife.

307

308

309
310
311 **Fig. 3**. **Main faunistic groups observed by the interviewees in the hedgerows in urban**
312 **areas**

313
314 **3.4 Plant species aspects**

315
316 **3.4.1 Species choices reasons**

317
318 In the study area general aesthetics were pointed out by the majority of the interviewees as
319 the main reason for choosing the plant species composing hedgerows. 100% of arboreal
320 and herbaceous types, 40% of shrubs, and 33.3% of climbing species were chosen for this
321 reason (Fig. 4).

322
323 The aesthetic characteristics, pointed out by the majority of the interviewees as the main
324 reason for choosing the plant species composing the hedgerows, can be analyzed from the
325 particularities of the parts of a certain species (leaves, flowers, bark, trunk and fruits) and the
326 species as a whole.

327
328 The interviewees who chose to plant hedgerows consisting of herbaceous varieties, did so
329 for general plant aesthetics. Those who chose hedgerows consisting of flowering varieties
330 did so for the coloring of the flowers and contrast with the environment.

331
332 The presence of flowers was mentioned as one of the main reasons for the plant species
333 selection. The shrubs were the most representative group, with 43.08 % of frequency.
334 Climbing species had a low frequency of choice for this reason. This reason was not pointed
335 out for choosing the arboreal species. This, due to the fact that the only species found
336 belonging to this group was *Ficus Benjamina*, which has no noticeable flowers and has no
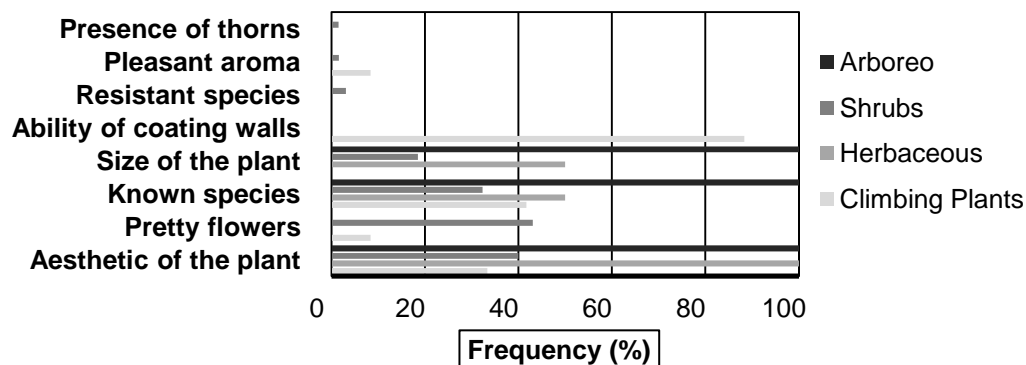337 ornamental value.

338
339 The prior knowledge of the species was mentioned as the reason for choosing 100 % of the
340 arboreal species. This option was almost equally pointed out by interviewees who had
341 herbaceous and climbing species, with 50.00% and 41.67%, respectively. Due to the bigger
342 variety of shrubs, this option was pointed out by only 32.31%. Interviewees who had
343 hedgerows composed by the *Ixora* gender, *Duranta* *repens* var. *aurea* Hort. and climbing fig
344 (*Ficus pumila* L.) were the ones who pointed out this reason the most.

345
346 Plant size was mentioned as the reason for choosing 100% or the arboreal species. Whilst,
347 in hedgerows composed of climbing plants, the size was not considered by the interviewees
348 due to their ability to adjust to the size of the support. The plant size refers to the height
349 preference of desired by the owner, which may be high to prevent visibility of one or both
350 sides of the hedge, or, low height to allow the visualization of one or both sides of the hedge.

351
352 The capacity to cover walls was mentioned as a reason for the selection 88.33 % of the
353 climbing plants, where, this characteristic is more present.
354
355 Other less mentioned reasons for choosing species, with lower frequency, were plants with
356 pleasant aroma, in hedgerows with shrubs and climbing species, resilient plants, and
357 hedgerows with shrubs.
358
359

360
361
**Fig. 4. Motifs of choice of plant species by group of plant species found composing
hedgerows in urban areas**

364
3.4.2 Plant species
366
367 Seventeen plant species and eleven families were observed. The species *Ixora coccinea* L.
368 var. c*ompacta* Hort. was the most found species in the study area in the Imbiribeira
369 neighborhood, representing a frequency of 48.78% of the found species (Tab. 2).
370
371 The Ixora, the most found species in the study area, is a shrub species, dense, multi –
372 branched evergreen, which height can reach more than 3m. It has attractive flowering, it is
373 widely used in landscaping, especially in tropical gardens. There are different varieties with
374 inflorescences in shades of red, orange, yellow and pink. It is widely cultivated for
375 ornamental purposes.
376
377 The species *Ficus pumila* L. represented the second highest frequency of found species in
378 the study area, with 14.62% of frequency. This species is one of the climbing species most
379 used in landscaping. The climbing fig is a species of climbing plant with leaves in branches
380 with adventitious roots that get attached to walls. The species has the ability to coat supports
381 like walls, which makes it ideal for hiding construction defects or avoiding constant paintings.
382 A study about green walls in residential real estate observed that most were composed by
383 *Ficus pumila* [10].
384
385 The species *Duranta repens* var. aurea Hort. presented a frequency of 6.10% among found
386 species in the study area. The species is also widely used in the formation of hedgerows in
387 urban environments, as well as species of the genus *Ixora*. The *Duranta repens* species is a
388 fast growing shrub, which can reach a height up to 3 m. It is a popular ornamental plant used
389 in hedges in tropical and subtropical parts of the world because of its showy flowers and
390 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 chinensi*s, *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 the 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 Species	F (%)
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.
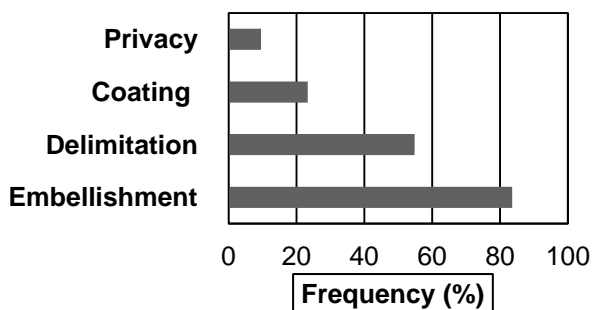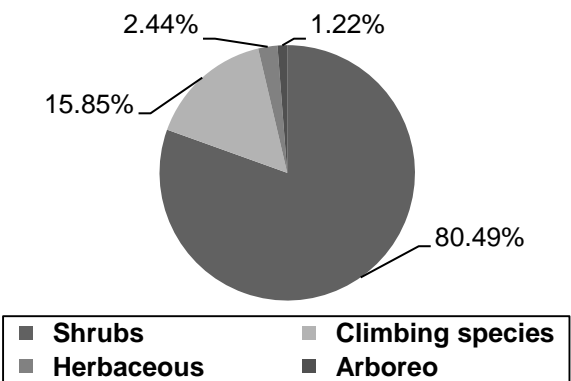

Fig. 5. Frequency of the different types of hedgerows in urban areas

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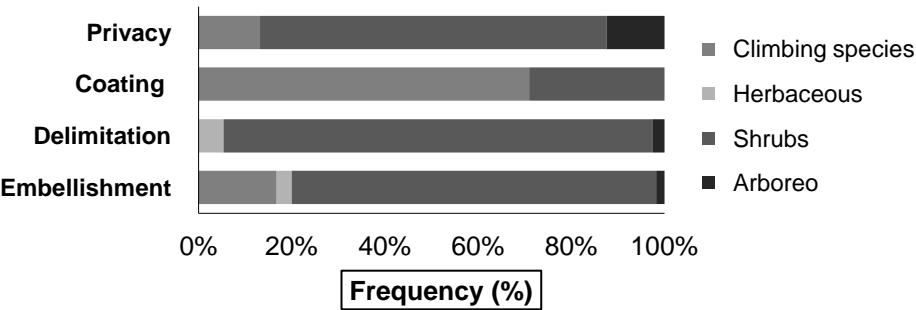
The hedgerows with the privacy function had more representatives from the shrubs group, with a 75% frequency (Fig.7) and equal representatives from the arboreal and climbing species.

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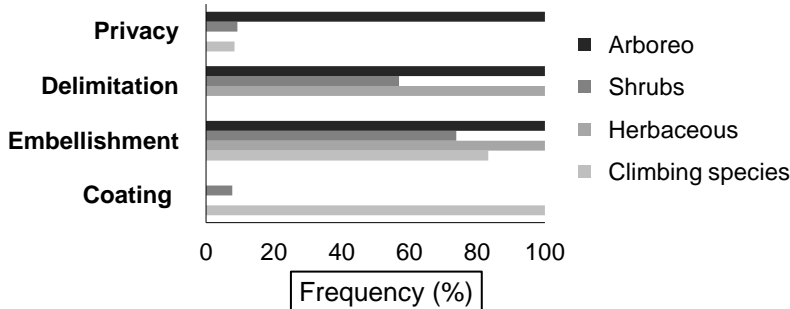
Hedgerows composed of herbaceous species were used to equally delimit and beautify the environment in all cases of the study area. This group was not found coating or exercising the privacy function.

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.

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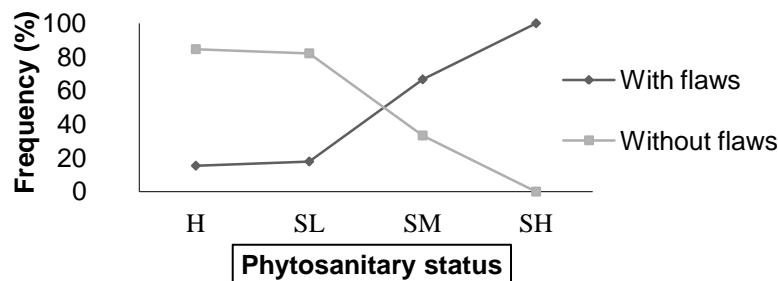540 **Fig. 9. Relation between phytosanitary status and the integrity of hedgerows urban**
541 **areas. Where: H corresponds to healthy plants; SL corresponds to sick plants of low**
542 **intensity; SM, sick plants of medium intensity; and SH, sick plants with high intensity**
543
544 ## 4. CONCLUSION
545
546 A considerable amount of relatively well conserved hedgerows of varying sizes could be
547 witnessed. Landscape beauty is the main reason considered for the implantation and the
548 conduction of hedgerows. Although there are difficulties in the management of hedgerows,
549 most of the interviewees do not consider maintenance enough of a problem for them to
550 consider taking out the plants. According to the majority of the interviewees general
551 aesthetics of the species and the presence of flowers were the main reasons for choosing
552 the species of hedgerows. The most found species comprising hedgerows in the present
553 study were the *Ixora coccinea* L. var. *compact* Hort., *Ficus pumila* L., *Ixora coccinea* var.
554 *lutea* (Hutch.) Corner and *Duranta repens* var. *aurea* Hort. The variety of shapes, flowers,
555 and colors of shrub species and their ability to form beautiful hedgerows can be considered
556 the main reasons why they are used in the composition of hedgerows. Uniformity of the
557 plants composing the hedgerow is of great importance, since a flaw in a single plant can
558 impair the objective and the visual aspect of the hedgerow. Although hedgerows are widely
559 used in urban and rural areas, studies on their composition, structure, ecological importance
560 and relevance to biodiversity conservation are scarce.
561
562 ## COMPETING INTERESTS
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564 Authors have declared that no competing interests exist.
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