

CHILDREN'S BOTANICAL CULTURE, IMPORTANT TO ESTABLISH PUBLIC POLICIES FOR REFORESTATION

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ABSTRACT

In support of anticipating how public policies can be successful in the short or medium term in the restoration and reforestation of lands degraded by agriculture or livestock production activities within the state, this article describes the knowledge that children from Yucatán have about the breadnut tree, called *ramon* (*Brosimum alicastrum* Swart). This forest species has aroused great interest due to the environmental services that it offers, among two that stand out are mitigating climate change through carbon capture and as a source of food through consumption of the seeds. Surveys were applied to 1,844 children from 8 to 12 years, preponderantly Maya speakers, from 20 Primary schools distributed in the state and the state's capital. Of the children, 81% from instate understand the ramon tree, while only 23.5% do in the city of Mérida. Of the 1,844 students, 809 (43.9%) do not have ramon trees in their gardens, which is the opposite for 1,035 (56%). The main uses of the ramon tree were grouped in order of frequency: fodder, ornamental, medicinal, food, microclimate, and fuel. The results allow to understand the children's culture about natural resources, which they get from their family and the surrounding population or from school, and to propose a new way of education for everything related to local and regional natural resources within the framework of sustainability.

Keywords: *Brosimum alicastrum*, diet, fodder, ramon.

INTRODUCTION

Mexico is within the ten nations with highest loss of tropical primary forest at the global level (BBC, 2020). According to data from CONAFOR an average loss of forest vegetation of 212,834 ha/year during the 2001 to 2019 period is estimated, within which Yucatán is among the states with highest loss of forest coverage, with an annual surface of 13,776 ha/year, only surpassed by Campeche, Chiapas and Quintana Roo (CONAFOR, 2022). Facing such an alarming situation, reforestation of the state territory with forest species from the region such as ramon (*Brosimum alicastrum*) has been undertaken by the state's political leaders.

One of the main problems to establish a public policy of reforestation is to know where and with whom it will be conducted. The social and general intelligence improves the

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collective action in a system of group common resources. Under this context, the new public policy for reforestation announced by the governor of the state of Yucatán, where the species *B. alicastrum* was selected to contribute to mitigate the impact of climate change, to preserve the recharge zone of the peninsular aquifer and its sustainability, demands studies of knowledge and acceptance of the forest species selected from the future generations, for a greater success (Carabias *et al.*, 2007; Alonzo and Velásquez, 2019).

The project suggests using a species that is present in the regional biodiversity to attend to an urgent need. The decision of sowing ramon trees was based on the environmental services that they offer, such as carbon capture, protection of the soil and bodies of water, and conservation and restoration of biodiversity; in addition to cultural parameters such as medicinal use and preparation of food for humans and animals, to which the authorities gave special priority, also because they are widely known by inhabitants of the state (Ramírez, 2017). The experts point out that this tree is in the list of plants of the sacred Maya texts, Popol Vuh and Chilam Balam, which gives certainty that it has accompanied this culture since many centuries ago (Pérez *et al.*, 2020). This study was conducted in support of anticipating how public policies can be successful in the short and/or medium term for restoration and reforestation of the lands degraded by agricultural or livestock activities within the state.

Selecting the species to be planted goes beyond the simple fact of reforestation; rather, it points to repeating the successful experience, together with the natural resources and technology, to drive the state's economy, as was the case of henequen. The society of this state understands the importance of technology as a result of the very successful agroindustry of natural fiber production, which was known as the green gold at the beginning of the 20th century (Gutiérrez *et al.*, 2011). The fact must be remembered that, in 1842, the state's governor implemented a policy to establish agave plantations in order to develop the henequen industry, which in few years would have a great impact on the landscape and the rise of the state's economy. At the beginning of the 20th century, the henequen zone was in the central and northwestern portion of the territory of Yucatán and it covered 34% of the state territory, with around 1'000,000 hectares planted, in close to 1,170 haciendas (Colunga, 2006; Villanueva, 2011).

The ramon tree also called the maize tree has been included in reforestation programs in the southeast of Mexico for different purposes; wood as fuel, leaves for medicine and fodder, and fruit as food for animals and humans (SIIDETAY, 2014). The use of seeds for human consumption is not a novelty, since there are evidences that show its use since pre-Hispanic times, as mentioned in previous paragraphs (Puleston 1982; Peters, 1983). However, there was a lack of scientific studies focused on determining its benefits in the diet and health. Presently, a group of researchers from the scientific research center in Yucatán, has been focusing on studying the nutritional composition, where it has been highlighted that the seed has a high content of proteins (11%), carbohydrates close to 70%, and practically no fats (1.5%); high content of fiber, vitamins B1, B2 and folic acid

present; it is rich in minerals such as calcium, iron, zinc and sodium; and contributes 318 Kcal for every 100 g of flour, which is why this species has aroused attention to compensate for the dietary deficit at the state and national level, so alternatives for consumption, making use of technology, have been sought. In addition to the nutritional composition and great benefits of the byproducts on the consumption of ramon seeds, this same work group has taken on the challenge of reincorporating the *B. alicastrum* seed into the human diet (Ramírez-Sánchez *et al.*, 2017).

In addition to the benefits highlighted for human consumption, advantages have also been suggested in the production of feed for livestock, such as the fact that this tree produces 100 kilograms of seeds per plant in its adult stage (more than 10 years old), with which 20 ton/ha per year could be harvested, which could be an option to reduce grain imports for the country's livestock sector. The quality of this fodder is highly palatable, contains 37% carbohydrates, 52.74% dietary fiber, 2.25% fats, and 11.23% proteins, among others. It is high in calcium, iron, zinc and sodium, and provides vitamins such as folic acid, B1 and B2 (Larque-Saavedra, 2014; Hernández-González *et al.*, 2014).

Among other advantages, it has been highlighted that this tree has an average growth rate of one meter per year, which can increase when it is managed without competition and with open exposure to sunlight; it proliferates under natural conditions of high stoniness and begins its flowering at seven years old; it presents a permanent production of fruits with two harvesting peaks per year, one in the spring and another in the fall; it is a monoicous species, efficient in water use, and a large part of the population states that they know the species (Hernández-González *et al.*, 2014a and 2015).

This public policy that emerges in Yucatán is an important innovation because it includes the initiative of incorporating the forest sector to food security, tending to the environment as a priority for the sustainability of the habitat of Yucatec people, which is of utmost importance and sets a precedent at the national level worthy of being reproduced by other states.

This study has the objective of presenting the knowledge that the children from rural and urban communities of the state of Yucatán have about the ramon tree, generating information to suggest a new form of education for everything that is related to local and regional natural resources within the framework of sustainability, which impacts the public policies of restoration and reforestation of the lands degraded by agricultural or livestock activities within the state (Ellis *et al.*, 2017), with this article being the detonator and driver for future research in the topic.

MATERIALS AND METHODS

This research stems from the hypothesis which suggests that there is a culture of knowledge of the ramon tree and the uses of its byproducts in the child population (8-12 years old) of rural and urban communities, influenced by the family, the surrounding population or school. Data were gathered by applying 1,844 semi-structured surveys, face to face,

with open questions focused on obtaining information about the identification, the existence of a specimen of the species *B. alicastrum* in their plots, and the use given to this forest species. This survey was applied to boys and girls who are 8 to 12 years old from 20 Primary schools, of which 14 are from communities that are predominantly Maya speakers, and 6 from the capital of the state of Yucatan (Table 1); the first are distributed in seven municipalities of the state and the second confined only to the capital. For the selection of municipalities to participate in the study, the state was divided into three strata, which consider the distance regarding the capital of the state, from which two or one municipalities were taken per stratum.

Table 1. Municipalities in Yucatán, schools and student boys and girls surveyed.

Municipality	Name of school	Male students surveyed	Female students surveyed	Total
Chankom, Ticimul, Yucatan	Jacinto Canek Elementary school	15	33	48
Chankom, X-Cocail, Yucatan	Luis Donaldo Colosio Elementary school	16	5	21
Chapab, Yucatan.	Santiago Méndez Elementary school	76	0	76
Chemax, Yucatan	Rafael Ramírez Castañeda Elementary school	114	80	194
Dzoncauich, Chacmay, Yucatan	Ignacio Peón Elementary school	50	4	54
Dzoncauich, Yucatan	Estado De Veracruz Elementary school	122	14	136
Izamal, Yucatan.	Agustín Melgar 2 Elementary school	18	0	18
Izamal, Yucatan.	Guadalupe Victoria Elementary school	12	2	14
Izamal, Yucatan.	Benito Juárez Elementary school	28	5	33
Izamal, Yucatan.	Aquiles Serdán Elementary school	93	6	99
Izamal, Yucatan.	Crescencio Carrillo Y Ancona Elementary school	131	17	148
Mayapan, Yucatan	José Vasconcelos Elementary school	84	38	122
Mayapan, Yucatan	Cristóbal Colón Elementary school	90	104	194
Merida, Sac Nicté	Redención Elementary school	9	2	11
Merida, San Pablo Uxmal.	Santiago Pacheco Cruz Elementary school	29	164	193
Merida, Yucatan Chuburna De Hidalgo	Bernabé Argáez Milanés Elementary school	66	108	174
Merida, Yucatan Col. New Yucatan	Jesús Manuel Ibarra Peiro Elementary school	10	57	67
Merida, Yucatan. Fracc. La Herradura II, Cd. Caucel	Ing. Armando Palma Peniche Elementary school	10	51	61
Merida, Yucatan. Fracc. Las Americas	Libertad Menéndez Elementary school	6	41	47
Tahdziu, Yucatan	Valentín Gómez Farías Elementary school	103	31	134
Total		1,082	762	1,844

Source: prepared by the authors.

The eight municipalities used as sample were selected randomly from a total of 106 that make up the state. The information gathered was analyzed through descriptive statistics, with the estimation of measures of central tendency and the elaboration of graphs to visualize the distribution of values.

RESULTS AND DISCUSSION

Through the information gathered it was evident that there is variation about knowledge of the ramon trees among children from instate and from the state's capital (Mérida). Table 2 shows that out of the 1,844 children from instate who participated in the surveys, 81.1% (1,495) know the ramon tree, while for the case of the city of Mérida only 23.5% of the 553 individuals said that they knew this species. This suggests that the children from instate and who come from Maya-speaking communities have better botanical knowledge of their environment than those in the state capital.

Although a variation is seen in the number of children who said they knew the ramon tree, among the municipalities, at least 50% of the child population in the study know this forest species. The municipalities of Chemax and Chankom reported the lowest percentages, while the highest values were for Chapab and Izamal. Regarding the city of Mérida, the localities closest to the city showed a low percentage of knowledge, contrary

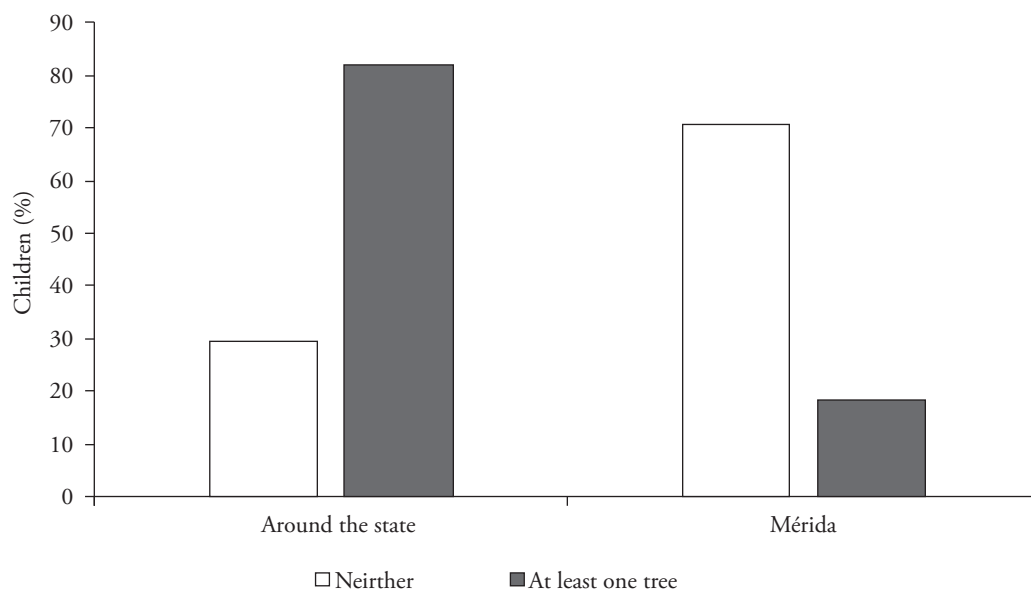
Table 2. Relation of Primary schools and number of interview respondents who know the ramon tree.

Municipality	Name	Students	Little boy	Little boy	Little girl	Little girl
			yes	no	yes	no
Chankom	Luis Donaldo Colosio (X-cocail)	21	9	3	7	2
Chankom	Jacinto Canek (Ticimul)	48	6	18	9	15
Chapab	Santiago Méndez	76	34		42	
Chemax	Rafel Ramírez Castañeda	194	69	36	45	44
Dzoncauich	Estado de Veracruz	136	75	6	47	8
Dzoncauich	Ignacio Peón (Chacmay)	54	27	1	23	3
Izamal	Agustín Melgar	18	12		6	
Izamal	Guadalupe Victoria	14	6	1	6	1
Izamal	Benito Juárez	33	15	5	13	0
Izamal	Aquiles Serdán	99	48	4	45	2
Izamal	Crescencio Carrillo y Ancona	148	71	11	60	6
Mayapan	Cristóbal Colon	194	87	3	98	6
Mayapan	José Vasconcelos	122	45	26	39	12
Merida	Ing. Armando Palma Peniche	61	6	27	4	24
Merida	Santiago Pacheco Cruz	193	15	75	14	89
Merida	Redención	11	2		7	2
Merida	Bernabé Argáez Milanés	174	37	45	29	63
Merida	Jesús Manuel Ibarra Peiro	67	6	26	4	31
Merida	Libertad Méndez	47	4	16	2	25
Tahdziu	Valentín Gómez Farias	134	57	11	46	20
Total		1,844	631	314	546	353

Source: prepared by the authors.

to what happened in the zones far from the city (commissaries of Sac Nicté and Sierra Papacal). The low knowledge of children about the species studied in the city of Mérida was perhaps due to the scarce vegetation and presence of this tree in their properties, as consequence of the small space in the plots, due to a high density of the human population, and because it is a tree that demands large space given its characteristics (it can reach more than 25 m of height, with trunk diameter over 50 cm, and very dense crown) (Orellana *et al.*, 2007). Likewise, the scarce knowledge of the parents and the use of exotic tree species in gardening, which does not happen in the communities far from the city, where there is more space for these trees to develop and the knowledge of parents regarding this species is high, since it is a fodder plant species of greater use in the rural communities (Rojas-Schroeder *et al.*, 2017).

Of the survey respondents, 43.9% said that they do not have ramon trees in their backyard. From the population who mentioned they had ramon in their gardens, 60% have 1 to 3, 33% have 4 to 6, 6% have 7 to 9, 5% have 10 to 12, and 5% more than 13. In the rural zones of the state is where the highest population of ramon trees is concentrated, since only 29.4% of the children surveyed do not have at least one ramon tree in their backyard, while in urban communities the surveys resulted in 81.7% not having at least one ramon tree (Figure 1). This trend is due to diverse factors, such as the availability of space, the lack of knowledge in its use, and the deforestation for human settlements in the city of Mérida (Boio, 2010), while instate there is still presence of vegetative spaces (Zamora *et al.*, 2009) and breeding of backyard animals allows to still conserve this species



Source: prepared by the authors.

Figure 1. Child population in state and in the state's capital who do not have ramon trees in their backyards.

(Barrientos *et al.*, 2016). In addition, the proximity to forests and the presence of birds, which feed and carry the seeds, make the proliferation in household backyards possible (Hernández-Ladrón *et al.*, 2016). According to Berg (1972), this species presents scarce abundance in the most populated communities, although not so for the communities far from urbanization, in which the abundance depends on the predominating ecosystem (Vega *et al.*, 2003).

Results from this study report that 67.7% of the total population of children surveyed know the ramon tree, although 32.3% do not. Regarding the gender, there was no great difference between the proportion of girls (65%) and boys (70%) who know the ramon tree. The behavior of the values reported can be attributed to the high frequency of ramon trees in the backyards of Maya families (Peters and Pardo-Tejeda, 1982) and to the custom of raising animals with this species in the plots that surround the households, to complement the dietary sustenance, where both boys and girls participate (Chimal *et al.*, 2012; Gutiérrez-Ruiz *et al.*, 2012).

Regarding knowledge from the children about the different uses given to the ramon tree (Table 3), the ones that stand out are fodder for livestock feed with 54.2% of the population who mentioned it, and its use as ornamental/microclimate plant with 22.2%.

Table 3. Knowledge about the uses given to the components of the ramon tree in the state of Yucatan.

Use of the tree by family	Number of students	Percentage (%)
Forage	642	54.22
Ornamental/microclimate	270	22.80
Sale	79	6.67
Medicinal/Forage	37	3.13
Fruit consumption/juice	32	2.70
Forage/Sale	20	1.69
Wood	17	1.44
Crafts with wood	16	1.35
Dough/tortillas	11	0.93
Medicinal	8	0.68
Forage /Fruit consumption	7	0.59
Forage/microclimate	7	0.59
More than two uses	6	0.51
Sale/Wood	4	0.34
Forage/Wood	3	0.25
Forage/coffee	3	0.25
Sale/Crafts with wood	3	0.25
Give away	3	0.25
Forage/Crafts with wood	2	0.17
Forage/Sowing	2	0.17
Forage/Dougt	2	0.17
Other groups	10	0.84
Total students with trees	1,184	100.0

Source: prepared by the authors.

Among other uses, 6.6% of the population reported a commercial use (sale of leaves), 3.1% medicinal, 2.7% consume the fruit, 1.7% give it double purpose for fodder/sale, and 1.4% as firewood. These results agree with those reported by Orantes *et al.* (2012) in a study carried out with adults in the state of Chiapas, to understand the use of various parts of the tree, in which certain uses stood out such as for fodder, poles, firewood, tools, furniture, honey-producing, edible and medicinal; however there is a greater predominance in the consumption of seeds as food in diverse dishes. Pérez-De la Cruz *et al.* (2012) mention that *B. alicastrum* provides medicine, fodder, food for humans, wood for construction, and numerous services to the ecosystem.

The high proportion of use of the ramon leaves and seeds in animal feed, in the state, has generated the perspective among children of its use as a livestock dietary resource, as shown by the data that resulted from the surveys, moving away from the knowledge of its use as an edible natural resource for humans, decreasing its value and resulting in higher acceptance in the diet. In other studies, its traditional use in the diet of domestic species is mentioned (Ayala and Sandoval, 1995; Martínez-Yáñez *et al.*, 2010; Rojas-Schroeder *et al.*, 2017), due to its high nutritional value which is adequate for the diet of most of the domestic productive species; from this the name in Spanish *ramón*, which comes from the verb *ramonear* (referring to cattle and other domestic animals that consume its seeds, seedlings and leaves) (Meiners, 2009). Among other things, its availability during drought season, due to its high tolerance, makes it an important tree for the rural communities in livestock production (Ayala and Sandoval, 1995).

The alarming situation of deforestation in the Yucatán territory (Sánchez and Rebollar, 1999) and the present problem experienced at the national level in corn production, cereal of great importance, for its contribution of more than 50% of energy in the Mexican population (García, 2002; Sierra *et al.*, 2004), where a deficit in production of 56% is estimated (SIAP, 2018), which makes it urgent to divulge dietary alternatives, such as the ramon seeds, which can offset the food deficit. There are reports of how in past times, the consumption of ramon seeds saved a population from famine, which was devastated by intense drought and attacks from pests (Meiners *et al.*, 2009).

To create a culture in new generations in the exploitation, care of natural resources and reforestation with species of economic importance, as is the case of the ramon tree, is a very important challenge, not only for schools but also for families. Furthermore, knowledge in this aspect is virtually absent in urban zones. However, the fact of understanding the importance of reforestation is not enough, but rather there is also the capacity of selecting species that fulfill several purposes (CONABIO, 2020).

The percentage of knowledge and use of this species in rural communities, found in this study, is a good precedent of high acceptance in the new public policy of restoration and reforestation by the child population, although promoting the knowledge about the transformation of these resources for a greater benefit is still lacking. Although it is true that in recent years the importance of ramon plantations in the contribution of great

benefits to food elaboration has been highlighted, it is also true that more exposure about it in the rural communities is still necessary (Domínguez-Zárate *et al.*, 2019; Martínez-Ruiz *et al.*, 2019; Santillán *et al.*, 2020).

On the other hand, the effects of climate change in the state as a result of global warming have been evident, which demand an urgent solution; thus, both adults and children must be aware of the importance of planting trees in their households, and in this sense, what could be better than a ramon tree, given its characteristics of drought tolerance (Ayala and Sandoval, 1995), carbon sink (Hernández-González *et al.*, 2019), source of food and medicine (Molina-Escalante *et al.*, 2015), and microclimate contribution, providing multiple benefits.

CONCLUSION

There is a greater culture of knowledge of the ramon tree and the uses of its byproducts in the child population of rural communities, where it stands out according to the order of frequency as fodder, ornamental, medicinal, food, microclimate, and fuel. These understandings that the child population of the state of Yucatan has regarding the importance of the *B. alicastrum* species and its uses, acquired mainly from their parents and the environment, are a good precedent of acceptance of this species in the new policy for reforestation. This is why what would be lacking is to direct the efforts to instill the culture of care of plant species in the environment, as well as their rational use and their reforestation.

The results allow understanding the culture that children have about natural resources, which they get from their family and the surrounding population or from school, and they propose a new form of education for everything related to the local and regional natural resources within the framework of sustainability.

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