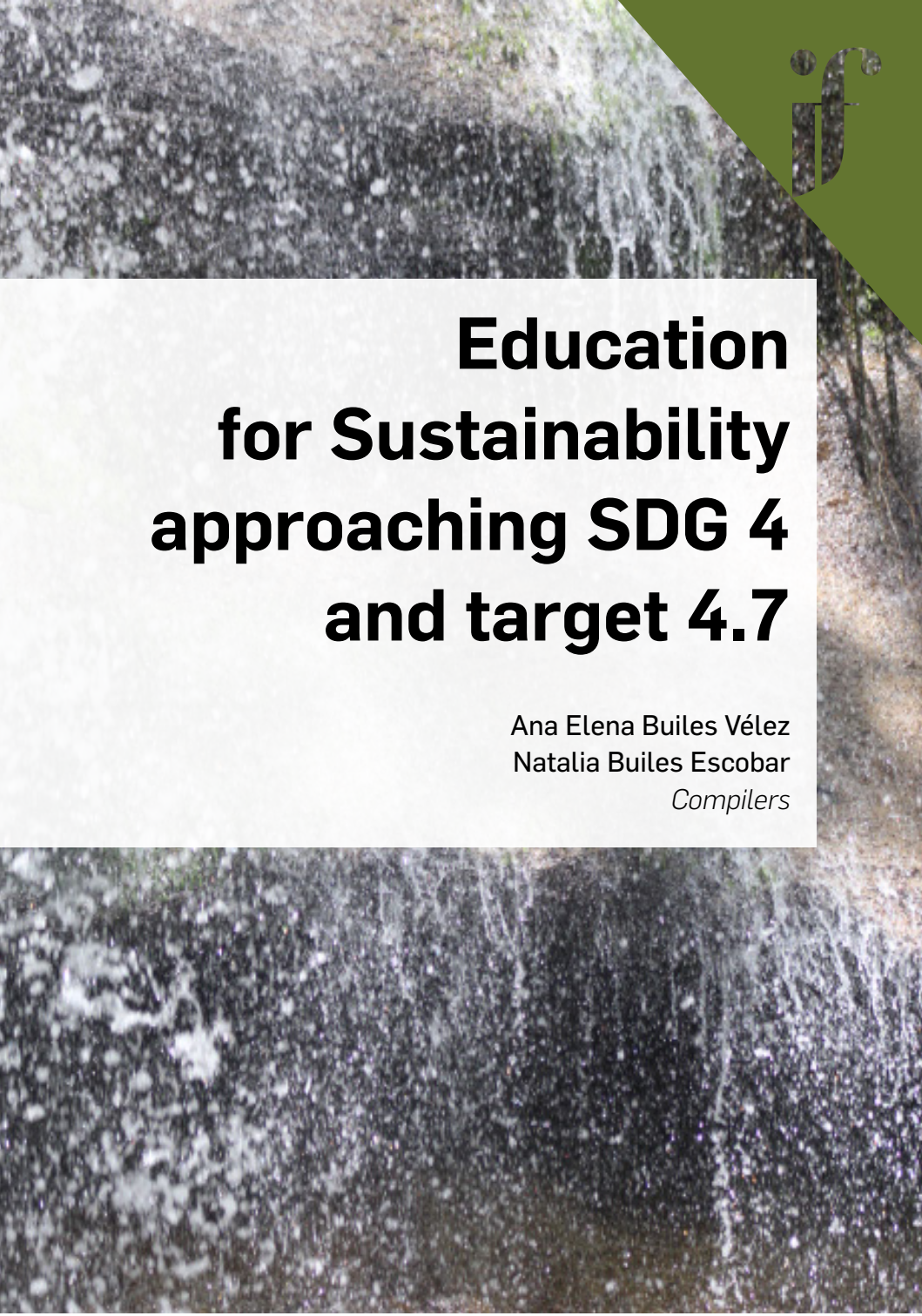

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Crafts, art and product design from agro-waste of Nopal cultivated in Sonsón, Antioquia[1]

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[1] Research Project: Desarrollo de nuevos productos para la valorización de residuos derivados del cultivo de nopal en Sonsón, Antioquia. Rdo. PCI21204

Abstract

This chapter shows, in a documentary way, the role of nopal in the social and cultural development of the municipality of Sonsón, Antioquia, highlighting its history and its impact on hundreds of families of this region. The nopal has historically been cultivated in Sonsón to harvest one of its flagship products, the fig; an exotic fruit cultivated primarily for export, and much less for local consumption. However, it is known that all parts of the plant are usable, including the waste associated with its pruning. In Colombia, the complete exploration of the entire plant has been timidly explored, so new potential uses beyond harvesting the fruit are unknown.

This document exposes the potential of nopal waste in the development of craft, art, and product design pieces using eco-design strategies based on circular economy trends. Hence, a look to an integral use of the plant allows the tradition of the so-called "fig trees" to endure over time, avoiding the threats associated with new agricultural products that promise the farmers "greater benefits" for the livelihood of their families and the development of the region.

This look, in addition, will contribute to responding to some of the Sustainable Development Goals - SDGs through interdisciplinary work between academy, public and private sectors, and citizen interest, promoting the encounter of scientific and artistic communities around the nopal, through the development of a museum exhibition in Medellin's Botanical Garden, which allows to exalt the nopal as an alternative for the sustainability of families in the municipality of Sonsón.

Keywords: Nopal, agro-waste, craft, product design, sustainability.

Sonsón territory

Sonsón was founded on August 4, 1800 during the Spanish Colonization of Antioquia, in western Colombia. For about a hundred years, Sonsón was the engine of the colonization of the west of the country (Parra Bedoya & Parra Arcila, 2009; Toro Gutiérrez, 2015). The history of this municipality has also been marked by a period of violence. In 1970, the settlement of armed groups in different villages and districts gave rise a period known as low intensity conflict that lasted until 1995 (Infografico línea de tiempo Sonsón, 2017; Montoya Ramírez et al., 2019). The armed conflict in Colombia worsened, generating an alarming humanitarian crisis that left several municipalities in eastern Antioquia: San Carlos, San Rafael, Granada, Cocorná, San Francisco, San Luis, Argelia, La Unión, Nariño and Sonsón; that started during the presidential period of Belisario Betancur (Montoya Ramírez et al., 2019).

Sonsón is the largest municipality in eastern Antioquia, with an area of 1323 km^2. Its territory occupies a vast geographical area that goes from the Caucana slope to the Magdalena River slope (Montes Henao et al., 2020). It has 8 corregimientos or small districts, 108 villages, and 36.000 inhabitants, Figure 1 (Alzate, 2017; Montes Henao et al., 2020).

Its urban area is on the western side of the Cordillera Central at 2475 masl, and covers 1.6 km^2 of the total extension of the municipality, Figure 2 (García Isaza, 2009; Montes Henao et al., 2020; Montoya Ramírez et al., 2019; A. Osorio, comunicación personal, 18 de diciembre de 2020).

Economic activities

Near 83% of Sonsón's economy is driven by the agricultural industry. The remaining 17% is moved by culture, education, infrastructure, and environmental sectors. A few years ago, Sonsón was known for cereals

Figure 1. Map of the municipality of Sonsón (Henao García, 2012).

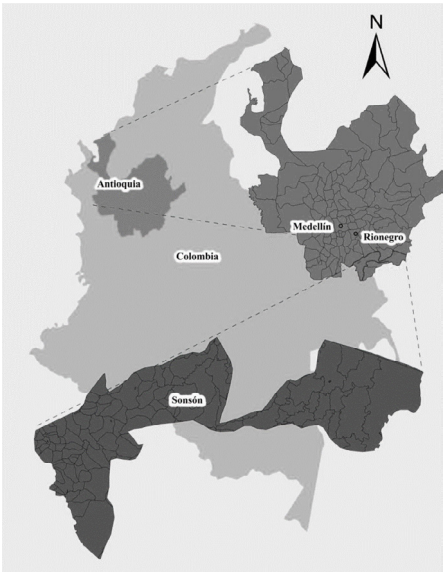


Figure 2. Location of the urban area of Sonsón (letf) and from Quintero brothers house, the most beautiful balcony in Antioquia, in the major park (right).

production such as corn, orzo, wheat, barley, among others. However, when the armed conflict ceased (Montoya Ramírez et al., 2019), much of their agricultural activities were industrialized in order to grown exportations of other products such as gulupa, passion fruit, and figs

(a few tons to Ecuador and Central America). Recently, products such as avocado has displaced many of the traditional products of the region because of the investment of large foreign companies (A. Osorio, comunicación personal, 18 de diciembre de 2020).

Nowadays, Sonsón has 38 productive items. The fig, together with the coffee, represent the emblematic products of the municipality. Those with the greatest impact, based on the number of families that benefit from them, are fig, coffee, avocado, dairy and dual-purpose cattle.

Additional, the cultural landscape of fig trees is unique Figure 3, which is an advantage that should be highlighted as a difference factor from other municipalities of Antioquia, and as an opportunity to explore and develop the culture of the fig (A. Osorio, comunicación personal, 18 de diciembre de 2020; Parra Bedoya & Parra Arcila, 2009).

Figure 3. Fig crop in Alto de Sabana village (Left/Own source); and Arma river Canyon took from Los Medios village (Montes Henao et al., 2020).

The nopal in Sonsón

The nopal is an endemic plant of the American continent. Belongs to the cacti group to Opuntia and Nopalea genera. It grows in territories from Canada to Argentina. However, Mexico has the greatest diversity of species. This plant is intimately linked to the history of Mexico, which, even on its shield, has a representation of an eagle stand on a nopal plant.

Since pre-Hispanic times, it has been used in different fields such as food, medicine, construction, and arts and crafts (Contreras-Padilla et al., 2012; Finck-Pastrana, 2014; Guzmán Lechuga, 2016; Inglese et al., 2018; Marin-Bustamante et al., 2017; Murillo-Amador et al., 1998; Torres-Ponce et al., 2015). In Colombia, nopal cultivation had not been recognized until a few years ago, and because of this, it is not planted or processed efficiently. It has great economic projection that may contribute to country's economy. Additionaly, it has become a solution to overcome the harsh drought conditions in some regions, as of Mesa de los Santos (Santander) (Baena, 2014).

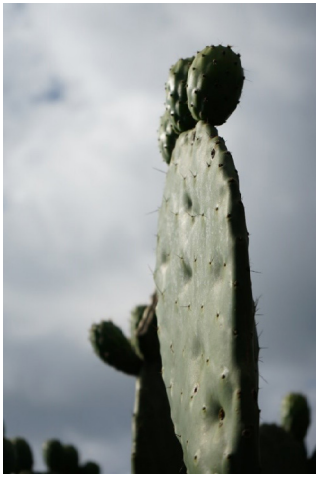
It is common to find that the nopal spreads easily thanks to its root system that allows it to grow in its underground and aerial stems, as well as in its leaves (Rivera, 2016). It is known that it bears fruit throughout its life. In Sonsón, nopal crops are mainly focused for harvesting and marketing its fruit, the fig, which gives its name to the well-known "higeras" (fig-trees). This economic activity represents the livelihood of near 500 families, where about 93 hectares (ha) planted represent a production of 25 tons per hectare each year (data provided by "La Higuera Asociación") (Rivera, 2016).

The role of fig in Sonsón

Sonsón has the privilege of being the only municipality in the department of Antioquia that harvests the fig, which makes it an exotic fruit and one of its flagship products, Figure 4. In Colombia, there are only two municipalities that grow export-quality figs: Iza, in Boyacá, and Sonsón. However, it is known that there are crops in other departments such as La Mesa de los Santos, in Santander.

Historically, fig trees have been the economic support for hundreds of families (A. Osorio, comunicación personal, 18 de diciembre de 2020). Despite of this, its production still has several problems to solve. One of them is related to transportation of the fruit to the distribution centers. Currently, over 40 tons of figs are lost per month because of poor accessibility to sidewalks and the difficulty of keeping the fruit in good conditions.

Figure 4. Nopal leaves with figs grown in Altos de Sabana village (own source).



Farmers also claims that nopal “does not represent a substantial income”, and it has been displaced by other agricultural products such as avocado (A. A. Escobar, comunicación personal, 17 de octubre de 2021; B. Jaramillo, comunicación personal, agosto de 2021; U. Ospina, comunicación personal, agosto de 2021; J. Panesso, comunicación personal, 17 de octubre de 2021), which has become a latent threat in the nopal’s disappearance. This issue has led the authorities to consider the declaration of the fig as intangible heritage associated with agriculture.

Arrival of the nopal to Sonsón from popular knowledge

One thing to highlight is that the history of the nopal in Sonsón is still to be built, and it is, according to José Fernando Botero Grisales, Operative Technician in Culture and Heritage of the Municipality of Sonsón, “a historical debt that we still have”. There have been identified fig trees of up to 80 years old, which represents an opportunity to recover the identity of Sonsón based on the historical value of the nopal.

Some stories collected from interviews made to farmers in Alto de Sabanas, allowed an approach to nopal arrival to Sonsón from the popular knowledge. Ubelio Ospina, a renowned fig grower, tells that fig arrived to Sonsón 120 years ago. According to Ubelio, his grandparents brought the first plants to El Roblal Arriba, where can still be found 5 of these ancient trees (U. Ospina, comunicación personal, agosto de 2021).

Another story told by Berta Jaramillo, says that the fig supposedly comes from a small river called Maitamá, where was the settlement of the cacique that bears the same name. This version coincides with that of Jaime Panesso, who also reported that it is a story that he was told since he was a child (B. Jaramillo, comunicación personal, agosto de 2021; J.

Panesso, comunicación personal, 17 de octubre de 2021). Jaime Panesso also says that it is believed that the fig was brought by birds that flew from Mexico, since the indigeneous could not walk such a long distances (J. Panesso, comunicación personal, 17 de octubre de 2021).

Weather and ease of growing in the unique conditions of Sonsón

This plant grows in Sonsón because of the microclimate that forms in the corridor of Sonsón´s paramo because the humid warm winds come together from the Magdalena slope, and cross with the dry warm winds of the Cauca River. These two streams intersect at the crest of the paramo and spill the microclimate (J. F. Botero Grisales, comunicación personal, 17 de octubre de 2021; A. A. Escobar, comunicación personal, 17 de octubre de 2021; B. Jaramillo, comunicación personal, agosto de 2021; U. Ospina, comunicación personal, agosto de 2021; J. Panesso, comunicación personal, 17 de octubre de 2021). These conditions favored the grown of high-quality figs. Ubelio Ospina says “Even though in La Mesa de los Santos and in Boyacá the plants are smaller, the fig pulp quality is better in Sonsón” (U. Ospina, comunicación personal, agosto de 2021).

During a visit of nopal experts from Mexico, they told Sonsón’s farmers that it was strange to see nopal in these green lands without deserts, and with those dimensions. In Mexico, they have plants of maximum 1.8 m tall which are easy to handle. It is because they only sow one leaf per plant, while in Sonsón they plant 3 or 4 leaves, which explains why it sprouts better and the enormous size of the plants Figure 5. In Sonsón, farmers figured out how to harvest the fig. Ubelio Ospina says “we didn’t learn it from anyone. We use a punch or needle, and a blade”.

Figure 5. Nopal plantation in El Brasil village (own source).

Collectors work and insights

The fig has a special value because it is the only plant that produces all year round, if it is well managed (A. A. Escobar, comunicación personal, 17 de octubre de 2021; U. Ospina, comunicación personal, agosto de 2021). “Right now, the avocado fever is leading everyone to plant it because it is a good option. It is easier to handle, and is better known by consumers, while fig is not known by almost anyone in Colombia” (U. Ospina, comunicación personal, agosto de 2021). But it is known that the fig is the only fruit that needs minimal chemical products, mineral fertilizers work very well, and organic fertilizers are used. It needs an important pruning management and small amounts of water. The fig, compare to many other fruits, is the least contaminating.

here are two big harvest times a year, from November to January, and from June to August, which is the best time (J. Panesso, comunicación

personal, 17 de octubre de 2021). A nopal produces 2 kilos of fig per week (12 to 16 figs), and it is sold at $3,500 COP per kilo. In Sonsón, the maximum production is 31 tons per week. “People realized that it is easier to handle avocado than fig due to the spines, so fig’s production has dropped” (U. Ospina, comunicación personal, agosto de 2021).

Dual crop: difficulty of its harvest and collection

The drawback of the fig are the spines (also known as pelusa or fluff) or the guate as the Mexicans call it (U. Ospina, comunicación personal, agosto de 2021). To be able hold it by hand, it is necessary to wash it with gloves, a tow, or a spoon to remove all the fluff, and hence it can be able to be consumed (J. Panesso, comunicación personal, 17 de octubre de 2021). In Colombia the culture of consuming fig is very poor (U. Ospina, comunicación personal, agosto de 2021), and sometimes they do not even buy it.

Despite of that, and because of the mentioned benefits of fig crops, they provide the minimum economic sustenance for the families (Marzola, 2021).

Products got from nopal in Sonsón

The Food and Agriculture Organization of the United Nations (FAO), described the nopal in 2013 as the food of the future, because it offers important nutritional properties in times of drought, becoming sustainable in the face of global climate change (Inglese et al., 2018). In countries like Mexico, the nopal is recognized for its applications in the food industry, with the young leaves being the primary product for consumption. However, other types of use have been registered thanks to

its high agrotechnological potential, being the base element for obtaining products that derive from industries already known as food (leaves and fruits can be consumed as vegetables and fresh fruit), medicine (for obesity and diabetes treatment) and cosmetics (soaps) (Marzola, 2021). In addition, new applications aim to respond to needs in fields such as materials science, design and art that allow to broaden the spectrum of its potential uses, Figure 6 (González & Ramírez, 2007; Marin-Bustamante et al., 2017; Torres-Ponce et al., 2015).

In Colombia has not begun with the awareness about the environmental benefits that the nopal planting brings, nor about the potential developments that derive from the integral use of the plant, and not only the leaves, fruits and flowers of the nopal are usable. Recently in Sonsón, some work has begun with fig by-products. The Municipal Association of Women Ana María Martínez de Nisser, produces nopalitos, marmalades, wines, flavored waters, among others. These initiatives make possible to promote the construction of the municipality's identity.

Figure 6. Teamwork interacting with nopal plantations in Altos de Sabana village (own source).

Opportunities for recent developments derived from nopal

The waste associated with pruning processes opens a window of possibilities to be used in multiple applications. Currently, the pruning waste is left on the ground to become the medium that gives growth to new plants, or to compost the existing plants.

Approximately 14 years ago, Ana María Orozco, an artisan and habitant of Sonsón, Figure 7, has worked empirically on the development of new alternative uses for the waste generated during the pruning of fig trees, to transform it into usable raw material to get different artisanal products («Creatividad e ingenio en Sonsón. Diseños en penca de nopal», 2016; Parra Bedoya & Parra Arcila, 2009). She says:

> "I've always liked art, so I started looking at those residues, and I started collecting material. Since that I felt in love with the work. The material

Figure 7. Ana María Orozco holding wastes and tender leaves of nopal, product of the pruning of a fig tree in Alto de Sabanas village (own source).

seemed to me to have a very nice texture, I worked on it in small things and thus I created" (Marzola, 2021)

With the development of lamps, caskets and vases, she has achieved recognition for her work at local and departmental levels. She has become as a benchmark for visualizing development options through the efficient use of the entire plant.

Agro-industrial waste applications in crafts, art and product design

Including crafts in the production methods of the regions could bring benefits at the local industry, and even though it apparently detaches from the globalized model that standardizes cultures and unifies society, production at the local level reactivates the microeconomy and promotes the circular economy. To generate income for the countryside, and even for demobilized sectors and victims of violence, if it is well organized, it can contribute to economic and social development. It may contribute to solve the problems of the Colombian countryside and the areas affected by the monetary and multidimensional poverty (Muñoz de Gaviria, 2013).

Craft development has traditionally been done from the countryside, in indigenous areas or in some areas of large cities. The techniques used for its development are ancestral or come from ethnic groups, cultures, or previous civilizations enhancing the historical heritage. In addition, craft seeks to promote the use of local raw materials, techniques for transforming materials through processes where manual work predominates and allows the dissemination of these techniques from generation to generation, seeking sustainability in the region where they take place.

This is quite important, as it gives the product a unique personality and great cultural value that can be seen beyond a utilitarian or decorative function, even allowing it to gain the character of a work of art (Muñoz de Gaviria, 2013). Crafts also allows for the possibility to promote the design of new products and the incursion of design as a disciplinary area that allows including market analysis, trends and new incursions into production processes.

With nopal, its by-products and wastes, they are a rich source of long fibers (hard or soft) that come from the vascular system of leaves or stems that can reach up to 5 meters in height (Finck-Pastrana, 2014); and short, which come from seeds or fruits (González & Ramírez, 2007). The architecture of the internal structure of the nopal, Figure 8, is a rich source of inspiration for product design. Biological processes exhibit ideal characteristics for creative processes, because of their ability to adapt and develop while they remain alive. These characteristics have been used in design studies and projects, either in the initial stages where the problem is identified, in the translation of the design requirements into forms, or in the last stage of inserting the object in use (Patiño Mazo et al., 2015).

Figure 8. Structure of nopal wastes got from different parts of the plant (own source).

Materials can be a source of inspiration in engineering based on their properties: dimensional changes, water absorption, thermal expansion and contraction, modification due to contact with chemical substances or mechanical effects. But also in design, since they can transmit emotions and sensations to the user, just as Mike Ashby mentions in his book "Materials and Design. The art and science of material selection in product design" (Ashby & Johnson, 2014).

This opens the possibility for inspiration and creation of artistic works, since the importance of finding new material sources for the creation of art cannot be ignored (Ashby & Johnson, 2014; Bernárdez Sanchís, 1994). The materiality against the conceptual load (idea) can be expressed as "the fight because of which the form overcomes the resistance opposed by the matter" (Bernárdez Sanchís, 1994). This statement reinforces the importance of mastering the technique of obtaining and transforming nopal waste.

The materials express the potentiality of the work and the artist imprints his own way of feeling and thinking on the materials. Materials, therefore, reflect life (Bernárdez Sanchís, 1994), and that is why the nopal is described in Artes de México as "a melancholic, ritual, emblematic and paradoxical plant, which offers us the blood of its leaves, the water of its fruit and the edge of its thorns as guides to enter the arid roads of Mexico" (Bermeo et al., 2002).

This is, without a doubt, an opportunity for endogenous development, not only for the municipality of Sonsón but also for Colombia's economic growth.

Contribution to the socioeconomic development of the region

Including the waste generated in a previous life cycle in the production of a new cycle is a way that offers sustainable options, favoring the circular economy, generating benefits both economically and environmentally, reducing the negative impact that is closely related to the last stages of the life cycle such as final disposal.

In 2015, the United Nations defined a list of goals to eradicate poverty, protect the planet and ensure prosperity for all (Naciones Unidas, 2021). They called them the Sustainable Development Goals (SDG). These are framed in the agenda for sustainable development, and each one has established goals to be fulfilled during the next 15 years. Our task is to work in cooperation between governments, the private sector, and civil society, to respond to these requirements.

In this way, and with a first attempt at cooperation between the private company, the public sector, academia and enthusiastic civilians, it is proposed to build and develop a museum exhibition and invite different artists to interpret the material from the nopal residue from the individual perspective of each artistic identity.

Museographic exhibition: The nopal, weft and permanence

This exhibition summarizes more than a year of work between a multidisciplinary group, where time, ideas, conversations and creativity made it possible to make the empirical knowledge of a rural woman, Ana María Orozco, an opportunity for union between different sectors, to build, to transform and to contribute through the use of nopal waste, Figure 9.

Figure 9. Workteam and Sonsón's mayor and agriculture secretary on the exhibition opening (own source).

The nopal

At the beginning of the exhibition, Demonte Studio, with its botanical installation, shows the fertility of the plant through its fruit, the fig, and the stunning beauty of its leaves, Figure 10.

In his curatorial text, Miguel Mesa Posada immerses us in the exhibition alluding to the georgic cactus. "Georgic is a poetic genre that evokes the rural, as expressed by its Greek origins ge=earth and ergon=work or labor. In this genre, the country life and the poet's native terroir are praised, glorifying his or her labor. It has a traditional accent that merges with lyrical inclinations", Figure 11.

Miguel also highlights the importance that "this exhibition does not seek to fill any historical lacunae, but to explore the aesthetic possibilities of what can be derived from this plant, so characteristic of the American landscape, but so recent, for some, in the antioqueño panorama. This

Figure 10. Demonte's botanical installation at the entrance of the exhibition (own source).

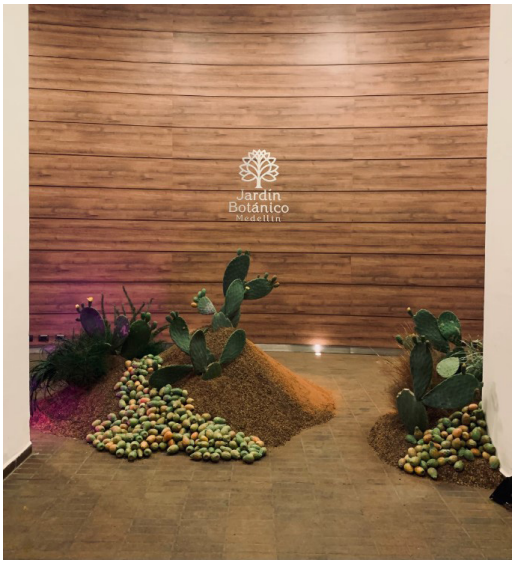


Figure 11. Assistants to the exhibition interacting with the curatorial text of Miguel Mesa Posada (own source).

exhibition suggests a georgic around nopal, this crop from Sonsón that is making its way into the agro-landscape of the region formerly known as "Corn's Jerusalem""

The invited artists who brought this exhibition to life with their creations, allowed the public to be taken into a journey that describes with great sensitivity the role of the nopal in Sonsón.

The weft

The documental video produced by Seis Audiovisual and directed by Santiago Marzola, Figure 12 , which carry the same name of the exhibition, reveals the testimoni of fig farmers and the construction that Ana María Orozco had built with nopal wastes through the years. The journey continues through the weft with the curatorial text by Mariana Peláez Rojas, where she explains that "The weft makes tissue possible when it crosses the warp on a loom, it is also part of the stories when it connects events in a narrative"; "The fig tree crosses family history as the weft crosses the tissue. Like the plot in the narrative, it connects the stories of the families of a sector of the municipality of Sonsón and offers them an identity, their story, in which they are owners of the strength, the resistance and the tenacity of enduring a work of habit and a life that avoids the poverty with the generosity of a plant that brings food to the table every week".

This allows us to continue the journey through the portrait photographs of nopal growers that Daniela Cortés exhibits; as well as the botanical illustrations where Pablo López interprets the colors, pollinating animals, and beauty of the plant residues. And she closes by saying: "The nopal is a weave of living tissue, peasants, animals, stories."

Figure 12. Fragments from the documental video Nopal, weft and permanence (Marzola, 2021).

The permanence

Finally, Santiago Marzola brings the public to the closing of the exhibition with his text where he defines the word permanence as "something that perseveres and is constant. Which is durable and sturdy", referring to the use of nopal and waste from different parts of the plant. He also says in his text that "...it can be said that something is maintained when it persists and does not change, but the actual way that something is perpetuated is through memory." to carry the public to the products and artistic works that gave rise to the engraving work of Ángela María Restrepo, jewelry work of Helena Aguilar, Brvtal Objetos and Ana-Taller sin Borde, the luminaries of Ana María Orozco and Lina María Agudelo, and the installation of artwork by Santiago Marzola, Figure 13.

Figure 13. Detailes of some products exhibited during the museographic exhibition: luminaires and jewerly (own source).

He concludes by saying that this work allows the public to testify "... the transformation of the material what allows us to extend the life of the plant and expand its possibilities towards an aesthetic and experimental field. We see how different parts become pieces interpreted by different creators who play with their unique characteristics: lightness, resistance, translucency and its own natural condition, to make it co-exist with the poetic of the material".

Conclusions

The information shown in this document, represents an opportunity to promote the development of the region by taking advantage of the waste generated in the production of figs, as well as the benefits of other extractable by-products of nopal such as leaves, mucilage, fibers, among others, that enhance the promotion and comprehensive use of the entire plant, raise awareness in the community, particularly in the municipality of Sonsón, about the uses and applications of nopal in new products which are engines of socioeconomic development in the region.

The agro-industrial waste generated during fig production will be a starting point to propose strategies from the circular economy, since they are usable raw materials, allowing the generation of new life cycles through the development of new materials, products and services. This will allow a positive impact on the population of Sonsón, not only economically through the products, but also culturally, with the production of artistic works, valuing the waste produced, relating the materiality of the products with the art, respecting and maintaining the identity of the region, and craft techniques.

The exhibition sought to promote projects around the use of the plant that have been developing during the time of research. The artists

invited to be part of this very first outreach space found formal richness, inspiration, and function in the raw materials that nopal wastes offered.

Finally, the possibility of building shared knowledge about the benefits of using these nopal waste is opened, and motivate community members to develop enterprises based on the findings of uses of the material, from the insertion and transition of adaptable technologies, for the strengthening of Antioquia's agriculture, specifically the municipality of Sonsón, Antioquia, through the complete optimization of the nopal, for the generation of new products, by-products and diverse applications that can improve the quality of life of the inhabitants of the region.

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