

Tests for Waterproofing Materials, Made of *Opuntia ficus-indica*

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Abstract. Mexican cacti have captivated the scientific community due their extraordinary characteristics and benefits. This research established a new way to use this ancestral plant as a substitute for other construction materials that given their industrial and technological processes have -in several cases- skyrocketed their costs, besides of being a constant hazard for the environment. Thus, by looking back how ancestors used to solve their construction needs, it would ultimately allow us to find better ways to protect the environment. Production process is analyzed; experimented with it; and its prominent characteristics analyzed derived from *Opuntia ficus-indica* extract combined with other natural materials to be then used it as a waterproofing material.

Introduction

Cacti are thoroughly found all across the Mexican Territory. In the mountain ranges, and sierras. The cactus known as *Opuntia ficus-indica* grows naturally in the State of Mexico. Cacti have been used for millennia for multiple purposes. From culinary, to art involving other materials such as calcium oxide and salt (Anderson, 2001).

There are about 300 different species of cacti around the globe. About 100 are found in Mexico. Extensive research has been made and often, new and innovative uses are discovered. This paper features another use for *Opuntia ficus-indica*: Waterproofing on building surfaces exposed to the elements (i.e. Sunlight and humidity).

This paper shows the process involving six stages using *Opuntia ficus-indica* combined with different natural materials were experimented with, and tested by evaluating their unique performance.

Development

As of today, Mexico is the top cacti grower. Just in 2016 more than six hundred thousand tons were produced only for food, and fifty thousand more just for fertilizing purposes. The ever-growing concern for optimal environmental conditions has pushed designers to find new materials and less hazardous materials. Such tendency is reflected in countless projects within several fields of design (e.g. architecture, industrial design, graphic design, and urbanism).

There are several tendencies where sustainable materials assume a critical role, some of them are Industrial Ecology, Eco-Efficiency, Eco-Design, Industrial Ecosystems, among others. All of them offer a strong focus on environmental issues. (Gonzalez, 2013).

This research points tests made with the species *Opuntia ficus-indica*'s natural properties, specially its behavior in the fields of construction maintenance using biomimicry, which is the discipline of solving human survival problems, by imitating nature's ingenious solutions.

Process

Fig. 1. 2 paddles of *Opuntia ficus-indica* were used. Total mass weight: 2.970 kg



Fig. 2. The paddles were chopped and deposited in a container with 20 lt. Of water



Fig. 3. The mix were left to be fermented for 25 days.
It was obtained a viscous and uniform substance known locally as “baba de nopal” (cactus sap)



Fig. 4. The cactus sap with different natural substances like chlorophyll, sugar, fig milk, and an extra undisclosed material



Fig. 5. The materials were applied on bricks, in order to determine waterproofing

Six bricks were then submerged in water for 15 days. Then, results were analyzed.

Table 1. Results

Subject.	Cactus sap. (<i>Opuntia ficus-indica</i>)	Material mixed.	Stand Period.	Coating process.	Water repellent. 0= Nule 5= regular 10= Excellent
1	250 gr.	Sugar, Fig milk, undisclosed material.	15 days	Brush	5
2	250 gr.	Sugar, Fig milk, undisclosed material.	15 days	Brush	5
3	250 gr.	Sugar, Fig milk, calcium oxide, alum, undisclosed material.	15 days	Brush	10
4	250 gr.	Sugar, Fig milk, cement, undisclosed material.	15 days	Brush	5
5	250 gr.	Sugar, Fig milk, alum,	15 days	Brush	0

Conclusions

Tests **1** and **2** absorbed a greater quantity of water when submerged. Test **3** absorbed less water than the others, followed by test **4**. Test **5** offered no waterproofing, whatsoever.

Looking back to our ancestors' solutions do not imply that they were all correct. However, it is utterly important to know the past to understand the future. Looking upon these ancient techniques once again, that some of them actually worked thoroughly to solve a design problem, could be an strategy to save our civilization. As a reminder, one must never assume that by imitating solutions from times past, means that these solutions are intrinsically the right ones (Lidwell, 2003).

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