DESIGN AND AGRIFOOD FOR NEW SUSTAINABLE LOCAL DEVELOPMENT

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ABSTRACT

This paper is about the relationship between design and the prickly pear of Roccapalumba (Sicily), a product of the agrifood chain, considering it as a resource able to start innovative strategies for waste recycling and for a sustainable local economy.

The study examines the entire life cycle of prickly pear and, among the various outputs, considers the cladodes to obtain cellulosic fibres, mucilage for cosmetics and for restoration of cultural heritage, the flowers for infusions and the fruit seeds for an oil with nutraceutical properties to generate a second life of the prickly pear. This will lead to economic and environmental benefits in the territory, creating a network of companies with zero waste.
Key Words: Design, agrifood, circular economy

1. INTRODUCTION

This study is about the relationship between design and the agrifood chain of a territory to promote a sustainable local economic development.

The article examines the prickly pear cactus of Roccapalumba (Valle del Torto) and considers it, as well as for its organoleptic and nutritive qualities, also as a resource able to start collaborations and innovations within the Sicilian territory, to enhance the relationship between local actors and synergies between disciplinary areas belonging to different areas, and improve the waste management. The study examines the entire life cycle of prickly pear and among the various outputs considers the cladodes (commonly called shovel of prickly pear), the flowers and the seeds of the prickly pear fruit to generate a second life of the prickly pear.

The methodological approach follows a systemic vision focusing on the relationship between the actors of a territory and the territory in which they live, and is based on Systemic Design that contributes to the development of a circular economy (Cradle to Cradle). With this methodological approach we move from a production chain of the linear prickly to a system (output of a system becomes input for another), using the cladodes to obtain a wood fiber, the flowers for infusions and the seeds of the fruit for the oil with nutraceutical properties.

This interdisciplinary approach is fundamental to implement a systemic vision that can link the various activities through the recovery and the use of by-products of a supply chain in other productive fields and make the system zero waste. The research involves actors, researchers and SME who are interested in experimenting with innovative products related to the fruit of prickly pear and its by-products.

Interdisciplinarity and the involvement of various actors highlights the role of the design as mediator to achieve results that will demonstrate how the waste of a local resource can be transformed to develop new supply chains. These new supply chains will bring economic repercussions on the territory and with a focus on respect for the environment.

This paper is divided in two parts one about the design applied to the territory and the other on the investigation of the role of the application to agrifood sector of the Systemic Design methodology in order to generate a development of the local economy.

2. METODOLOGY

The aim of the research is to explore sustainable design practices related to zero waste of the prickly pear and the benefits that can be gained from implementing a circular economy, not only to the environment but also in economic local development.

Prickly pear cultivation is important for symbolic, historical, and territorial reasons and its study is analysed through, innovative productive techniques in order to increase consumption and to reduce disposal problems.

To do this, it is necessary to review the process that involves the entire prickly pear life cycle. So, through redesigning the processes of production, transformation and marketing of the prickly pear, is possible to start virtuous processes of innovation and valorization within the local territory, favouring its economic development with greater attention to environmental resources.

In fact, it is important to review the process from the production of the prickly pear to its distribution on the market, passing it from a linear to a circular production.

Circular economy employs principles from industrial ecology, reuse, repair, and recycling of the materials and products. In industrial ecology the goal is to reduce resources consumption, pollution in the environment and industrial metabolism refers of industrial systems that act as natural ecosystems (Ayres,1989). Circular economy is an industrial economy that reproduces nature, optimizing the systems and following principles from nature (Ellen MacArthur Foundation, 2015)

This research shows prickly pear as a resource that, if redesigned according to the Systemic Design approach (Bistagnino, 2009) can identify new production chains that can interact with existing activities.

This methodology allows to design the flow of material and energy, transforming the outputs of one process into inputs for another, eliminating the linearity of the current production chain that generates waste, with the possibility of creating new value chains at the local level (Barbero, 2012)

This analysis clarifies the origin of what happens in all the processes, considering the inputs and outputs, the resources used for the transformation of waste and their final destination.

Furthermore, to understand the relationship between the parties involved and the context it is fundamental to identify the actors involved in the system, and their know-how.

To this end, research through the methodology of the systemic approach, investigates the production, processing and marketing of prickly pear with respect for the environment to generate local economic development. To achieve this goal, the phase of analysis of the production of prickly pear has used the methods and tools of Cycle Design (LCD). The study is based on a historical-cultural study of prickly pear, following which the production processes and the techniques used for cultivation and distribution were considered, highlighting where it is possible to make a redesigning intervention to move to a circular production

Furthermore, the study is based on a real case developed with the support of local producers that have made the designed solutions feasibility.

3. DESIGN AND LOCAL DEVELOPMENT

The design, in the past few years, has play a role in production systems and innovative models for the management of territorial resources. In fact, design has broadened its scope of action and can play a crucial role in the development of a territory, offering solutions for the growing demand of competitiveness, and creating new products and services. This is demonstrated by how the relationship between design and territory has been explored in the discipline of design, defining and bringing the succession of three different approaches (Parente, Sedini, 2017): "design in the territory", "design of the territory" and "design for the territory". Design, as propose Tim Brown (Cicoria, 2013), it has become an asset in any product or service in the market and a strategic tool in the landscape of innovation. Today Design is confronted with territorial, social and economic characteristics in the place in which it operates, and highlights those aspects that help to build a production identity in a specific territory.

Within of a territory, among his elements of identity other than natural and cultural heritage, there is also, agrifood which represents a primary good, a means of expression of community's traditions, a source of well-being and health and a symbolic element of socio-cultural and of identity.

In order to launch innovation processes with the goal of environmental sustainability, it is crucial to put the focus on the potentiality of territories based on the transformation of existing, economic, human, cognitive and cultural resources and role that different players of a territory. More specifically, to do that, is important to adopt an interdisciplinary approach where know - how, cultures, and techniques related to innovation can answer to new changes of cultural, social and economic paradigms.

The aptitude to power the typical resources, which is no possessed by others, is presented as competitive opportunity and change is determining factor in the fame of the place.

This suggests that design is becoming increasingly important in the field of innovation. It is becoming indispensable in the design process of any product or service, shifting its focus from the mere design of the product to the whole process and exploring new business models (Brand, Rocchi, 2011).

4 .ANALYSIS ABOUT PRICKLY PEAR

The prickly pear (Opuntia ficus indica), is a member of the Cactacee family, originating from Mexico and distribuited in America, Europe and Africa for the production of fruit, forage or vegetable. In Sicilian production and distribution areas, located in the San Cono Hills, South-West of Etna, Belice Valley, the Valley of Torto and to Roccapalumba in the province of Palermo, and that in 2009 established the consortium of producers of prickly pear, 'Roccapalumba and its flavors'. The bark of the prickly pear is composed of cladodes (commonly called pads) that branch in a tree-shaped. The cladodes form the stem of the plant, this stem is naturally modified to retain water. Cladodes contain water, carbohydrates and fibres, mucillage, proteins, minerals and a moderate amount of vitamin A and C. Scientific literature recognizes cladode components for use in the pharmaceutical, herbalist and cosmetic fields. The prickly pear after hand - picking is packed in cardboard boxes, the fruit and the inside of the skin, are used for the production of beverages, jams, mustards and a variety of food products From study of the cycle of production of the prickly pear among the various outputs considers the cladodes, the flowers, mucillage and the seeds of the prickly pear.

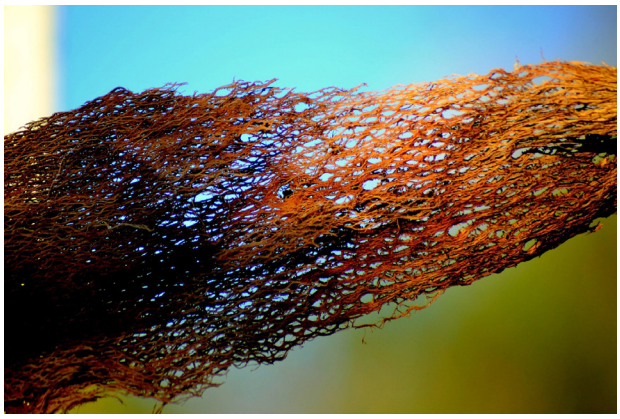
5. NEW PRODUCTS FROM OUTPUTS OF PRICKLYPEAR

This study examines the outputs of the prickly pear: flowers, seed, mucillage and cladodes. Opuntia ficus indica flowers for the decoctions and infusions can be destined to the herbalist's shops while, as regards to the seeds that are an ouput from fruit is extracted an oil that rapresent an interesting cactus by-products. In fact, this oil has nutraceutical properties that is rich in polyunsaturated fatty acids and vitamin E content. These compounds are responsible of the antioxidant and hypoglycaemic effect mediated by the inhibition of carbohydrate-hydrolysing enzymes. Health benefits of fruit and vegetables came from additive and synergistic combinations of phytochemicals. (Am J Clin Nutr 78: 517S-520S). In this context Opuntia ficus-indica seed oil represent a promising source of healthy compounds useful not only as antioxidant to preserve lipid components in food preparation but also as functional ingredient due its hypoglycaemic effect. The scientific results on the seed oil for human nutrition, have been developed, with the collaboration of a research team made up of chemists, biologists and pharmacists of the University of Palermo, Reggio Calabria and Marche, and can be added to the best known use for cosmetics.

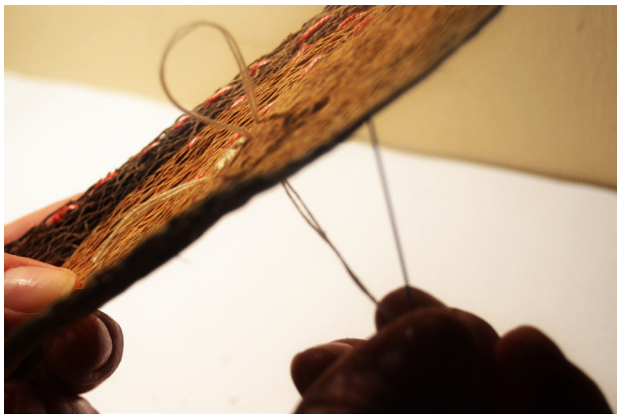
Mucilages of Opuntia are compounds of great potential to be applied in different fields, such as conservation of cultural heritage, pharmaceuticals, cosmetics, foods and biodegradable polymers. Mucilage is a polysaccharide generally composed by varying proportions of l-arabinose, d-galactose, l-rhamnose, and d-xylose, as well as galacturonic acid (Sáenz C. et al., 2004), and it tends to be negatively charged (Gibson and Nobel, 1990). Thanks to its natural viscosity, its ability to form molecular networks that are able to retain large amounts of water (Saag et al., 1975), and its capability of forming gels in water, mucilage can be used for the development of bio-based innovative products, like additive and organic binder to improve the mechanical properties of materials used for the conservation of cultural heritage or as an alternative for producing added-value industrial polysaccharide gums. For example,

in Mexican historical buildings nopal juice extracted from Opuntia spp. is often incorporated in lime mortars [Ca (OH)2], it works as an organic adhesive that prevents the mortar from drying too quickly and helps to retain the necessary amount of moisture, transporting CO2 from the atmosphere that combines with the lime to form an artificial limestone, using the iuice as an organic adhesive to restore and protect historical buildings (Cárdenas A. et al. 1998).

The cladodes, that come from the pruning serves to ensure the propagation of cuttings and the preparation of soil for new production, the remaining part decomposes due of the water present in the cladding, thus wasting the wood fibre within them that could be a resource. In fact to obtain the vegetable fibre it is necessary to extract it and to dry it at open air; the extraction procedure is manually carried out by the green cladodes. This extraction process is under patent phase; the extracted fibre (Figure 1)has a complex, texture and thanks to its plasticity, such as wood, it allows steam treatment or immersion in hot water at a temperature between 30 and 40°C, in order to take the shape of the mold. The natural fibre obtained from the cladode waste, has led to a return to manual work in the process of product realization. Through this approach design can to coexist with local craftsmen who propose, artifacts that reveal a material and immaterial heritage. The embroidery was chosen to be used, where necessary, as an element of union of decoration and identity, thus bring back a local tradition (Figure 2). The embroidery, together with the art of processing, are the elements for a new dialogue between craftsmanship and design, which focuses on the identity of a territory through a new resource obtained from a waste. The project and context become inseparable, and the project and production activity are in close contact with the collaboration of the artisans from the Valley of Torto.



[Figure 1]Prickly pear fibre

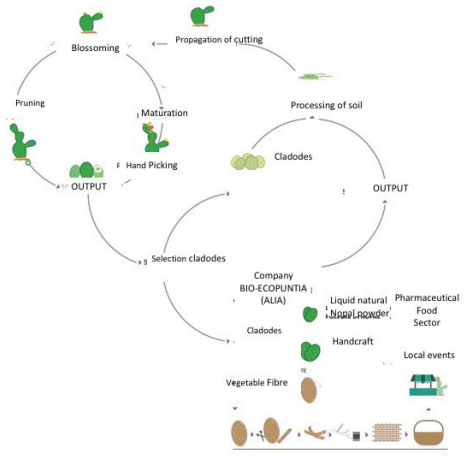


[Figure 2]Prickly pear fibre and embroidery

The prickly pear fibre was applied to make a basket to carry, expose, and contain the prickly pear (Figure 3). For the production of the basket prickly pear fibre was used, the olive branch for the handle and the embroidery to join and decorate the parts that make up the basket.

[The design a basket, as a first artifact, came from the necessity to expose and contain prickly pears during the XVIII edition of Opuntia-Ficus Indica Fest, Sagra del Ficodindia (Prickly pear Festival) in Roccapalumba.

Then the approach of Systemic Design has allowed to identify new productive chains that have led to the creation of the Bio-ecopuntia srl company. From the cladodes the Bio-Ecopuntia company is able to extract three natural elements: nopal powder, to be used as a food ingredient gluten-free, the natural liquid to be used in the pharmaceutical and cosmetic sectors, and the wooden lattice to be used as vegetable fibre; the cuticle (the external layer of the cladode) can be used as fertilizer or as food for animals. It is also possible to dry the flowers and to use them as phytotherapeutic products (Figure 4).



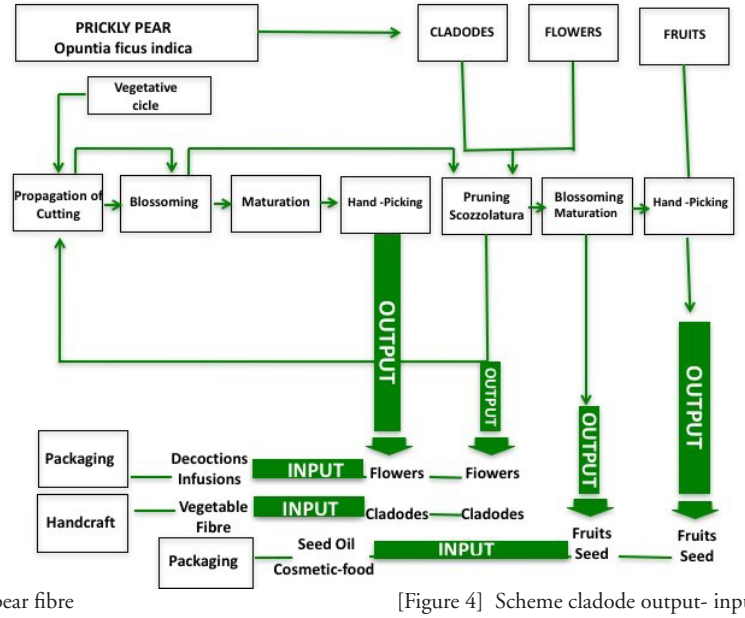


Figure 3] Basket with pricly pear fibre

[Figure 4] Scheme cladode output- input

[Figure 5] Scheme Prickly pear and output - input

6.OUTLOOK AND CONCLUSION

The results show that from output prickly pear there are some potentialities within the project and which could be further developed (Figure 5):

Opuntia ficus indica seed oil

Actually used in top cosmetic products and beauty treatments, the Opuntia ficus indica seed oil could be shortly be produced for applications well beyond cosmetic, to become a new ingredient in nutraceutical, food supplement, sport drink and food.

Opuntia ficus indica flowers

Opuntia flowers used as medicinal plant are astringent and are used for problems of the gastro-intestinal tract, colitis and irritable bowel syndrome. This flowers could be more valued as decoctions and infusions.

Packaging

Packaging to enhance and distribute Opuntia ficus indica seed oil and Opuntia ficus indica flowers for the decoctions and infusions. This packagings, certainly, to reduce environmental impact will be design following certain guidelines to reduce environmental impact: single material to facilitate the separate collection, recovery, recycling or composting in end of life, used recycled and further recyclable material, to extend the useful life of the product by integrating new function coherent with the intended purpose of use.

Vegetable fibre extractded from cladodes

The design of the basket to contain prickly pear marks the beginning for the development of different products.

The results show that, turning these outputs into resources for the territory will give new opportunities for local development economic. If we exploit the territorial resources we may boost a type of development that favours the local dimension and will allow to produce, supply and generate autonomously.

To conclude the study shows, through the Systemic Design and the multidisciplinarity, the role of mediator of design to achieve results that demonstrate how the waste of a local resource can be transformed to develop new supply chain as: the possibility of designing new packaging to enhance and distribute prickly pear flowers decoctions and infusions and Opuntia Ficus Indica seed oil in the nutraceutical sector. It is possible to see a new path made by the interaction between design and craftsmanship development, that starting from a new local renewable material, and other products is able to bring innovation in the tradition.

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