Biodiversity as a source of innovation and development: the Trapani and Marsala saltworks

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Morphology of the coast (flat and low)
climatic characteristics (dry and windy)
high productivity of the fishery resources
ORIGIN? • high productivity of the fishery resources

- Carvings 11/12,000 years
- Paintings 5/6,000 years

- Roman fish processing plants

- pits for *garum*, a salted and fermented fish sauce (tonnara San Vito)
ORIGIN? • high productivity of the fishery resources

- Tonnara of Scopello
- Tonnara of Bonagia
- Tonnara of the Island of Favignana
high productivity of the fishery resources

- Tuna fish
- Bottarga
- Tuna fish row
- Heart
- Stomach
- Intestine
- Salami
- Lung (pyloric caecae)
- Meat

150/220 €/kg
Salt and fishery have been the pillars of our economy. Today they are no longer important.

Surface 1,200ha (Trapani and Marsala)

Harvested 75%
25% abandoned (fish farming)

80% industrial salt work (1)
20% artisanal salt works (15)

90,000 t annual salt production
80% industrial production

HIGH ADDED VALUE

geometry of the basins and the "wind machines" make a unique landscape of this part of Sicily
Artisanal saltwork innovation

manual harvesting

home made mechanization

“willingness to experiment”

tourist exploitation

Sosalt spa
University of Palermo
Marine Biology of Trapani

The Fresh Salt Company S.r.l.,
Trapani
S. Daidone, 2005
The economic value of biodiversity in solar salt works
3rd-4th June 2014, Sicily, Italy

1984
R.N.O. Isole dello Stagnone

1995
R.N.O.
Saline di Trapani e Paceco
ARTIFICIAL ENVIRONMENTS
generated and maintained only by human labor,
used for the purpose for which they were constructed

colors between the need to protect and the need to use

1996 113 bird species in 2005 200 bird species
derogation by the Council Directive
2009/147/EC (Birds Directive)

ECOSYSTEMIC APPROACH
The organisms that immediately attract the attention of tourists

- **Birds**, more than 200 species

- **Plants**, more than 450 halophytes, with some endemisms

- **Insects**, endemism

- **Etc.**
SALT WORK BASIN BIODIVERSITY

Strong gradient effect

- First storage basins 70% vegetated surface
  - 2 sea grass *Ruppia cirrhosa* and *Cymodocea nodosa*
  - 47 taxa of algae
  - Farmed and wild fish *Syngnathus abaster*, *Atherina boyeri*, *Aphanius fasciatus*
  - Some specialized species of Crustaceans, molluscs, polychetaes etc.

Increasing salinity

*Aphanius fasciatus*

*Artemia salina*

*Dunaliella*

*Halophilic bacteria and archaeabacteria*
Crucial role of halophilic microorganisms in salt production

Vs

Scientific interest

- the initiation of the crystallization process (Castanier et al., 1999),
- the acceleration of the formation of crystals (Norton and Grant, 1988);
- the determination of the size and halite number (Lopez-Cortes et al., 1994).

“giant bioreactor”. In salt works basins extremophilic microorganisms, their metabolites, with biological processes associated with them and with the biological processes that they determine, significantly influence the formation of halites in the crystallizing basins.
In situ effects

compatible solutes, antioxidants, carotenoids and polyphenols, for stress management and adaptation and in scavenging free radicals and oxidative stress, related to UV exposure.
Biodiversity of salt work can be profitably used to increase the income of salt works exploitation.

Taking advantage in a sustainable manner of the peculiar biological characteristics of extremophilic organisms living in these environments.

Dufossé e coll (2013) d 16S rDNA profiles PCR DGGE
Carotenoid-derived aroma GC-MS (Silva et al., 2009; 2010; Donadio et al. 2011)
biomarkers to trace geographic origin of marine salt

red water of $10^7 - 10^8$ CFU /ml
incorporate the brine $10^5$-$10^6$ CFU per gram salt
survive for long periods, tens of thousands of years

growing need for a pan-European tracking system that gives information about the origin of food products
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IDENTIFICATION, EXTRACTION OF BIOACTIVE MOLECULES FROM HALOPHILIC ORGANISMS AND EVALUATION OF THEIR EFFECTS

Halophilic Plants and bacteria extracts
Nutraceuticals Pharmaceuticals Cosmetics
Nutraceutical applications

*H. glaucum* and *H. Strobiliaceum* secondary metabolites, mainly phenolic compounds

coupling MAP and antioxidant from halophytes to increase shelf-life of local fisheries species

*Coryphoena hippurus* antioxydants SFE extracted

MAP (45% CO₂, N₂ 50%, 5% O₂)

Improvement of sensory properties, reduced the levels of biomarkers of:
- lipid peroxidation
- protein degradation
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Halite inclusions
Isolation
16s RNA
Characterization
Mass culture

Extract characterization
Pilot scale SPD Extraction
Pilot scale SFE Extraction
Lab scale SFE Extraction
CEPA Le
Pharmaceuticals applications
Antiproliferative and pro-apoptotic effect of Bacterioruberin extracted from *H. salinarum* in cancer cell line

Antioxidants activity preventing or scavenging free radicals ROS induced (procancerogenic)

decrease of cell viability up to 50% time-dose dependent

Treated cells underwent to apoptosis
Increase of P53 (pro)
Reduction of BCL2 (anti)
Activation of procaspase (pro)
Pharmaceuticals applications

Time and money consuming

more interesting but less scientifically fascinating
Cosmeceutical application
Photoprotective effect of antioxidants of bacteriruberin ROS, induced by UV exposure:

Photoprotective effect on cells

Reduction of expression of MMP-1 after UV stress

anti-wrinkle effect
Induced degradation of protein related to tissue structure
Collagene, elastine………
Cosmeceutical application

Anti-aging and anti-wrinkle effect of bacterioruberin
On differentiation of staminal like cells

ACo
A + Hal

Stimulation of adipogenesis

BEFORE
wrinkled skin

AFTER
smooth skin

FAT CELLS
PREADIPOCYTES
ADIPGENESIS

Control of molecular markers involved in adipocyte differentiation
Such as PPARγ transcription factors involved in modulation of proteins related to adipogenesis

Effect dose dependent
Convention on Biological Diversity - Nagoya Protocol,

- a virtuous approach to exploit resources of biodiversity
- sharing their benefits at a fair and equitable way, with local population,
- and by appropriate transfer of relevant technologies.

proposed technologies are reflected in industrial biotechnology, one of KETS indicated in by EU to boost innovation and development

They present a value of technological readiness quite high.

In particular as regards the nutraceutical applications that have already been tested in the production cycle a local artisanal seafood enterprise.

In our opinion this could be a virtuous approach to biodiversity: study biodiversity to protect and, at the same time, take advantage, in a sustainable manner, to produce innovation and development and to generate income, part of which will be reinvested in the study and protection of biodiversity.