Biotechnology: a tool to develop high quality, innovative, functional and eco-sustainable textiles

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Stazione Sperimentale per la Seta

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Industrial Biotechnology

⇒ use of biological systems, living organism and their derivatives (enzymes) in industrial processes

Enzymes

⇒ biological catalysts used in place of chemical agents

(biodegradable molecules, zero environmental impact, less problem regards effluents and emissions, increased product quality/safer processing conditions)

Why

⇒ Same or better product quality
⇒ Costs reduction (estimated from 10 to 30% less)
⇒ Low environmental impact
⇒ Observance of law restriction (health, safety, environment protection)
⇒ Added value to MADE in ITALY brands

The BIOTEX Project

Biotex - Biotechnology: a tool to develop high quality, innovative, functional and eco-sustainable textiles

ID 4052 - MD 2007

R&D:

Stazione Sperimentale per la Seta
Centro Tessile Cotoniero e Abbigliamento S.p.A
Università Bergamo, Dip. Ing. Ind.
Univeristà Torino, Dip. Biologia Veg.

RegioneLombardia

IND:

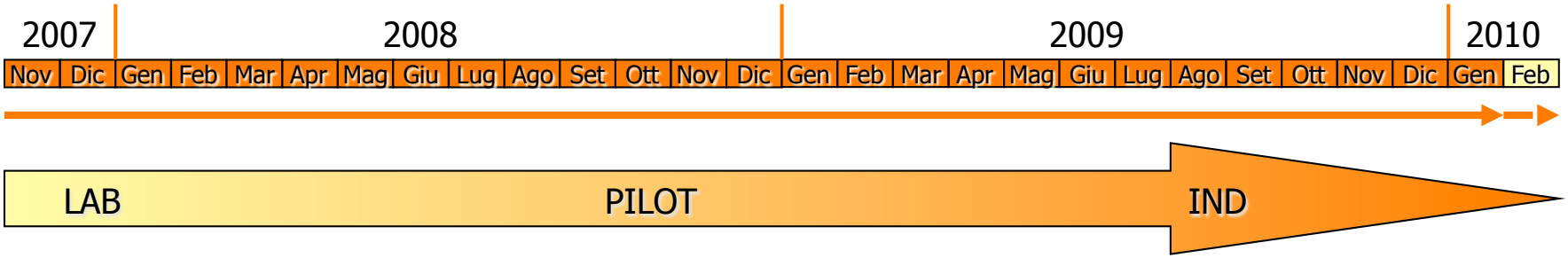
F.T.R. Forniture Tessili Riunite S.p.A.
Felli Color S.p.A.
Cittadini S.p.A.
C. Sandroni e C. S.r.L.
Tessitura Enrico Sironi S.a.S.
Mascioni S.p.A.
Linificio Canapificio Nazionale S.p.A.

BIOTEX

Main objectives

- Innovation of traditional textile manufacturing cycle (wet treatments)
- Improving functional and aesthetic properties of textile goods
- Creation of new qualitative standards
- Widening market opportunities (innovative products for new markets)
- Addressing the choice (life-style) and improving the customer/consumer satisfaction
- Optimizing energetic efficiency, safety and environmental sustainability of processes (BAT, REACH, EU Water Framework Directive)
- Encouraging company competitiveness (process and product innovation, stabilizing/ increasing employment, sustaining inter-sectorial networking)
- Training of new and highly qualified/skilled textile experts

Biotex: project timetable



1-50 g

1-5 kg yarns
2-10 m fabrics

250-500 kg yarns
500-1000 m fabrics

Project was divided into three main actions:

Action 1:

Biocatalytic processes

Action 2:

Bioactive textiles

Action 3:

Biosorption

Oral presentation A09

G.C. Varese - *Scale-up of biosorption process for the textile wastewaters treatment using a selected fungal biomass*

Action 1: Biocatalytic processes

Implementation of enzymatic processes into the manufacturing textile cycle

a. Cotton/flax bioscouring
b. Chemo-enzymatic bleaching
c. Biopolishing and biofinishing of natural and synthetic fibres
d. Bio-functionalisation of cellulosic fibres.

Enzymes:
pectinase – cellulase – xylanase – cutinase – laccase – mix …

a. Bioscouring of cotton yarns

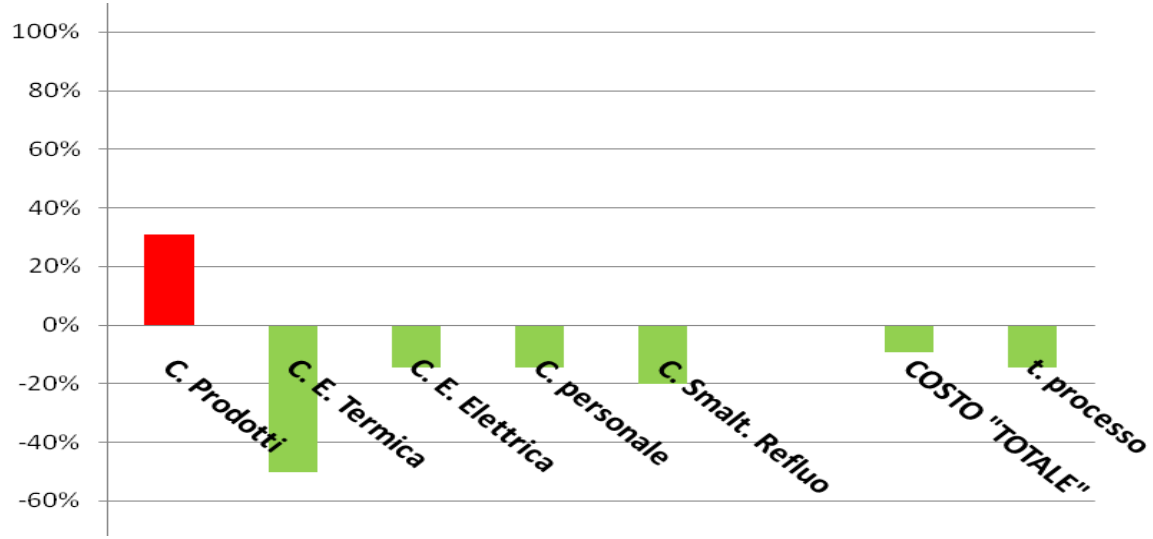
Most SIGNIFICANT PARAMETERS investigated:

- Properties of starting material (cotton yarn)
- Enzyme concentration (pectinase and cutinase) and enzyme mix (one formulation, possible synergies)
- Integration of processing steps
- Reaction temperature and time (enzyme optimum conditions)
- Wash out after enzymatic treatment and drying technology

The enzymatic process has been developed up to the industrial scale, including analysis of economical and environmental impact

BIOTEX

a. Bioscouring of cotton yarns



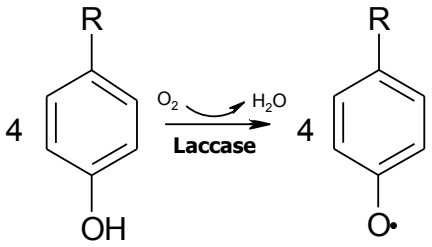
EVALUATION of ECONOMIC IMPACT of enzymatic process:

Costs and time reduction: from 9 to 15% → competitive and advantageous

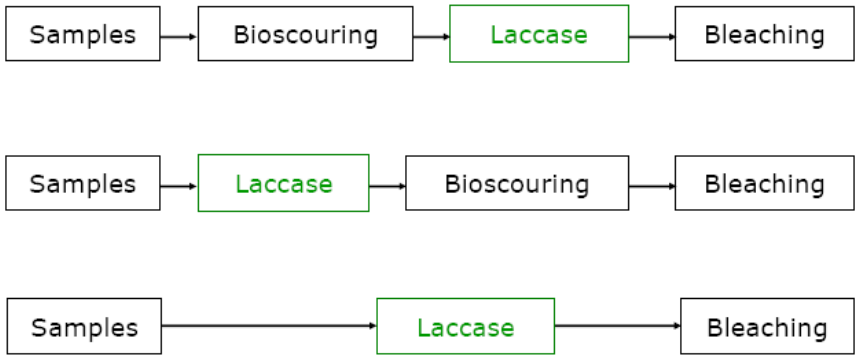
(-50% methane consumption; -15 % energy consumption and staff cost; -20% wastewater purification cost; -30-35% COD)

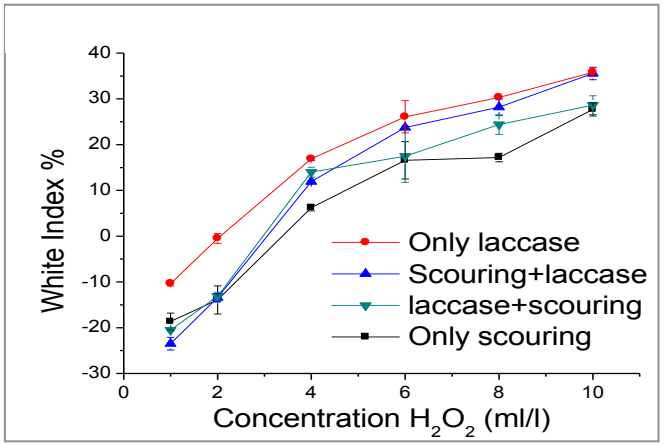
⇒ Improvements due to a shorter working cycle and to less use of chemicals

b. Chemo-enzymatic bleaching of flax



Laccases effects on cellulosic fibres
→ oxidizing lignin

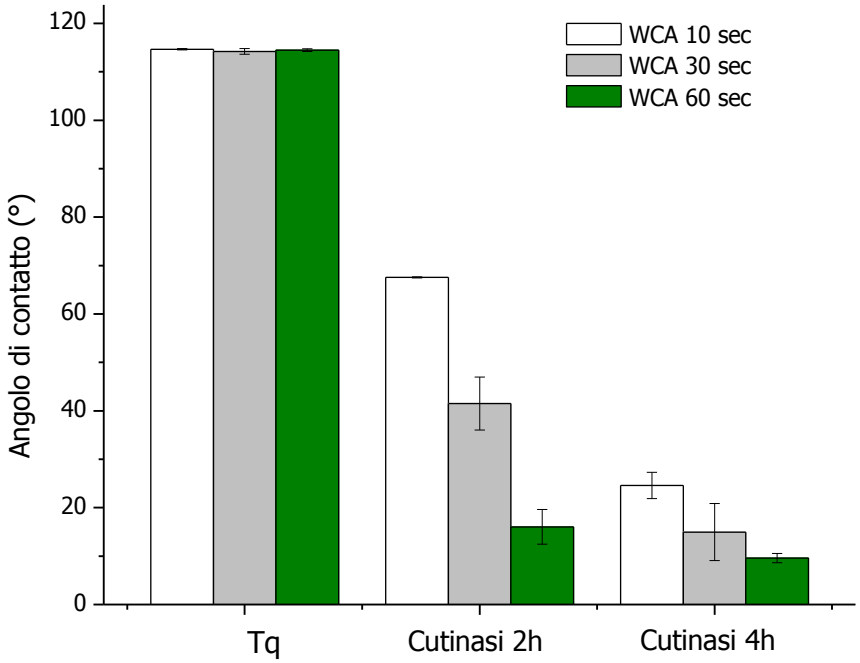


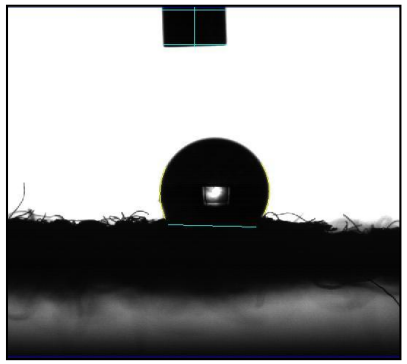


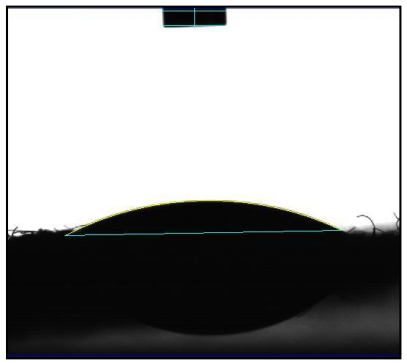
- Laccase pre-treatment could aids bleaching process
- Possibility to reduce the environmental impact (lower amounts of H_2O_2)

c. Biopolyshing and biofinishing of natural and synthetic fibres

Polyester ⇒ Inert surface ⇒ Cutinase

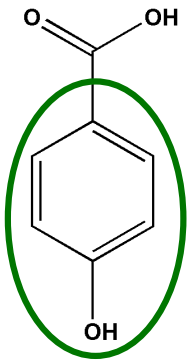




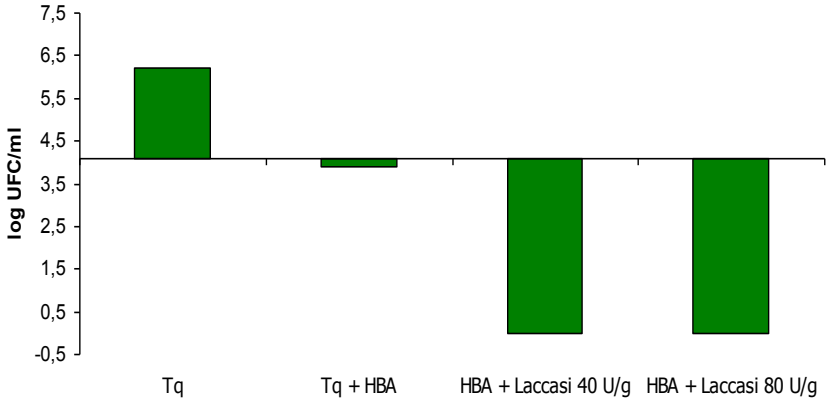


Polyamide ⇒ Protease (work in progress)

d. Biofunctionalization of cellulosic fibres

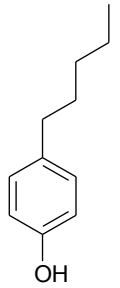


***p*-hydroxy-benzoic acid**

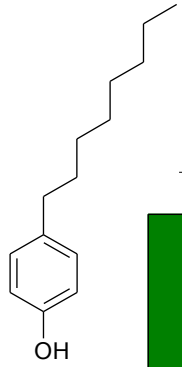


Antibacterial flax

Pentyl-phenol



Octyl-phenol



Hydrophobic flax

Action 2: Bioactive textiles

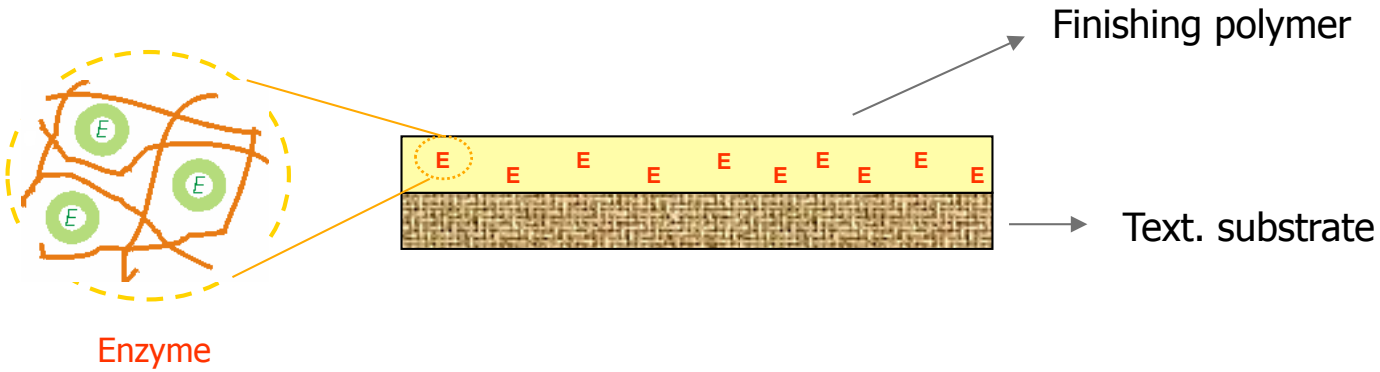
Development of bioactive textiles.

- Antifouling properties textiles;
- Protective clothes (bioprotection);
- Filtrating textile devices (biofiltration);
- New approaches to biotraceability

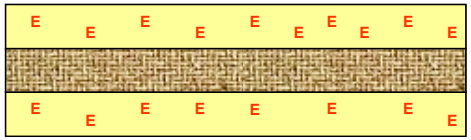
Enzymes:
- protease
- organophosphourous hydrolase
- catalase

Most SIGNIFICANT PARAMETERS investigated:

- **Enzyme activity** → depending on different applications;
- **Carrier** → enzymatic entrapment → verifying activity and stability;
- **Textile substrate** → depending on different applications;
- **Application technology** → already existent in textile field (coating, spraying, padding, etc.)

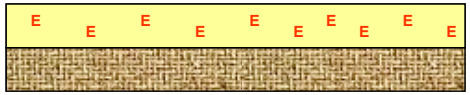


Double layer



Different ways for immobilizing

Single layer

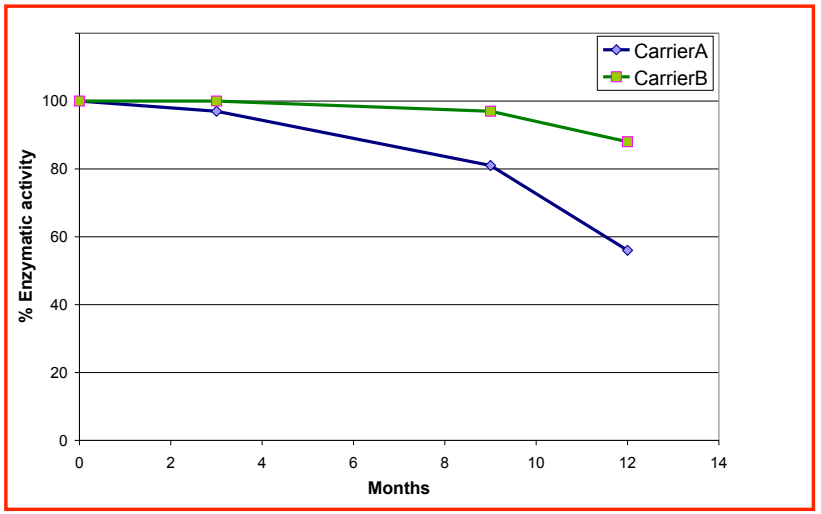


Study of stability of bioactive devices

Enzyme stability ⇒ one of the most important functional parameter.
Depending from: textile substrates, immobilizing agents, treatments conditions.

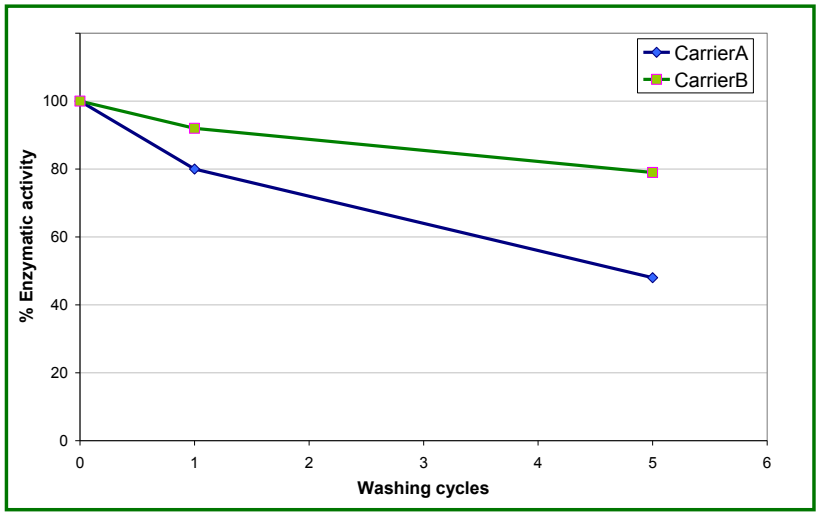
Enzymatic activity stabilization: SHELF LIFE

⇒ **Optimum up to 12 months**



Enzymatic activity stabilization: OPERATIVE CONDITIONS

⇒ **Washing resistance to be improved**



Conclusions

MAIN PROJECT ACHIEVEMENTS:

⇒ **Bioprocesses developed up to industrial scale** (bioscouring, biofinishing);

⇒ **Bioprocesses developed up to pilot scale** (bioprocessing of synthetics, bioactive textiles, biotraceability);

⇒ **Bioprocesses studied at lab scale** (biobleaching, biofunctionalistion);

⇒ **Patents**: 4 submitted;

⇒ **Training-education**: 1 bachelor's degree, 5 Master's degree, 1 Doctorate degree;

⇒ **New projects submitted** (Green Made) and financed (BioIn Nano)

Web site: www.progettobiotex.it

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