Sustainable exploitation of silk by-products
SILK
SILK degumming
Environmental impacts

- Degumming effluents
  - $\text{BOD}_5$ (mg/l): 30’000-50’000
  - COD (mg/l) > 2’000
  - SST (mg/l) >1’000
- 25% of animal-produced material actually wasted
- Energy used to heat the water
- Co-formulants of the degumming moisture: soap, detergents, emulsifiers
- Water depletion
Numbers from the Como Silk District
Numbers from the Como Silk District

- 2,000 tons of silk manufactured on a yearly basis
  - 140,000 mc of depleted water
  - > 7 mln kg of steam
  - 300,000 kg of co-formulants
  - ....

... to produce 1,500 kg of silk to be used (fibroin)

... and 400-500 kg of sericin to be discharged
Virtues of sericin

Although sericin is a byproduct of the textile industry throughout the world and is produced during the processing of raw silk cocoons, sericin potential utility ranges from cosmetics to biomedical products, which includes its use in anticancer drugs, anticoagulants, cell culture additives and for its antioxidant properties in pharmacological and biotechnological applications.

In particular, low-molecular-weight sericin is used in various blends for cosmetic, medical and pharmaceutical applications since it helps to enhance the elasticity of skin and has anti-wrinkle and anti-aging effects. Sericin enhances the light-screening effect of UV filters like triazines and cinnamic acid esters. Sericin has also many medical applications. Study of the macrophage response of silk protein concludes that sericin usually does not manifest inflammatory activity when present in soluble form.

The recovery and recycling of sericin byproducts could be a significant environmental, economic and social benefit.
Current practices

In degumming water, the low concentration in sericin induces its aggregation and precipitation at room temperature. To avoid this drawback and to prevent material decomposition, sericin solution must be lyophilized.

However:
• lyophilized sericin is less soluble in water (about -60%), due to conformational rearrangement after water removal,
• the lyophilization process is relevantly energy- and time-consuming
• the lyophilized sericin is usually sold around 150-200€/kg
Ultrafiltration!

Our **prototype** is based on a ceramic-filtering ultrafiltration that allows:

- Elimination of contaminants
- Sericin solution concentration

Through:

- ceramic membrane with cutoff 15kDa
- Cavity pump with flow-rate 2400l/h
- working temperature around 40°C
Ultrafiltration!

INPUT:

• 40 l
• Concentration: 21.38 g/l
• Sericin in the solution: 855.2 g

OUTPUT:

• 10 l
• Concentration: 37.4 g/l
• Sericin in the solution: 374 g
Ultrafiltration!
Cost

Current practices

In degumming water, the low concentration in sericin induces its aggregation and precipitation at room temperature. To avoid this drawback and to prevent material decomposition, sericin solution must be lyophilized.

However:
• lyophilized sericin is less soluble in water (about -60%), due to conformational rearrangement after water removal,
• the lyophilization process is relevantly energy- and time- consuming
• the lyophilized sericin is usually sold around 150-200€/kg
Preliminary estimations performed using the prototype show a FULL cost that would allow to sell the sericin (sterilized) gel (10% of sericin in the solution) for less than 10€/kg

→ < 100€/kg of sericin to the customer

• the lyophilized sericin is usually sold around 150-200€/kg
... and the environment?

- **Degumming effluents**
  - BOD \(_5\) (mg/l): 30’000-50’000
  - COD (mg/l) > 2’000
  - SST (mg/l) >1’000

- **With respect to lyophilization:**
  - ½ energy consumed
  - Improved sericin *quality*
  - -40% production costs
Contributors...

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SUPSI
Patent

Camera di Commercio Industria, Artigianato e Agricoltura di MILANO

Verbale di Deposito Domanda di Brevetto per INVENZIONE INDUSTRIALE

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Data di deposito: 23/09/2013

In data 23/09/2013 il richiedente ha presentato a me sottoscritto la seguente domanda di brevetto per Invenzione Industriale.

MILANO, 23/09/2013
L'Ufficiale Rogante

A. RICHIEDENTE

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INNOVHUB - STAZIONI SPERIMENTALI PER L'INDUSTRIA - AZIENDA SPECIALE DELLA CAMERA DI COMMERCIO DI MILANO
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C. TITOLO

Titolo PROCEDIMENTO E APPARECCHIATURA PER LA PREPARAZIONE DI MATERIALI PROTEICI DERIVANTI DA FIBROINA, IN PARTICOLARE PER USO MEDICALE E COSMETICO

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