



## **SUMMARY**

### **DESIGN, REALIZATION AND EXPERIMENTATION OF A MOBILE STATION FOR SAMPLING AND TREATING ALGAE. – Nanobioalgae Project. Dott. Ing. Stefano G. Carnevale, Ph.D.**

*Abstract* – This paper presents a schematic summary of the technical solutions developed by Technores for the preliminary, final and executive design and the successive experimentation steps of the prototype of a mobile station for sampling and treating algae in order to use them in chemical processes employed to extract proteins and active substances.

#### **1 NANOBIOALGAE PROJECT**

The NANOBIOALGAE Project, cofinanced by Regione Toscana within the Regional Operational Programme FESR 2014-2020-research and development projects for SME (Call n°2), (D.D. Regione Toscana 3389 30/07/2014), aimed at developing micro/nanostructured systems based on natural polymers extracted from algal biomass in order to use them as functional active substances for the development of new high-value-added products in the cosmetic, textile and food industry.

Even though algal biomass is used in the food sector, it proliferates in an uncontrolled way because of eutrophication and it is difficult to dispose of and harmful for the environment. Even if algal biomass represents an ideal source of materials, it has been scarcely exploited so far and it has only been used to extract lipids from microalgae in order to produce biodiesel. The ubiquity and abundance of this biomass make the exploitation and the cultivation processes of the algae sustainable and make it possible to extract materials from them at competitive costs and by means of environmentally friendly methodologies.

The NANOBIOALGAE project has developed reproducible procedures with a low environmental impact for the extraction of mainly polysaccharides from algal biomass available in Tuscany. The matrices developed have been experimented for the design of micro/nanostructured systems to be used – within industrial production processes which must be adequately modified or developed ex-novo – for the production of alcoholic and non-alcoholic drinks, filling for dough and confectionary products, cured meats, baked products (in the food sector), micro/nanoformulated substances with essences/essential oils/ antioxidants and active substances for supplements (in the cosmetic sector), textiles with flame-retardant and antibacterial properties (in the textile sector). These results have been achieved thanks to the contribution of a partnership made up of: the consortium INSTM-UdR-Pisa, Department of Chemistry and Industrial Chemistry (INSTM-UdR-PISA), which has worked mainly on the extraction of substances from algal biomass and the realization of the micro/nanostructured systems; an enterprise specialized in the application in the

food sector (Enrico Giotti S.p.A.); an enterprise operating in the cosmetic sector (Officina Profumo-Farmaceutica di Santa Maria Novella S.p.A.); an enterprise specialized in the development of the reactors and of additional prototype systems for the application of the encapsulated substances (Campanella Costruzioni Meccaniche S.r.l.); finally an enterprise interested in the applications in the textile industry (Tessiltoschi Industrie Tessili S.p.a).

Within the NANOBIOALGAE project, Technores s.r.l. has carried out consulting activities for all partners involved and it has contributed to the development of the innovative processes in the different industrial fields. In particular, as regards Enrico Giotti s.p.a. and Campanella Costruzioni Meccaniche S.r.l., Technores s.r.l. has designed and taken care of the realization, testing and successive experimentation of the innovative prototype of a mobile system for the treatment of algae able to provide the algal biomass necessary for this project.

#### **2 SPECIFICATIONS OF THE TREATMENT PROCESS**

The most critical need of the partnership was represented by the design of the prototype of an innovative system able to treat the different kinds of biomass in field, directly where the algae are found, in order to minimize storage times and make it possible to get a stable semi-finished pre-product in the shortest time possible thus avoiding the deterioration of the active substances contained in the algae caused either by their exposure to air or by the temperature.

To this end, Technores staff has carried out research activities aiming at identifying which washing, drying, homogenization and storage processes were suitable for the present application and could be realized in a movable container.

According to the project's provisions the system to be developed had to be able to treat on site about 60-70 Kg of algal material per hour immediately after its harvesting and in particular to wash, homogenize and store it at a temperature not exceeding 12° and then to allow its subsequent direct transport to Enrico Giotti s.p.a. in Florence.

In order to meet these requirements, a process including following sections has been developed:

- Multiple washing to clean the algal material in three subsequent water tanks with air agitation;
- Drying by means of centrifuge;
- Cryogenically freezing by means of a system using CO<sub>2</sub> (dry ice) as refrigerating fluid (this system is particularly good for applications on site, far from energy sources);
- Direct grinding of the Cryogenically frozen semi-finished product;
- Direct storage of the Cryogenically frozen semi-finished product in dry ice and transport.

The entire process has been designed in order to be realized in a container and to be carried out also in remote places with no utility available.



In the application envisaged by the present project the system had to be experimented at Orbetello employing the algae (*Chaetomorpha* and *Ulva lactuca*) living in the lagoon.

### 3 PROTOTYPE

Considering the process specs and the necessity to implement the process also in remote places with no utility, a 3D container has been designed as shown in figure 1.



Figure 1 – 3D project

The designed system autonomously performed the washing, drying, hibernation, grinding and storage of 60-80 Kg/h of algal biomass by means of following devices:

- a 40kVA 32kW generator;
- a 2 hp compressor;
- 100 kg of dry ice per day;
- 1000 kg of water per day;

When closed, the container would look as shown in figure 2 in order to disseminate the NANOBIOALGAE project and to show the contributions of the partners and of Regione Toscana.



Figure 2 –3D project from outside

Once the project has been completed and approved by the partners involved, Technores together with Enrico Giotti s.p.a. and Campanella Costruzioni Meccaniche S.r.l. (i.e. the enterprise which has built the designed container) have realized the final system using sections which were all available on the market except for the cryogenic chamber which has been specifically configured by SOL s.p.a. for the present application according to Technores' specs. The final system, as shown in figure 3, has therefore been tested at the headquarters of Campanella Costruzioni Meccaniche S.r.l. and then transported to Orbetello for the first experimentation in field as shown in figure 4.



Figure 3 – Transport of the prototype

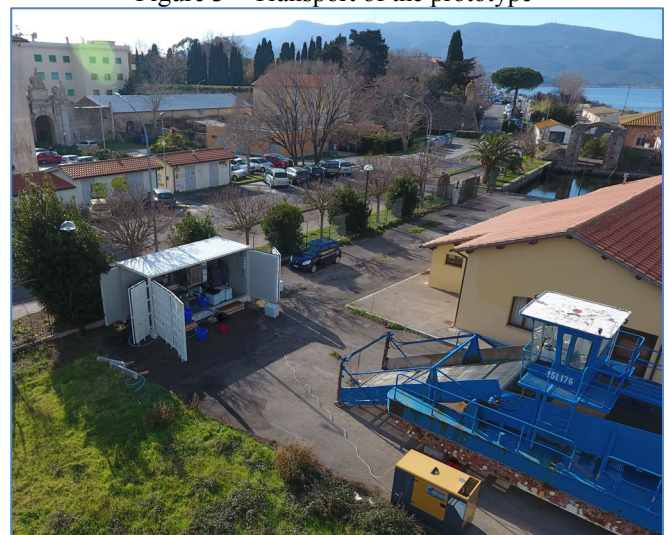


Figure 4 – Prototype operating on site

### 4 EXPERIMENTATION AND CONCLUSIONS

The system prototype has been installed near the Lagoon of Orbetello as shown in Figure 4 and it has been used for the experimentation of the project in field during which it has achieved all project's objectives as regards both the *Chaetomorpha* and the *Ulva lactuca* because it has made it possible to treat a preindustrial scale quantity of bioalgal mass.

Technores' staff has actively contributed to the logistics and the realization of the experimentation in field providing its operational support both in the operation of the prototype and in the management of the whole process from the harvesting of the algae to the cryogenic transport to the headquarters of Enrico Giotti s.p.a.

At present the system is functioning and it is available to the project partners and it will be used for the future sampling campaigns of algal biomass.

The Management.