



DEVELOPMENT OF A VACUUM-COOKING APPLIANCE FOR USE IN THE PROFESSIONAL CATERING BUSINESS

“Scientists need to understand how the creative processes used by Chefs and classic cooking techniques can help them to develop new and improved products”.

*Niel H. Mermelstein; “Combining culinary arts with food science”,
Food technology March 2003 –*

*In recent years, **gastronomy** has become one of the socio-economic driving forces behind this country. An increasing number of professionals in the restaurant business are dedicating part of their work to researching new cooking techniques that enable them to preserve the optimum characteristics of raw materials of a high gastronomic and economic value. This has led to much interest in **low-pressure cooking techniques** as a way of preparing basic products whilst maintaining their organoleptic characteristics, and also making it possible to modify their colour and even their initial flavour according to the chef’s imagination.*

*Within this context, **Valencia Polytechnic University** and the restaurants **La Sucursal** (Valencia) and **El Rodat** (Javea) have developed a vacuum-cooking appliance sold by the company **ICC** under the trade name **GASTROVAC**. It is a compact system for professional use that makes it possible to cook at low pressure, improving on the results produced by traditional culinary techniques such as boiling, frying, marinating, pickling and impregnation.*

ORIGIN OF THE PROJECT: THE RESTAURANTS “LA SUCURSAL” AND “EL RODAT”



The restaurant **La Sucursal** opened in 1995 in the Conde de Miraflores Palace, in Valencia. From those initial days to its current location at the Valencian Institute of Modern Art its image might have changed, but its quality has not. Thanks to chef **Javier Andrés**, this restaurant is at the cutting edge of Valencian gastronomy, its basic principals being to offer excellent service and constantly seeking to create new dishes.

Not far from Valencia, in his restaurant **El Rodat**, in Javea, **Sergio Torres** has always shared this same concern for quality and innovation in gastronomy. In addition to cooking, Sergio also spends a great deal of time researching new culinary techniques that treat foods with more “respect”.

Sergio Torres and Javier Andrés in the laboratories at UPV

Both these restaurants belong to “**Asociació de Restauradors Menjar i Viure**”, a restaurant association whose members include the most important restaurants and chefs in the Valencia Region, which does a great deal of work to raise the profile of gastronomy in Valencian society, represent the sector and encourage its members to innovate.

This case study has been carried out for Fundació Innova by Alberto Echavarría García under the supervision of Adrián Escardino Malva. The purpose of the Case Studies produced by the *Ciudad Politécnica de la Innovación* is to show the dynamics of cooperation between the researchers at the Park and their business environment. Fundació Innova would like to thank the researchers Xavier Martínez, Puri García and Neus Sanjuán, the restaurants La Sucursal and El Rodat and the company ICC for their collaboration.

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THE PROBLEM / OPPORTUNITY FOR THE CATERING SECTOR

Growing social awareness of the impact of eating habits on our health, together with a higher quality of life in Spain, are two factors that are leading to the emergence of new professional cooking techniques that treat food less aggressively. If we add to this the need to reduce the time we spend cooking, the result is a whole range of modern appliances that have come into the professional catering business to speed up the preparation process and help maintain the organoleptic and nutritional characteristics of the raw materials.

This phenomenon is particularly clear in more prestigious establishments, where the kitchens are beginning to look increasingly like small laboratories and the preparation of almost every type of dish requires a specific appliance. However, despite the wide range of technological possibilities that are available, whether for cooking by any traditional means or using more modern methods, chefs invariably face the deterioration of the food's natural properties as a consequence of heat stress.

“A chef's work is carried out in a transition zone between the original characteristics of a food product and those induced during its preparation. During this process, as we create something new, its original features must necessarily be lost to a greater or lesser extent. And unfortunately, normal cooking conditions mean that we have to work at temperatures that deteriorate our raw materials more than we would wish”.

Javier Andrés (La Sucursal)

In the case of preparation processes that involve heat treatments, this modification occurs selectively according to the temperature resistance of the different components of food products. Some changes are desirable and necessary, whereas others could be classed as parallel damage and they limit a chef's ability to create new dishes. The possibility of changing the rules of the game and working at sub-atmospheric pressures, thus reducing the working temperature, is therefore of great interest in present-day cuisine.

THE ENCOUNTER WITH THE RESEARCH TEAM FROM UPV

In April 2002, the restaurant association **Asociación de Restauradores Menjar i Viure** signed a **Collaboration Agreement** with **Valencia Polytechnic University** in order to bring cuisine and technology closer together through training and the exchange of expert knowledge (See Appendix 3: standard agreements and contracts for establishing relations between UPV and companies and institutions). This **Agreement** was to provide the context for a meeting between the two restaurateurs and the research team led by **Xavier Martínez** at a restaurant congress where Xavier was presenting the results of his research in the field of vacuum cooking.

“Javier and Sergio showed a great deal of interest in the possibility of cooking at low temperatures but they also saw an excellent opportunity with regard to developing a product that we, as researchers concerned with nutrition, had given very little thought to: vacuum impregnation. Javier and Sergio's inclusion in the research team, as end users, was crucial in achieving an appliance that was suited to the real needs of professional chefs.

Xavier Martínez (Head of the Gastrovac development team)

The research team led by **Xavier Martínez** belongs to the **Institute of Food Engineering for Development (IIAD)**, which started out as part of the Department of Food Technology of **UPV's Higher Technical School of Agricultural Engineering**, and it conducts a great deal of research in collaboration with Spanish and Latin American organisations.



In particular, the **IIAD** has conducted many projects related with mass transfer and the determination of quality parameters in food processing, which have formed the basis for the research dealt with in this Case Study. Much of the research that **UPV** conducts into areas related to food industries, covering aspects of food quality and safety, process innovation, preservation technologies, product innovation, and sustainability and lifecycle, is carried out by the **IIAD**. (See Appendix 2: Technological trends in the food and agriculture industry and research areas developed at UPV).



The research team: Javier Andrés and Sergio Torres with Puri García, Xavier Martínez and Neus Sanjuán.

THE RESEARCH PROJECT

Javier and **Sergio** met **Xavier Martínez's** research team at a congress in Bilbao where Xavier was presenting the results of his research in the field of vacuum cooking. That moment marked the beginning of the joint research project that led to the first prototype of the system: The "**Batiscafo**".

"This first prototype had to meet several requirements. On the one hand, it had to be capable of working at sub-atmospheric pressures and the temperature had to be controlled at all times. It had to be small and compact and, lastly, it had to be versatile and adaptable to cooking, frying, marinating and impregnation processes".

Xavier Martínez (Head of the Gastrovac development team)

The "**Batiscafo**" was patented by **UPV** as a utility model and presented at the 5th "**Lo Mejor de la Gastronomía**" congress, where it was noticed by the company **International Cooking Concepts (ICC)**, which showed an interest in participating in the future development of the prototype and in marketing it.

ICC started out in 1998 as a result of its founder **Marc Calabuig's** initiative and passion for cooking, to offer advanced technical solutions for professionals in the catering business. His advisors include chefs of great renown such as **Joan Roca** and **Ferran Adrià**, and part of the production is subcontracted to **SELECTA**, a company with 50 years of experience in developing and manufacturing scientific apparatus for laboratories.

*"We have decided to work with universities such as **Valencia Polytechnic** in order to gain a scientific understanding of what happens in a kitchen".*

Marc Calabuig (Executive Director of ICC)

The relationship between **ICC** and **UPV** was formalised by signing a **Collaboration Agreement**, within the framework of which they developed the improved system that was named **Gastrovac** and presented at the **Hostelco** trade show in October 2004.

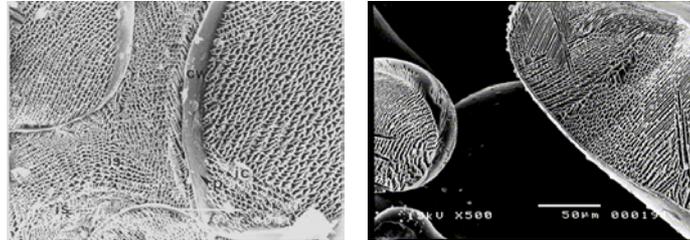


From the "**Batiscafo**" 2002, to the "**Gastrovac**" 2004; development of the product.

The **Gastrovac** is a professional cooking appliance for vacuum cooking and impregnation. It works by creating an artificial oxygen-free, low-pressure atmosphere in which the food is cooked. In these conditions it is possible to considerably reduce boiling and frying temperatures, thus maintaining the original texture, colour and nutrients.



Furthermore, when the atmospheric pressure is restored, the product undergoes a “sponge effect”, absorbing the liquid around it in a natural and uniform manner. This effect is the basis for cold impregnation, which is opening up a new field of creativity for chefs. (See Appendix 1: Recipes using the Gastrovac).



Effect of vacuum impregnation: difference between a tissue before (left) and after (right) vacuum impregnation treatment.

OTHER APPLICATIONS OF VACUUM TECHNOLOGY IN THE FOOD AND AGRICULTURE INDUSTRY

The use of vacuum techniques in cooking is revolutionary because it is such an innovative concept and because of its advantages in food preparation: better consistency, respect for its original characteristics, a better harmony of flavours and lower costs. But its use is not only limited to cooking.

The **IIAD** is analysing the use of vacuum impregnation for salting cheese, fish and meat, achieving a much more uniform and less aggressive treatment. Its use is also being studied for the cryoprotection of fruit, by introducing cryoprotective solutes using impregnation combined with partial dehydration to lower its freezing temperature.

It can also be used to develop functional foods, making it possible to produce food products that are enriched with physiologically active compounds with a similar structure to the fresh product. This is leading to a new range of products aimed at groups of the population with specific needs, such as coeliacs or diabetics.

Finally, the use of Gastrovac is being studied for new cooking techniques; for example, the use of its vacuum pump as a packaging tool or for vacuum filtering to clarify stock, or to package aromas once they have been extracted during cooking.



APPENDIX 1 RECIPES USING THE GASTROVAC

Ingredients:

1 beetroot
1 carrot
1 custard marrow
1 courgette
2 cep mushroomss
Chicken stock
10 g butter
15 ml virgin olive oil
6 ml white wine
6 ml truffle juice
30g white Alba truffle.

VACUUM-COOKED VEGETABLE AND WILD MUSHROOM RAVIOLIS WITH WHITE ALBA TRUFFLE. Created by: Sergio Torres

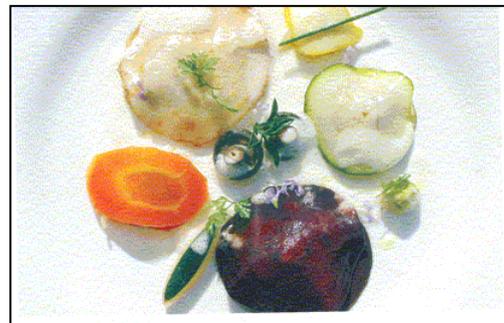
Method:

Cut the vegetables into very thin slices using a food slicer and then vacuum wrap. Cook in the Gastrovac for 1 hour at 45 °C. Once cooked, leave to cool. Clean the mushrooms and use the stalks to prepare an infusion with 60 ml of chicken stock. Filter to remove any soil. Dice the mushrooms, putting them into the rest of the chicken stock and the truffle juice, and then place them in the Gastrovac. Switch on the vacuum pump at room temperature for about 10 minutes then restore the normal pressure. Leave the mushrooms in infusion for a further 10 minutes so that they are completely impregnated.

Reduce the white wine. Bind the mushroom infusion with butter and olive oil, and add the white wine reduction.

Assemble the dish:

Place a slice of each vegetable on a plate. Place on top a little mound of the cep mushrooms impregnated with truffle juice and cover it with another slice of vegetable. Grate white Alba truffle over the dish and drizzle with the cep mushroom emulsion. Season with sea salt and pepper.



Ingredients: 2 carrots
8 mange touts
Assorted wild mushrooms (according to season)
8 green beans
2 custard marrows
1 mini courgette
8 Chinese artichokes
4 green asparagus spears
8 wild asparagus spears
8 ratte potatoes
4 celery sticks
4 red cardoon stalks
2 artichokes
4 shallots
Spring onion
Garlic shoots.

MIXED VEGETABLE CASSEROLE WITH WILD MUSHROOMS. Created by: Sergio Torres.

Method:

Wash and spin all the vegetables. Make an infusion using the mushroom stalks and the remains of the vegetables. Precook first the potato, carrots, root vegetables/Chinese artichokes, green beans and artichoke in the Gastrovac. Then add the more tender vegetables and mushrooms and finish cooking.

Assemble the dish:

Serve the vegetables in a casserole dish with an olive oil emulsion, a knob of butter and the vegetable infusion. Season with grey sea salt and pepper.





APPENDIX 2 TECHNOLOGICAL TRENDS IN THE FOOD AND AGRICULTURE INDUSTRY RESEARCH AREAS DEVELOPED AT UPV.

FOOD QUALITY AND SAFETY

Widespread use of sensors in the control of processes:

- Development of immunosensors for microbiological control of food products.
- Development of DNA matrices for early detection of pathogenic agents.
- Development of immunochemical sensors for detection of pesticide residues.

Determination of internal parameters by non-destructive technologies:

- Use of ultrasound for characterisation of dairy products.
- Use of ultrasound for detection of foreign bodies in fluids.

Traceability and control of processes:

- Hazard analysis and critical control points in the Food and Agriculture Industry.
- Development of traceability systems and shelf-life studies for food products.
- Bromatology and microbiology of food products.

PROCESS INNOVATION

Salting:

- Salting of dairy products, fish and meat products by vacuum impregnation.
- Fish desalting.

Extraction:

- Supercritical fluid extraction technologies.

Drying and dehydration:

- Osmotic dehydration of fruit and vegetables.
- Cryoprotection of fruit by osmotic dehydration and vacuum impregnation.
- Drying of food products using combined methods: air-microwave-vacuum.

Membrane processes:

- Use of nanofiltration, inverse osmosis and pervaporation in the food industry.

Traditional product innovation:

- New Technologies for the production of turron.

Vacuum processing technologies:

- Vacuum impregnation and cooking; use in crystallising fruit and in producing jams at low temperatures.

Modelling and simulation:

- Prediction and measurement of the physical properties of food products.
- Analysis and Modelling of mass-transfer processes.

PRESERVATION TECHNIQUES

Active packaging:

- Development of functional waxes and edible films for fresh fruit.
- Use of zeolites for the elimination of ethylene in packs of fresh-cut produce.

PRODUCT INNOVATION

Functional food products:

- Use of Matrix engineering in the development of functional food products.

New products:

- Colloidal product technology: emulsions, foams, gels, etc.
- Use of stabilisers and emulsifiers in the formulation of food products.

SUSTAINABILITY AND LIFECYCLE

Waste Evaluation

- Characterisation and evaluation of organic waste for agricultural purposes.
- Characterisation and use of solid waste as building materials.

Recovery:

- Treatment of brine from the food and agriculture industry.



APPENDIX 3 STANDARD AGREEMENTS AND CONTRACTS FOR ESTABLISHING RELATIONS BETWEEN UPV AND COMPANIES AND INSTITUTIONS

1. **Framework collaboration agreement:** This consists of a declaration of intentions for future collaboration in different fields and forms, it establishes the general terms of cooperation and, in certain cases, the parties agree on a Monitoring and Planning Committee for the activities.
2. **Agreement for a Research and Development project:** This includes the terms in which a company contracts UPV to carry out an R&D project. It specifies the aims of the project, the work plan, the intermediate milestones to be achieved, the expected results, the necessary resources and the contributions to be made by each party, and it establishes a confidentiality regime and economic conditions. The ownership of the results is negotiated for each case according to the contributions made by each party.
3. **Patent and software licence agreements:** This includes the terms in which a company or institution acquires the industrial rights of a certain technology owned by UPV. The exclusivity terms, geographical limits and duration of the licence are negotiated for each case according to the plan for use of the results and the economic conditions of the agreement.
4. **Technological Support and Advice Agreement:** This consists of carrying out technical laboratory work leading to the application of knowledge acquired by researchers at UPV to achieve new products or processes without this work involving a research activity. The structure and terms of this type of agreement are similar to those of the Research and Development agreement.
5. **Technical services agreement:** This consists of rendering a technical service (measurement, report) or selling a product manufactured directly by the University as a consequence of its R&D activity.
6. **Training:** Training provided by UPV can consist of attending general courses offered by UPV through the Post-graduate Training Centre or requesting a custom-designed course.
7. **Work placements for students in companies:** This establishes the conditions in which students of UPV can spend a period in a company on a work placement scheme. The work assigned to the student must have educational value and be of use to the company. The student will receive a grant from the company, without this involving any employment relationship. There must be a tutor in the company and at the University to supervise the work.
8. **Recruitment of university graduates:** The UPV-FSVE Recruitment Agency is in charge of finding suitable candidates for job offers received by UPV.



APPENDIX 4 GRANTS FOR CORPORATE R&D; MANAGEMENT BODIES, GRANT SCHEMES AND FINANCING

Regional: Institute of Valencian Small and Medium-sized Industries, **IMPIVA**; Company support schemes. <http://www.impiva.es>

National: Ministry of Industry, Trade and Tourism <http://www.mityc.es>

- Programme for the Promotion of Technical Research, **PROFIT**.

Ministry of Education and Science <http://www.mec.es>.

- Grants and Aid for Science and Technology: **PETRI** programme for the promotion of technical research; Unique and Strategic Projects; R&D Projects.

- **Torres Quevedo** programme for promoting the placement of doctors and technologists in companies.

Centre for Industrial Technological Development <http://www.cdti.es>. Financing of corporate R&D projects. Support for the creation of new technology-based companies **NEOTEC** <https://www.neotec.cdti.es/>

European: **European Commission:** EU Framework Programme for Research and Technological Development. http://europa.eu.int/comm/research/fp6/pdf/blue_guide_es.pdf

APPENDIX 5 TAX TREATMENT OF R&D

Tax Deductions for R&D are the strongest financing framework for innovation activities in Spanish companies. They can be applied by means of reductions in the total tax payable by companies depending on how much they invest in R&D during each financial year and depending on the characteristics of the activity undertaken with said investment according to a classification of Technological Research, Development and Innovation projects.

Companies may decide to present their own declaration justifying their expenditure on R&D, or they may request that an organisation accredited by the Spanish Accreditation Agency (ENAC) issues a reasoned report certifying the expenditure, classifying the project and specifying the type of deduction that is applicable. This type of report is binding.

The regulatory framework consists of **Legislative Royal Decree 4/2004 of 5 March** (*RDL 4/2004 de 5 de marzo*), which approved the revised text of the Corporate Income Tax Law (*Ley del Impuesto sobre sociedades*), and **Royal Decree 1432/2003 of 21 December** (*RD 1432/2003 de 21 de diciembre*) on the regulation of reasoned reports.