SME	**EC - Contract n° COOP CT-2005-017554** **EUROPEAN COMMISSION** **COOOPERATIVE RESEARCH PROJECT** **"Development of new nutraceutical meat products - NUTRAMEAT**

Project no. **017554**

Project acronym: **NUTRAMEA**T

Project title: **Development of new nutraceutical meat products**

Cooperative Research Project

Publishable Final Activity Report

Period covered: from	01/09/2005	to	31/08/2007
Date of preparation:	15/03/2008		
Start date of project:	01/09/2005	Duration:	24 months

Project coordinator name	Mr Angel PEREZ
Project coordinator organisation name	GOIKOA
Revision	1

Publishable executive summary

New "functional foods" are coming onto the market, nutraceutical foods, pharmafoods…, which are becoming key products in the diet of many Europeans. Although at present the new meat products proposed here do not exist yet in the market.

"Nutraceuticals" or "pharmafoods" comprise ingredients, formulae and supplements based on bioregulating principles such as vitamins, mineral salts, anti-oxidants, microbial flora, amino acids and vegetable extracts.

In this project a new line of meat products with nutraceutical properties have been developed. The formulation of emulsified meat products has been varied to decrease total fat content, and replace saturated fat with lipid components with demonstrated positive health impact. The stabilisation of the meat emulsion of lower fat content was promoted by the incorporation of vegetable fibre, as well as through the use of transglutaminase enzyme, capable of cross-linking the protein matrix of the emulsion. This general strategy has been applied to various emulsified meat products, such as meat paste sausages and reconstituted meats. Prototype formulations with the best technological and sensory evaluation scores were then further developed at the meat industry level. Nutritional assessments were conducted by nutrition specialist to assess the effect of these products on the serum lipid profile of the consumers. Consumer acceptance studies were also carried out to determine the potential of these products in the market.

The **general objective** of the Project has been to develop **new nutraceutical meat products with** a very **high palatability** and **health properties** such as:

- reduction of unwanted cholesterol in blood **(low fat content, olive oil)**
- decreasing animal fat and enhancing meat quality attributes (**CLA - Conjugated Linoleic Acid supplementation on pork)**
- reduction of colon disorders, constipation, cancer of the colon, hyperlipidemia problems, cardiovascular disease, diabetes and obesity (**oat bran fibre**)

These new nutraceutical meat products have been stabilised with **TG (transglutaminase enzyme)** and meat product oxidation has been slowed due to the addition **natural vegetable antioxidants**.

The **specific objectives** were:

- To research meat emulsions containing low fat content (olive oil), oat bran (fibre) and transglutaminase enzyme (TG).
- To research meat emulsion containing conjugated linoleic acid (CLA), evaluating the effect of CLA supplementation on the enhanced healthiness of pork products

- To protect meat preparations from degradation and oxidation phenomena, especially as far as lipidic fraction is concerned, by incorporating plant extracts rich in polyphenols

- To evaluate the nutritional benefits of the new meat products formulated with olive oil and fibre components.

- Each SME to develop the nutraceutical meat products most appropriate for its respective product catalogue.

- To implement the corresponding industrial processes, previously tested in pilot plants, analysing possible results deviations and solutions.

- To analyse the technological quality and stability of the new nutraceutical meat products.

- To fully validate the industrial products developed by the SMEs. The validation will consist in the analysis of consumer acceptability.

Partners involved

The SME group is formed by: GOIKOA (Spain), GRANBY (Ireland), PASCAL MASSONDE (France) and HUNNIA (Hungary), all meat products manufacturers with a high interest in new nutraceutical technologies.

The industrial group is completed by the large company VIVARTIA SA (Greece) with a sole role that is to validate the new products from the consumer point of view.

The RTD performer group is formed by: UPNA (Spain), HMRI (Hungary), TEAGASC AFRC (Ireland) and ADIV (France), all of them will be dedicated to develop, jointly with the SMEs the new nutraceutical products and the corresponding manufacturing technology. Additionally, a complete and independent nutritional study will be carried out on the influence of the new nutraceutical products on human health

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SME

EC - Contract n° COOP CT-2005-017554
EUROPEAN COMMISSION
COOOPERATIVE RESEARCH PROJECT
"Development of new nutraceutical meat products - NUTRAMEAT




UPNA
Vegetable oil, fibre and TG in turkey
(SPAIN)

Development of nutraceutical products (turkey meat) integrating low fat, fibre and TG

NFC
CLA in pork
(IRELAND)

Development of nutraceutical products integrating CLA

ADIV
Antioxidant Polyphenols in beef
(FRANCE)

Development of healthy and safety cooked meat products with natural vegetable antioxidants

HMRI
Vegetable oil, fibre and TG in pork
(HUNGARY)

Development of nutraceutical products (pork) integrating low fat and fibre




GOIKOA
(SPAIN)

Producing as new market turkey meat products containing low fat content (olive oil), oat bran (fibre) and transglutaminase enzyme (TG)

GRANBY
(IRELAND)

Fabrication of products with elevated CLA is highly innovative research and of great interest to the pork industry

PASCAL MASSONDE
(FRANCE)

Development of nutritional minced beef cooked meat products integrating antioxidant polyphenols to preserve nutritional qualities and health

HUNNIA
(HUNGARY)

Producing as new market pork meat products containing low fat content (olive oil) and oat bran (fibre)

VIVARTIA
(GREECE)

To test product acceptability

PROJECT PART - FINANCED BY THE EUROPEAN UNION

1. Project execution

Overview of general project objectives and relation to the state-of-the-art

New "functional foods" are coming onto the market, nutraceutical foods, pharmafoods…, which are becoming key products in the diet of many Europeans. Although at present the new meat products proposed here do not exist yet in the market.

"Nutraceuticals" or "pharmafoods" comprise ingredients, formulae and supplements based on bioregulating principles such as vitamins, mineral salts, anti-oxidants, microbial flora, amino acids and vegetable extracts.

In this project a new line of meat products with nutraceutical properties have been developed. The formulation of emulsified meat products has been varied to decrease total fat content, and replace saturated fat with lipid components with demonstrated positive health impact. The stabilisation of the meat emulsion of lower fat content was promoted by the incorporation of vegetable fibre, as well as through the use of transglutaminase enzyme, capable of cross-linking the protein matrix of the emulsion. This general strategy was applied to various emulsified meat products, such as meat paste breakfast sausages and reconstituted cooked meats. Prototype formulations with the best technological and sensory evaluation scores was developed beyond the laboratory and pilot plant scale to the meat industry level. Nutritional assessments were conducted by Basque nutrition specialists on the effect of these products on the serum lipid profile of consumers in clinical trials. Consumer acceptance studies were carried out by a taster panel at an independent organisation to determine the potential of these products in the market.

The **general objective** of the Project was to develop **new nutraceutical meat products with** a very **high palatability** and **health properties** such as:

- reduction of unwanted cholesterol in blood **(low fat content, olive oil)**
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The **specific objectives** were:

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- To research meat emulsion containing conjugated linoleic acid (CLA), evaluating the effect of CLA supplementation on the enhanced healthiness of pork products

- To protect meat preparations from degradation and oxidation phenomena, especially as far as lipidic fraction is concerned, by incorporating plant extracts rich in polyphenols

- To evaluate the nutritional benefits of the new meat products formulated with olive oil and fibre components.

- Each SME to develop the nutraceutical meat products most appropriate for its respective product catalogue.

- To implement the corresponding industrial processes, previously tested in pilot plants, analysing possible results deviations and solutions.

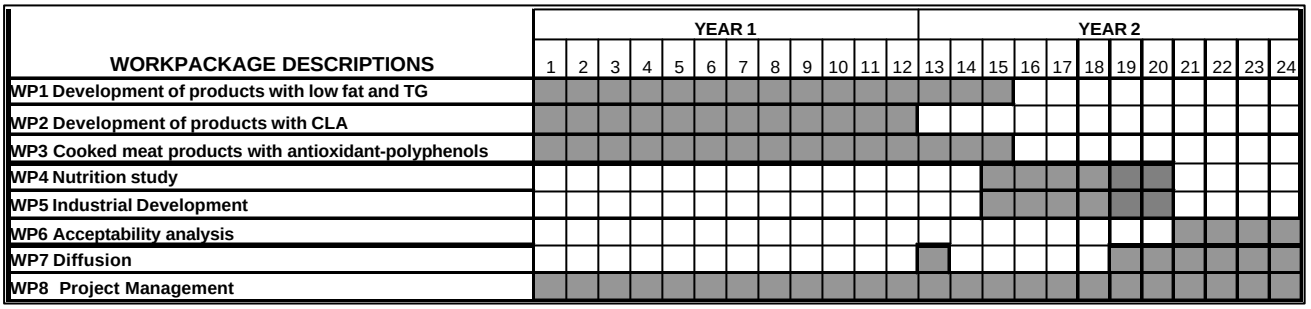
- To analyse the technological quality and stability of the new nutraceutical meat products.

- To fully validate the industrial products developed by the SMEs. The validation will consist in the analysis of consumer acceptability.

Summarise the objectives for the reporting period, work performed, contractors involved and the main achievements in the period

The project completed the first reporting period on schedule and the final year of the project took on the developments of the first year, completing **WP1 & 3**, and moved these developments and those from WP2 from small laboratory scale products and processes (1-5 kg production series) to prototypes (25kg production series) and then finally to full scale industrial processes and production series (400kg product runs) in **Workpackage 5**. Once the SMEs were happy with their products, these were then sent for subcontracted Nutritional Study (**Workpackage 4**) under the supervision of UPNA; and finally the industrial products were sent for Acceptability Analyses at the Greek Partner VIVARTIA in **Workpackage 6**. Dissemination and IPR protection have been covered in **Workpackage 7**

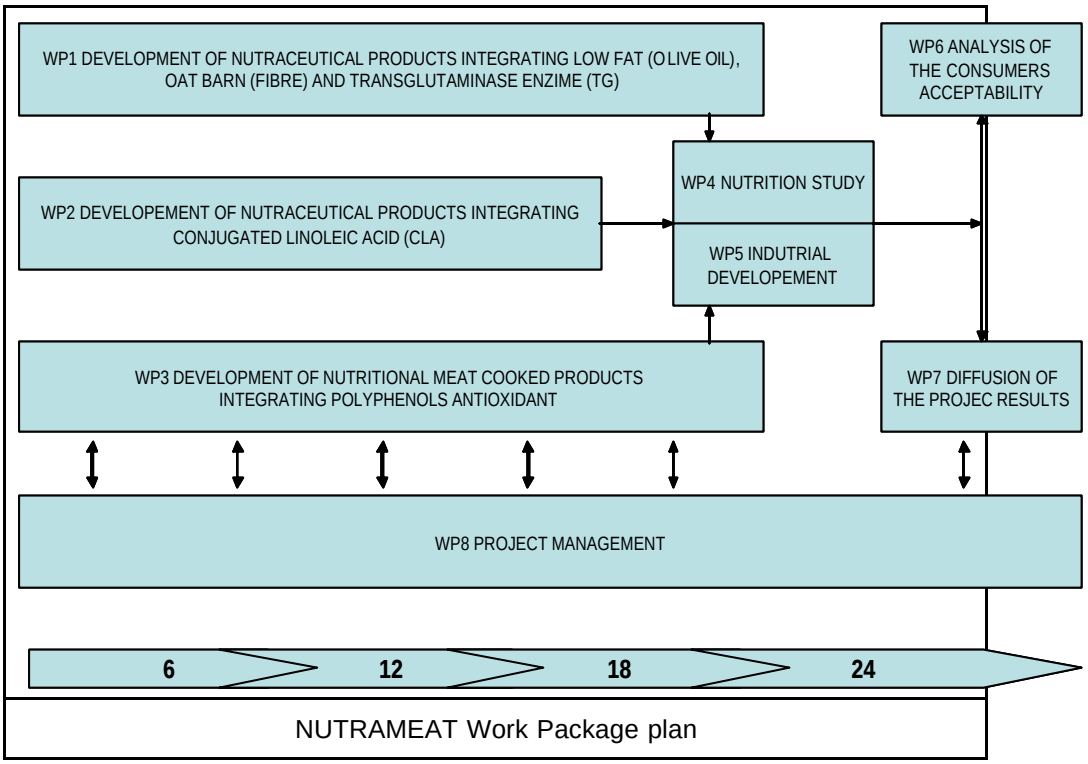
The close cooperation and collaboration between the RTD centres and their corresponding SMEs has continued to be supportive and productive.



The main developments have been achieved in Work packages 1, and 3 in the finalisation of the product development process.

Management activities have also been done during this final 12 months of the project.

WORKPACK NO.	WORKPACKAGE TITLE	LEAD SHORT NAME	PERSON MONTHS	START MONTH	END MONTH	DELIVERABLE NUMBER
1	Development of nutraceutical products integrating low fat and TG	UPNA	54	1	15	D7, D8
2	Development of nutraceutical products integrating CLA	NFC	27	1	12	D2, D3
3	Development of nutritional cooked meat products integrating polyphenols antioxidant	ADIV	21	1	15	D7, D8
5	Industrial Development	HUNNIA	65	15	20	D11
4	Nutrition study	UPNA	1.5	15	20	D10
6	Acceptability analysis	VIVARTIA	20	21	24	D 14
7	Diffusion	GOIKOA	22,5	13	24	D13, D15
8	Project Management	GOIKOA	18.5	1	24	D12, D13, D16, D17
	TOTAL		**229.5**			



The main results from this work that are in line with the specific project objectives can be summarised as follows:

- *To research meat emulsions containing low fat content (olive oil), oat bran (fibre) and transglutaminase enzyme (TG).*

New meat emulsions were developed in the two research centres participating in WP1. The preparation of these emulsions was completed in the first year of the project and numerous trials have been done on the composition: experimenting with fat content, bran, and TGA. The SMEs were satisfied with the results which have ensured reduced cooking losses and the partners then went on to collaborate on the seasoning of the products to ensure that they are palatable for their destined markets

- *To research meat emulsion containing conjugated linoleic acid (CLA), evaluating the effect of CLA supplementation on the enhanced healthiness of pork breakfast sausages*

New meat emulsions were developed in the first year of the project, oil inclusion levels were established to replace back-fat and study the influence on thermal/cooking and quality parameters of the emulsion with CLA. Both reduced and high fat emulsions were prepared with four levels of oil (three replicates). The heating profile was monitored during sous-vide cooking. Colour and texture of the product were determined. As the cost of the CLA oil is quite high following the initial animal feed results it has been decided to continue focusing efforts on inclusion of the oil into the sausage formulation rather than inclusion through feeding trials.

All sausages underwent sensory analysis. Shelf life studies were carried out with TVC at days 3, 7 & 14 of storage. TBARs were also measured at these time points. Colour, water holding capacity and emulsion stability have been completed.
At the start of the second year of the project the CLA supplier stated that CLA was to undergo reclassification as a **Novel Food**. This signified a setback in timing for the use of CLA in the EC food market, as until the application has been processed and approved it cannot be used in food products as this may upset precedents. However, given that the products have been developed, this just means that they have to go on hold before further commercial development. It will offer significant and unique new opportunities in the near future when CLA will have been officially approved as Novel Food by European authorities. In the meantime, **new product developments with sunflower oil rich in Omega 3** instead of back fat were made to cover this gap and both products were tested in the nutritional and sensory/acceptability analyses.

- *To protect meat preparations from degradation and oxidation phenomena, especially as far as lipid fraction is concerned, by incorporating plant extracts rich in polyphenols*

The main tasks here were carried out in the two French partners to study the impact of antioxidising plant extract incorporation and process parameters on lipid an protein oxidation of diced cooked beef meat products. This began by defining the manufacturing process of diced cooked beef products, selecting the process parameters to study and then building the experimental design.
The general process contains the following steps : mechanical tenderisation, marinating, dicing, pre-cooking, cooking and storage. Factors and factors levels tested were :

- type of marinating : - tumbling
  - injection
- Anti-oxidising plant extract : - no plant extract
  - rosemary 1
  - rosemary 2
  - rosemary 3
- Pre-cooking process : - no pre-cooking
  - browning
  - pre-cooking in water
- cooking process : - cooking under vacuum
  - sterilisation

A fractional factorial design was done to minimise replicates. The experimental design led to 16 experiments. Preliminary work has also been performed to define all parameters of the experiments (brine composition, tumbling cycles, time and temperature for pre-cooking and cooking modes). Technological (colour, yields) and nutritional analysis (MDA, Carbonyl, Vitamin E) were carried out at 2 different dates of storage (2 and 21 days).
For the technological characteristics, the main results was that pre-cooking process is the only significant factor and pre-cooking in water led to the worst overall yield.
For the nutritional characteristics, the main result was that cooking process has a significant effect on protein oxidation (carbonyl analysis) and cooking under water lead to a lower protein oxidation than sterilisation. After 2 days of storage, all the factors had no significant effect on lipid oxidation and vitamin E consumption.

- *To evaluate the nutritional benefits of the new meat products formulated with olive oil and fibre components.*

Samples from all the SME producers were sent to a research group specialising in Nutritional Analyses. This group is based in the Basque region of Spain and nutritional trials were carried

out under the supervision of UPNA following the specific guidelines of the different RTD centres who specified which nutritional hypotheses were to be tested.
The Nutrameat project shows that the meat based on food ingredients with health properties, such as olive oil, conjugated linoleic acid, fibre and rosemary, have an impact on the health when they are included regularly in the human diet . These effects have been seen in elderly subjects, which are considered a risk group for his profile of plasma lipids and their potential risk of malnutrition.
From the obtained results it is possible to say that when the subjects consume the products analyzed by the UPNA, MHI and NFC, they show a favourable effect on the blood lipid profile which is associated with cardiovascular risk. In addition, in the case of the product developed by ADIV, there is a positive effect on the lipid peroxidation, which is associated with atherogenic risk.

- *Each SME to develop the nutraceutical meat products most appropriate for its respective product catalogue.*

All the SMEs took their laboratory developed products from the corresponding RTD centres. Often this was in the form of the basic constituent meat paste (GOIKOA, GRANBY and HUNNIA) and then all the SME partners used their own tasting experts (some internal and some external tasters) to fine tune the seasoning mix to ensure the product was well within their product profile and therefore **best suited for the corresponding consumer markets**. At this stage it became apparent that the consumer analysis in Greece may cause some anomalies. This is because the final products have been developed for specific national markets and the consumer tastes in one country are not always the same as in another especially considering the climate and cultural differences that can be seen over the huge geographical distances involved. Spain, France, Ireland, Hungary and Greece aren't exactly geographical neighbours.

As such, the analyses of greater importance were those performed by the partners in their own consumer market tests although the Greek analyses did show some interesting facts about increased acceptability where information of health benefits was available. SME partners feel that this highly important task that **has been successfully accomplished**.

- *To implement the corresponding industrial processes, previously tested in pilot plants, analysing possible results deviations and solutions.*

This was also a crucial stage where laboratory scale developments (1-5kg product runs) and industrial prototype level (20-30kg product runs) are scaled up again further to industrial scale production runs (over 400kg per production run). This gradual scaling up **has been successfully achieved** and is essential to ensure the homogeneity of ingredient mixes can be achieved at these far larger product sizes and volumes.
GOIKOA, GRANBY, HUNNIA and Pascal Massonde were all working in close collaboration in experimental design and discussion of methods and results with their corresponding RTD Developers. With frequent movement of RTD personnel to the SME production plants to give advice on manufacturing and to participate in quality testing.

- *To analyse the technological quality and stability of the new nutraceutical meat products.*

The stability of all the meat products being developed has been studied in collaboration with the industrial partners RTD centres and also through the participation of the SME's own quality control laboratory. This has been **successfully completed** and is an obligation before any of

the products can be used for testing or for posterior commercialisation. This ensures that they achieve and surpass the minimum market requirements guaranteeing that the products will be able to reach the market in optimum conditions for consumers.

- *To fully validate the industrial products developed by the SMEs. The validation will comprise the analysis of consumer acceptability*.

This task was addressed in the second year of the project in Work-Package 6 through a consumer panel methodology and through an internal experts panel in VIVARTIA.
Nutrameat products have been tested for classical sensory parameters. It was not their objective to re-test with a different tester group.
But consumer behaviour regarding the consideration of food as a health determinant is influenced by an increasing involvement of policy, media and public opinion makers, on nutrition related health factors
Given that Nutrameat products are meant to be healthy alternatives to food products which are considered as (almost) harmful, and that Nutrameat product development aims in healthy nutrition rather than traditional food selecting factors (*i.e.* indulgence, convenience, price, etc), products were tested over their mission accomplishment.
11 out of 16 panelists accepted the involvement of special process – high technology – scientific knowledge in order develop therapeutical properties of food products

- *To protect the new nutraceutical product technology and to establish licensing agreements among the partners to protect knowledge of the new technology.*

An exploitation agreement has been signed between SME partners. It declares that all SME partners agree they have interest in possible exploitation of all developed products, Each SME partner agrees to inform all others if they begin to produce any product developed by another centre during the project - this is for courtesy as all are entitled to do this. All RTD centres agree to ask all SME partners if they wish to use the results from Nutrameat for further research - permission will not be refused if it is requested in writing. All RTD partners will inform SMEs of any intention to publish or present articles based on results from Nutrameat and will present the SMEs with details of the contents so that SMEs can ensure their IPR is not being prejudiced

- *To carry out a diffusion of the results of the project, both towards the meat industry and towards other agro-food industries.*

Each of the partners have been publicising their participation in the project in their local media and in their usual dissemination channels. Dissemination material has been discussed at each of the Consortium Meetings and it was accepted that all partners could freely use any information from the executive summary for dissemination in the second year of the project without having to request authorisation from the SME Committee. The second year was a key date as the products had already been developed and so competitive advantage would still be maintained if competitors were to discover the brief information on project developments. The RTD performers were keen to present their results in International Conferences and it was accepted that all presentations were sent to SME committee for evaluation to ensure IPR would not be jeopardised. Minor changes were requested in the amount of specific scientific and ingredient content.

Changes during the project and the corrective actions undertaken

At the start of the second year of the project the CLA supplier stated that CLA was undergoing reclassification as a **Novel Food**. This signified a setback in timing for the use of CLA in the EC food market, as until the application has been processed and approved it cannot be used in food products as this may upset precedents. However, given that the products have been developed, this just means that they have to go on hold before further commercial development. It will offer significant and unique new opportunities in the near future when CLA will have been officially approved as Novel Food by European authorities. In the meantime, new product developments with sunflower oil rich in Omega 3 instead of back fat have been made to cover this gap and both products will be tested in the nutritional and sensory/acceptability analyses.

No other developmental problems were encountered in this second reporting period. However it should be noted that **Partner 5 GOODY'S SA** was taken over by a larger corporation and re-established as **VIVARTIA SA**. As such an amendment was requested to reflect the disappearance of **GOODY's** and the entrance of **Partner 10, VIVARTIA SA** in the project consortium. There was a slight change in development order of the WPs, with ***WP 5 INDUSTRIAL DEVELOPMENT*** starting before ***WP 4 NUTRITION STUDY***, this was essential as the nutrition study had to be performed with the industrial product and not with laboratory scale samples.

Table 1: Milestones List

List all milestones, giving date of achievement and any proposed revision to plans.

Milestone no.	Milestone name	WP no.	Date due	Actual delivery date	Lead contractor
1	Technical results on CLA research already supplied by NFC. Revision of Technical Risk already carried out and defined the derivate actions, if necessary	2	12	15	TEAGASC
2	Technical results on oil, fibre, TG – Antioxidants already supplied by UPNA, HMRI and ADIV Prototypes already made by the SMEs including quality study	1 & 3	15	15	UPNA
3	Results of the Nutrition study. Technical report including all industrial issues necessary for the SME´S	4	20	24	UPNA
4	Exploitation agreements on the new technology already made. Diffusion measures carried out All project technological results completely validated by the SMEs and end users (VIVARTIA)	7	24	24	GOIKOA

Section 4 – Other issues

Co-operative Research Projects

Describe the overall contributions of the group of SMEs, of RTD performers, and of other enterprises and end-users. In particular the extent to which the work of the RTD performers has provided benefits to the SMEs and the balance of the work/resources between the RTD performers and all other contractors.

All of the SMEs have been very active in this first period of the project providing the RTD centres with frequent information on their individual requirements and then giving detailed feedback on the suitability of the developments. This close and frequent collaboration has ensured that the efforts of the RTD centres directly address the specific needs of the SMEs. As such, the industrial partners are ensured that this project has a "market pull" approach and not "technology push" from the RTD centres.

This approach will guarantee that the results are of immediate use for the SMEs providing them with new products in the market and will give them competitive advantage in the marketplace thus guaranteeing their sustainability.

Annex – Plan for using and disseminating the knowledge

The new industrial product for **GOIKOA**

GOIKOA PROYECTO NUTRAMEAT

RESULTADOS

PRODUCTO PLANTA GOIKOA

Vegetables /Spinach & Carrot

GOIKOA PROYECTO NUTRAMEAT

RESULTADOS

PRODUCTO PLANTA GOIKOA

Dried fruit & nuts

GOIKOA

PROYECTO NUTRAMEAT

RESULTADOS

PRODUCTO PLANTA GOIKOA

Mediterranean fruit / Peach

GOIKOA

PROYECTO NUTRAMEAT

MARKETING

PRODUCT PRESENTATION

•Sliced – protected atmosphere

•11x11 for sandwiches

•Diced producto 12x12 mm for pizza & salad

•Sliced into steaks for frying

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Product presentation

Final products: **Bologna** and **Frankfurter** integrating olive oil and oat bran

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Photo. Final product: Bologna type sausages

Photo. Final product: Frankfurter (Vienna type sausages)

Enjoy!

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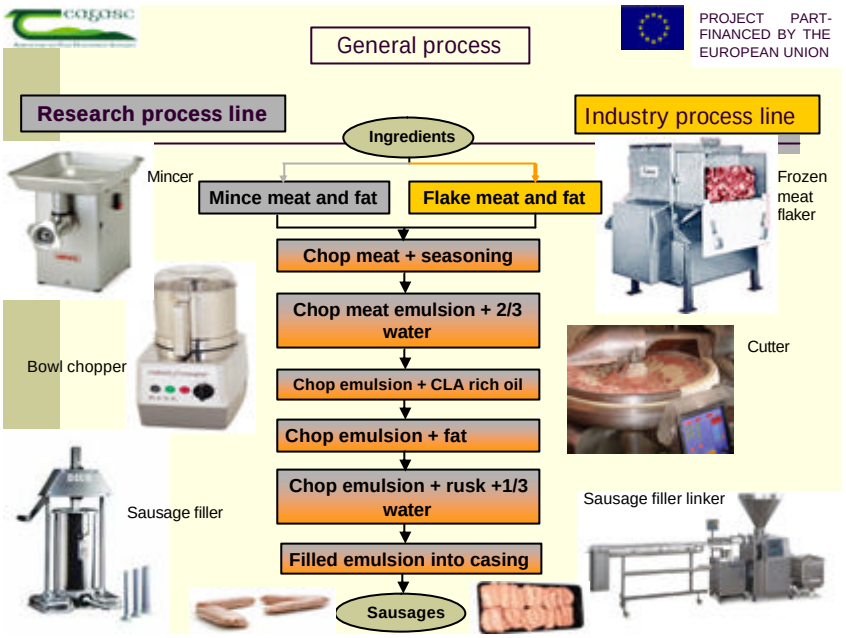
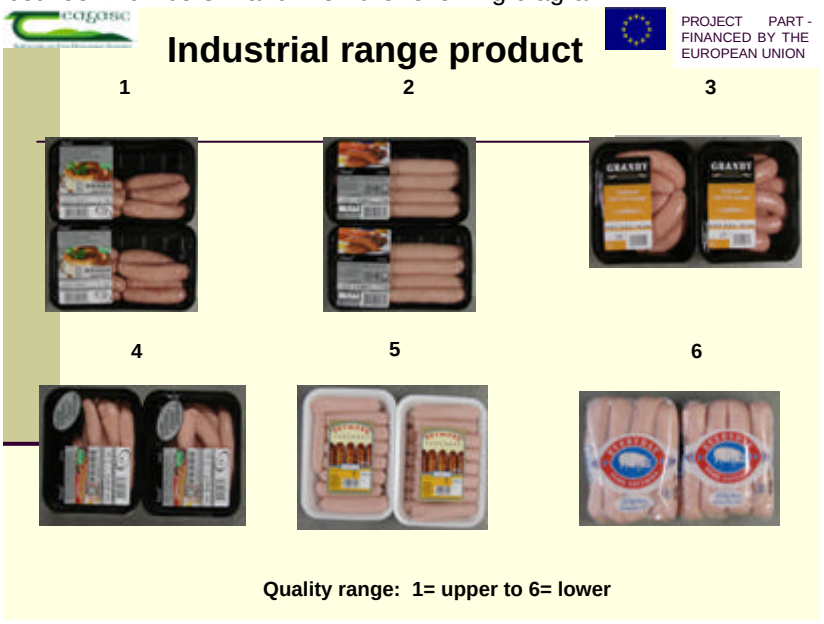
GRANBY LTD new fresh breakfast Sausages



In the Granby LTD product range, the new products will fall into the higher quality product presentation, between numbers 1 and 2 on the following diagram.



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PASCAL MASSONDE new products in collaboration with ADIV

Industrial development

- Type of products developed : beef/veal cooked products with rosemary extracts
- Product specification :
  - Basque
  - Under-utilised muscle
  - Combine meat and vegetable
- Steps of development :
  - Developing recipes with chefs
  - Pilot plant tests
  - Industrial tests
  - Modifying existent industrial recipes

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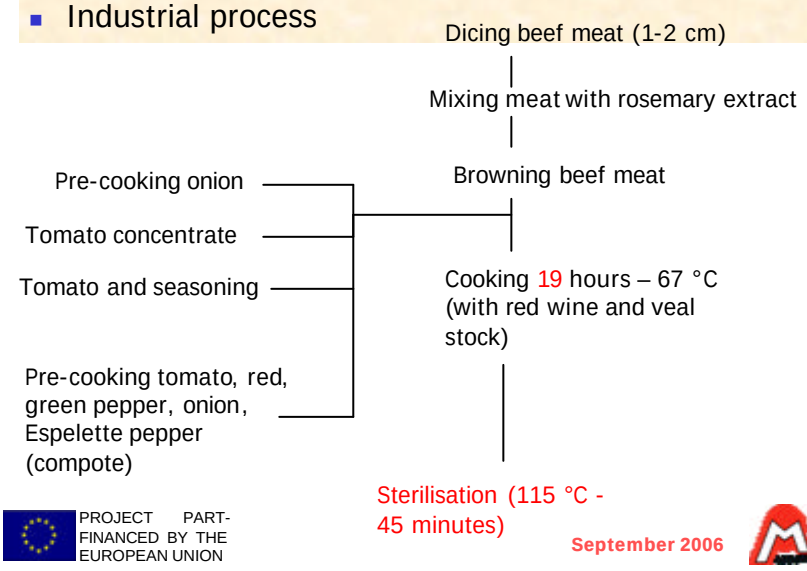
Daube à la basquaise (basque stew)

- Industrial process



PROJECT PART-FINANCED BY THE EUROPEAN UNION

September 2006

Daube à la basquaise (basque stew)

- Parameters tested and selected by panel in Pascal Massonde :
  - Type of muscles : 4 muscles tested (forequarter)
    muscle selected : cheek (more tender)
  - Time of cooking : 12 and 19 hours
    time selected : 19 hours
  - Combination meat/vegetables : all vegetables pre-cooked together

PROJECT PART-FINANCED BY THE EUROPEAN UNION

September 2006

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