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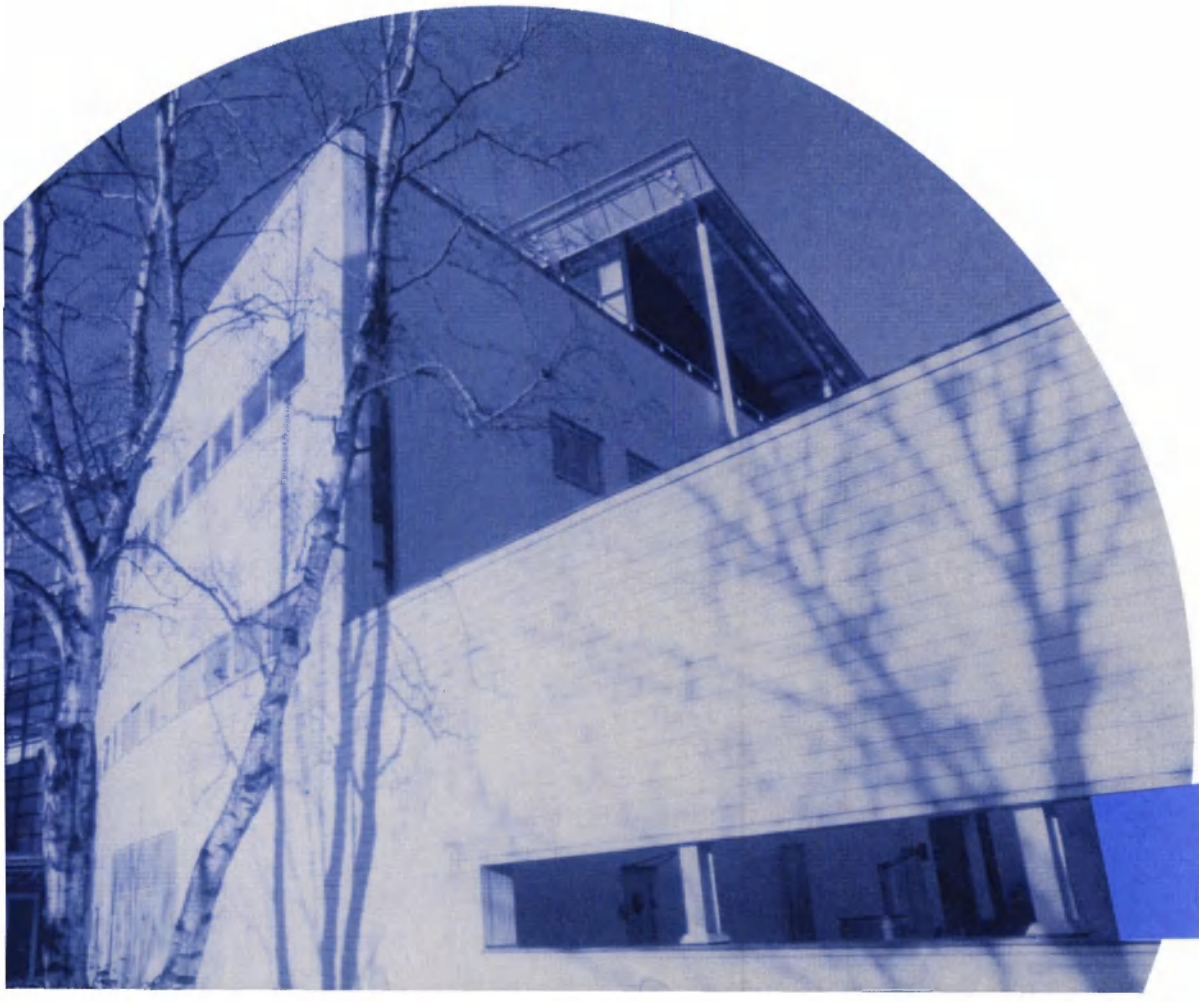
Proposal

A combined hurdle approach using natural antimicrobials and modified atmosphere packaging to assure food safety and product quality

Proposal acronym: HURDLEPACK

November 12th, 1999



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B1. Title Page

Proposal Full Title:

A combined hurdle approach using natural antimicrobials and modified atmosphere packaging to assure food safety and product quality

Proposal acronym: HURDLEPACK

Date: 12 November, 1999

B2. Table of Contents

B3. Objectives and expected achievements

In recent years, the consumer's demand for healthy, nutritious food with fresh characteristics is steadily increasing. In addition, the changing lifestyle of the consumer leads to an increased demand for easy and quickly to prepare meals: convenience food (e.g. prepared meals, fresh cut vegetable and salad mixes) has conquered a large segment of the market, and one expects a further growth of this market. Providing a wide choice of convenience food products which consist of healthy and nutritious ingredients (e.g. fresh fruits, prepared salads, prepared seafood) would ensure the supply of high quality food which will contribute to the consumer's health and well being.
However, assuring food safety and sensory quality of fresh prepared meals poses often a challenge [1]. In order to supply the consumer with safe food with satisfying sensorial quality, optimised processing steps, preservation and packaging techniques have to be applied. Parallel to the trends in convenience food, the consumer develops an increasingly suspicious attitude towards artificial food additives and preservation techniques which extend the shelf life of these food items. In order to achieve food safety and to extend the fresh-like characteristics of perishables, several techniques have been *individually* studied which can be perceived by the customer as 'natural' or 'minimal intrusive' means to assure food quality. Among these techniques are (equilibrium) modified atmosphere packaging (MAP)[2-5], the application of lactic acid bacteria (LAB) cultures [6,7,8], and the use of antimicrobial extracts from animal origin and plant volatiles [9,10,11] (LAB cultures, antimicrobial extracts from animal origin, and plant volatiles will be referred to as 'natural antimicrobials' in the remainder of the proposal), which can be perceived by the consumer as 'natural' or 'minimal intrusive' means to assure food quality. Some of these techniques (e.g. equilibrium MAP or gas packaging) have found widespread use. The antimicrobial action of other techniques, e.g. the application of plant volatiles, is proven, but undesired side effects (phyto-toxic effects and off-flavours) limited or prevented their widespread application in the food industry.
A promising way to optimise the efficiency of techniques which assure food safety and prolong the shelf life is the 'combined hurdle' approach: by combining several techniques, one can achieve a synergetic effect: the required dosages of the individual technique decreases drastically if it is applied in combination with other techniques [12]. Lower dosages result – in turn – in lower or possibly no side effects (such as off-flavours and phyto-toxic effects). Finally, a minimised use of preservation techniques is what the consumer expects if he/she wants to buy fresh prepared products.
The technological aim of the project 'Hurdlepack' is to apply several (partially already established) techniques such as MA packaging, protective LAB cultures and plant volatiles or extract from animal origin with an antimicrobial action in order to assure food safety and to extend the fresh-like characteristics of convenience food. Focus of the proposed research will be to find 'smart combinations' of the individual hurdles in order to minimise their dosages and to avoid negative side effects on the sensorial quality of the packed products. Ultimate goal of the project is to produce prototypes of packaging concepts, which integrate the combined hurdle approach of MA packaging and natural antimicrobials.
Parallel to the technical development of the above described combined hurdle approach, we will study the consumer attitudes towards the novel technique and the legislative aspects for the introduction of a combined hurdle packaging concept on a European scale.

The 'Hurdlepack' project uses therefore a multidisciplinary research effort in order to investigate technological, societal, and legislative aspects of the introduction of a novel technique for preservation and packaging of convenience food.

The **main objectives** of the 'Hurdlepack' project are:

- To develop and improve a combined hurdle approach for single / mixed product which employs natural antimicrobials and MAP in order to assure food safety, fresh-like characteristics of the food items, and an optimal shelf life;
- To technically implement and test the above developed combined hurdles technique in a packaging concept for a range of (within the project) chosen food items;
- To study consumer attitudes and to provide the consumer and future producer with the necessary information for an introduction of the new technique;
- To survey the legal framework which is necessary for an EU-wide introduction of the developed techniques.

The **main achievements** of the 'Hurdlepack' project are:

- A combination of MAP and natural antimicrobials which assure food safety and sensory quality of selected food items;
- Prototypes for a packaging concept which applies the developed techniques and assures food safety and product quality;
- A guidelines document which describes consumer attitudes towards the new technique and which outlines the information on the technique which the consumer and requires.
- A survey of the current legislative framework for the application of natural antimicrobials in food packaging and an identification of the steps which are necessary for a EU-wide introduction of the new technique.

The 'Hurdlepack' project will focus on three product groups which are important in the convenience food sector: seafood, vegetables, and fruit. The food safety of seafood and certain types of vegetables (e.g. bean sprouts) is in general a critical issue, whereas maintaining sensorial quality and fresh-like characteristics of fresh cut vegetables and fruit are often problematic.
This project is not part of a cluster. However, the proposers of the project are willing to form a loose cluster with suitable projects which focus e.g. on combined hurdle technology or packaging of perishable goods, if the Commission suggests this during the negotiation stage.

B4. Contributions to programme/specific action objectives

The 5th framework programme ' Quality of life and management of living resources' aims via its key actions at *'improving the competitiveness of European industry and enhancing the quality of life of the EU citizen'.* The key actions focus on *'immediate socio-economic and market needs in areas such as improving our food'.* The aims of the proposed 'Hurdlepack' project matches very well with the general aims of the programme since we want to develop a novel packaging concept which should provide the EU citizen with healthy and nutritious prepared food items, which is a quickly growing market. The project investigates all steps (technological, societal, and legislative) which are necessary for a rapid market introduction of the developed food packaging and preservation technique for fresh prepared and should give the corresponding European industry an advantage over competitors.

The key action 'Food, Nutrition and Health' addresses the *'need to better understand consumer requirements and to provide a healthy, safe, and high quality food supply'* as well as the problems arising from a *'changing regulatory environment... hindering the innovation of products that can contribute to consumers health'.* One of the anticipated deliveries of the key action are *'optimised raw materials/processing combinations offering added value, safety and improved nutritional characteristics'.* These objectives comply very well with the aims of the proposed project: a combined hurdle approach will be developed which assures food safety and sensorial quality of healthy and nutritious prepared food items. Using 'natural' techniques to achieve this goals is in line with recent consumer demands. Parallel to the technological research, legislative aspects and consumer attitudes with respect to the introduction of this technique are investigated on a European scale.

The proposed project focuses in particular

- on **action 1.1.2** which calls for the *'Development of safe, efficient and sustainable processing and packaging technologies (e.g. minimally processing), to optimise the nutritional and sensory quality of food'*, the *'re-evaluation and subsequent optimisation of conventional and traditional processes for maximising quality and safety and reducing food losses'*, and to study *'the kinetics of changes of food quality indicators as affected by processing and packaging conditions'* ;
- on **action 1.2.3** which addresses *'new food preservation techniques and optimal combinations of processing methods for destroying or inactivating micro-organisms'*, and
- on **action 1.3.4** which addresses *'consumer attitudes and reactions with regard to food products, food processing and labelling'*

B5. Innovation aspects

Assuring food safety and shelf life is the key task for processing and packaging convenience food items. The microbial quality of the for this project considered food items is often problematic: vacuum-packed salmon as well as ready to eat products like seafood patés in combination with vegetables (broccoli, pea, carrots, unions and roots) are quite often found to contain *Listeria*. The vegetable components are also identified as products containing high levels of spoilage micro-organisms, in general from the family *Pseudomonadaceae* and *Enterobacteriaceae*, which results in an extremely short shelf life of the product. In the Nordic countries 11% of the fish and shellfish patés are contaminated with *Listeria monocytogenes*. Up to 75% of tested cold smoked salmon have tested positive for *Listeria monocytogenes*. Another critical component are bean sprouts, which are frequently used in stir fry mixes, prepared salads and sandwiches: A number of sprout-borne *Salmonella* and EHEC outbreaks have been reported during the last decade.
In order to prevent or slow down bacterial growth, assure food safety and prolong the shelf life of the product, the individual efficacy of several measures has been established in the last decades:
Modified atmosphere packaging is well established to 'protect' perishable goods: For seafood, one uses CO_2 which delays and slows down bacterial growth, packaging without O_2 or with very low levels of O_2 prevents lipid oxidation of fatty fish (e.g. salmon) [4];. Equilibrium modified atmosphere packaging uses the natural respiration of respiring products (vegetables, fruits), in order to create a micro-climate within the package which slows down the metabolic rate of the product, and therefore delays the quality decay of the product [2].
In recent years, the potential of LAB based protective cultures for controlling microbiological risks has been widely studied [6]). Partner 3 has expertise on the antimicrobial action of specific LAB cultures on *Listeria monocytogenes*; partner 6 carried out a study which revealed that a treatment with protective LAB cultures significantly retarded the growth of *enterobacteria CEAE* during the sprouting process of mung beans and Persian clover.
The anti-microbial action of plant volatiles (e.g. thymol, carvacrol) and certain novel extracts / peptides of animal origin which would be (from a consumer's point of view) very interesting substitutes for synthetic preservatives has been for example studied and established by partner 1 and 6 [10,11]. Although first results on the antimicrobial action were very promising, some of these compounds have undesired side effect like off-flavours or phyto-toxic effects[13].
Antimicrobial extracts of animal origin include peptides (micro-active proteins from mussels), and chitin-chitosan (LIZYX from shrimp or moulds). The expertise of partner 7 will be used to apply these substances on seafood within the proposed project.
A possible way to optimise the action of the individual 'hurdles', to avoid undesired side effects (e.g. off-flavours), and to minimise the dosages of the individual 'hurdles' is a combined hurdle approach. Fundamental aspects of a combined hurdle approach has been studied in the projects FAIR-CT96-1066 and FAIR-CT96-1148 (see also [12]).
Investigations on the consumer acceptance of novel types of packaging, e.g. active packaging and the legislative aspects of adding active devices and ingredients to food packaging have been carried out in the actipak research project (FAIR–CL98–4170) (see also [14]).
Aim of the proposed research project is to progress beyond the **level of fundamentally studying** the action of individual or combined hurdles in order to assure food safety, and to combine the existing knowledge in the area of MA packaging, natural antimicrobials, and legislative and societal aspects of active

packaging on **an applied level**: The research and development of a prototype of a packaging concept which integrates the hurdles modified atmosphere natural antimicrobials and identification all steps which are potentially necessary to achieve a legislative approval and consumer acceptance of the newly developed technique on a European level.
The proposed project progresses beyond the current state of art in the following aspects:
In order to succeed in the technological development of a packaging concept which applies the combined hurdle approach, research has to focus strongly on the mutual interaction of the applied hurdles [15].
Using the synergetic effect of a combined hurdle approach of lactic acid bacteria, plant volatiles, and / or antimicrobial extracts of animal origin in a modified atmosphere packaging is to our knowledge a novel approach.
A successful combination of the different hurdles requires an in-depth study of the interaction hurdles, product, and packaging, which focuses not only on the synergetic antimicrobial effect of several hurdles, but also on the effect of e.g. plant volatiles on the vitality of the protective LAB cultures, or the respiration rate of the packed vegetables and fruits. A possible effect of the natural antimicrobials on the respiration rate of fruits and vegetables will in turn influence the build up of the modified atmosphere and has to be considered when a packaging material with an ideal permeability is chosen.
Another crucial issue is the sensory quality of the packed food: the proposed research aims at a combination of hurdles which assures food safety and a long shelf life **as well as** a satisfactory sensory quality of the food: the project aims at the development of a packaging concept (including prototypes) which in principle can be introduced in the market.
The project also requires research into the application of volatile or non-volatile antimicrobials in a packaging. This research is either directed at developing novel methods of gas packaging (i.e. introducing antimicrobial volatiles while applying a protective atmosphere), or the research is directed at the development of novel active packaging concepts (integrating a controlled release system into the packaging, or developing active packaging materials which contain an antimicrobial). The idea of an active packaging which actively alters the microclimate in the packaging in order to assure food safety and improve food quality is a logical extension of the modified atmosphere packaging concept. Considering the widespread use op MA packaging, it is to expect that active packaging will play a prominent role in food packaging in the future[16].

B6. Project workplan

Introduction

The proposed project will be carried out in a time period of three years. It consists of 8 workpackages (WP0 – WP7) which are subdivided into further tasks. The main aim of the project is to develop a packaging concept which applies a combined hurdle approach consisting of modified atmosphere and natural antimicrobials in order to assure food safety, to prolong the shelf life, and to guarantee the sensory quality of the packed food items. We will develop the packaging concept for selected types of seafood, vegetables, and fruit, as well as combinations of seafood and vegetables, and vegetables and fruit. Parallel to the technological development of the combined hurdle approach and the packaging concept, legislative aspects and consumer attitudes regarding the developed technology will be investigated.

In **WP0** the boundary conditions for the future research are defined: the types of product will be selected, relevant food borne pathogens and spoilage micro-organisms will be identified, promising natural antimicrobials will be selected, and a review of the current state of art on MA packaging and combined hurdle technology will be given. In addition, a survey of the logistic chain for the selected products will be carried out in order to define the conditions under which the packaging concept has to function.

The research carried out in **WP1** to **WP4** moves from a – rather fundamental – *in vitro* study of the action and interaction of the hurdles in WP1 to an investigation on packaging level of the functionality of combined hurdle approach integrated in a packaging concept in WP4. The *in vitro* studies in **WP1** focuses on finding robust combinations of natural antimicrobials and on assessing the synergetic effect of a combined action of different antimicrobials. It forms the basis for the following workpackages. The results of WP1 will be verified on the actual product in **WP2**: in addition to the antimicrobial action of the applied hurdles and the interaction of the antimicrobials on a single product, effects of the combined hurdle approach on product quality and sensory attributes will be determined. In **WP3**, this research is extended to mixed products. In addition to the research which resembles the activities in WP2 (now for mixed products), issues as cross contamination and migration of natural antimicrobials between product components will be addressed. WP2 and WP3 will yield an optimal combination of natural antimicrobials and MA which will be implemented in a packaging concept in **WP4**. WP4 will start parallel with WP2 and WP3. Before the for WP4 necessary results of WP2 and WP3 are obtained, the research in WP4 will focus (where necessary) on optimal MA conditions of single and mixed products, technological aspects of applying antimicrobial volatiles and non-volatiles in packaging, and the choice of optimal packaging materials in order to build up or maintain a modified atmosphere or equilibrium modified atmosphere in the packaging. The technological development of the packaging concept for applying a combined hurdle approach will be completed with packaging trials with the selected product under optimal and sub-optimal storage conditions and test runs with an industrial partner (partner 5) in order to assess and optimise the functionality of the developed technology.

WP5 and **WP6** will focus on the legislative aspects and the consumer acceptance of the novel packaging and preservation technique on a European level. The results of these workpackages are essential for a market introduction of the combined hurdle packaging concept.

In **WP7**, the results of the project will be disseminated and their exploitation will be planned.

The **microbiological research** will be carried out *in vitro* (WP1) and *in situ* (WP2 – WP4). In order to assess the vitality of LAB cultures and the effect of the combined hurdle approach on food borne pathogens and spoilage micro-organisms, rapid impedimetric techniques, fluorescence microscopy, flow cytometry, and luminometric methods for lux-gene strains are applied [17,18]. In addition, research will be carried out on the physiology of food borne pathogens and spoilage micro-organisms in order to determine the antimicrobial mechanism of the applied hurdles. The effect of single and combined application of natural antimicrobials on growth kinetics, their mode of action and the targets of plant volatiles and modified atmosphere on food borne pathogens and spoilage micro-organisms will be determined.
The detailed action of **modified atmosphere** on seafood will be determined by coulometric methods [19]; the effect and build-up of a modified atmosphere for respiring products (fruits and vegetables) will be studied with a specially designed controlled atmosphere storage system, which analyses the composition of the atmosphere surrounding the product and monitors the respiration rate of the product for different micro-climates and temperatures. These experiments can also be carried out at the presence of natural antimicrobials.
Barrier properties of packaging materials will be determined instruments using chromatographic or electrochemical techniques in order to determine permeation rates. These experiments can be carried out temperatures and relative humidities which occur in a real distribution chain.
The **conditions in the logistic chain** will be recorded with data loggers which can monitor temperature, relative humidity, and mechanical vibration as a function of time.
For **packaging trials**, standard packaging equipment (gas packaging machines and flow packers) are available. The packed product will be stored in climate controlled rooms which simulate a realistic distribution chain. The **composition of the headspace** (environmental gases and antimicrobial volatiles) can be determined *in situ* with gas chromatography.
The **shelf life and sensory quality** of the product will be assessed by various quality indicators: the microbial quality, the visual quality, and the sensory quality. For the sensory assessment of the product, a sensory panel will be used (both trained and consumer sensory panel).
The **consumer attitudes** and perceived benefits and risks will be assessed by qualitative interviews and quantitative questionnaires. Consumer research will be carried out in three countries of the EU.
Legislative aspects of the developed technique will be surveyed by communication with experts, authorities and work groups in various EU countries.

Project planning and time table

Task	Start date	End date	Duration	1. year	2. year	3. year
				1. -3. 4. -6. 7. - 9. 10. - 12.	13. -15. 16. 18. 19. - 21. 22. - 24.	25. -27. 28. -30. 31. - 33. 34. - 36.
WP0 Specification product / natural antimicrobials / state of the art						
Task 0.1 Selection of suitable products for a combined approach of natural antimicrobials and MAP; survey of the distribution chain.	1	6	6			
Milestone: Types of produce				★		
Deliverable 1 Survey distribution chain				◆ → WP4		
Task 0.2 Concise study of the state of the art of MA technology for single and mixed product	1	6	6			
Deliverable 2 Review on current state of art of MAP technology				◆		
Task 0.3 Identification pathogens / spoilage micro-organisms	1	6	6			
Task 0.4 Selection of natural antimicrobials	1	6	6			
Task 0.5 Selection / establishment of a LAB culture collection	1	6	6			
Milestone: Selection of natural antimicrobials and pathogens / spoilage micro-organisms				★ → WP2 – WP6		
Deliverable 3 Review of the current state of art of hurdle technology				◆		
WP1 In vitro screening individual and combined action of plant volatiles, mollusc extracts, and LAB cultures						
Task 1.1 Development of fast enumeration technique	4	12	9			
Deliverable 4 A rapid detection and enumeration technique				◆ → WP2 – WP4		
Task 1.2 Testing of the efficacy of natural antimicrobials in individual application	7	12	6			
Milestone Dosages for individual application of natural antimicrobials				★ → WP2, WP3		
Task 1.3 Study of the effect of plant volatiles and extracts of animal origin on LAB cultures	7	12	6			
Milestone: Robust combinations of natural antimicrobials				★ → WP2 – WP4		
Task 1.4 Study of the combined action of natural antimicrobials	13	18	6			
Deliverable 5: (Report) Suitable combinations and synergetic effect of combined application of natural antimicrobials				◆ → WP2 – WP6		

Task	Start date	End date	Duration	1. year				2. year				3. year			
				1. -3.	4. -6.	7. - 9.	10. - 12.	13. -15.	16. 18.	19. - 21.	22. - 24.	25. -27.	28. -30.	31. - 33.	34. - 36.
WP2: In vivo testing of the combined action of natural antimicrobials and MAP on single products															
Task 2.1 Investigation of LAB cultures on single product: vitality, distribution, time development	13	18	6												
Task 2.2 Effect of plant volatiles, extracts of animal origin, and MA (singly and combined) on vitality LAB	13	24	12												
Task 2.3 Impact of the combined approach of natural antimicrobials and MA on spoilage micro-organisms and pathogens	13	24	12												
Milestone Optimised threshold values for concentrations natural antimicrobials												WP4			
Task 2.4 Effect of different application patterns for plant volatiles on the efficacy	13	24	12												
Milestone Optimised application pattern for plant volatiles												WP4			
Deliverable 6: (Report) Report on the optimal combination an application pattern of th combined hurdles for single product												WP4 – WP6			
WP 3: In vivo testing of the combined action of natural antimicrobials and MAP on mixed products															
Task 3.1 Investigation of LAB cultures on mixed product: vitality, distribution, time development	13	18	6												
Task 3.2 Studying the absorption of plant volatiles and migration of mollusc extracts by different product components	13	18	6												
Task 3.3 Effect of natural antimicrobials MA (singly and combined) on vitality LAB	19	30	12												
Task 3.4 Cross contamination of food borne pathogens and spoilage micro-organisms between different product groups	19	30	12												
Task 3.5 Impact of the combined approach of natural antimicrobials and MA on spoilage micro-organisms and pathogens	19	30	12												
Milestone Optimised threshold values for concentrations natural antimicrobials												WP4			
Task 3.6 Effect of different application patterns for plant volatiles on the efficacy	19	30	12												
Milestone Optimised application pattern for plant volatiles												WP4			
Deliverable 7: (Report) Report on the optimal combination an application pattern of th combined hurdles for mixed product												WP4 – WP6			

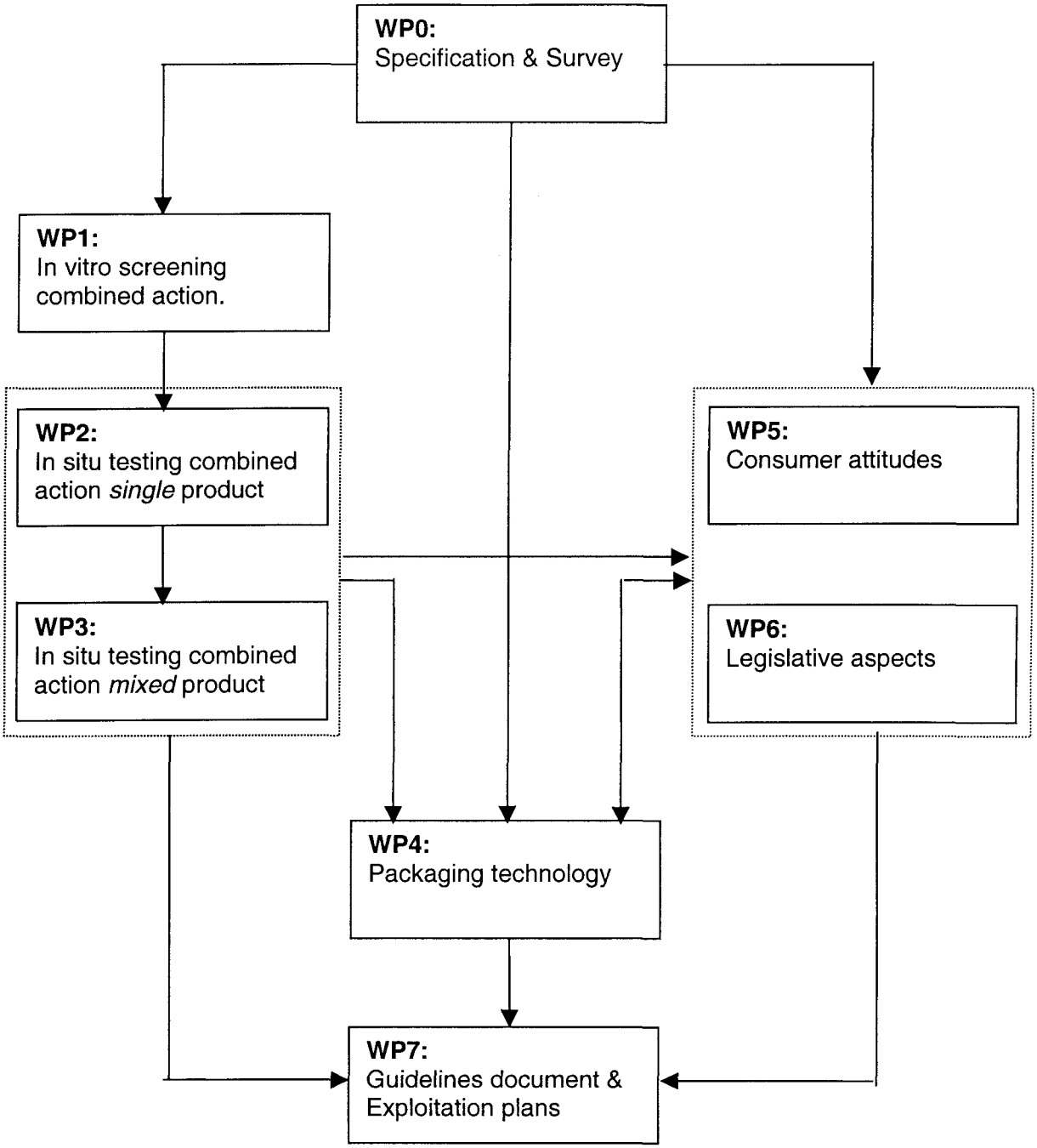
Task	Start date	End date	Duration	1. year				2. year				3. year			
				1. -3.	4. -6.	7. - 9.	10. - 12.	13. -15.	16. 18.	19. - 21.	22. - 24.	25. -27.	28. -30.	31. - 33.	34. - 36.
WP4: Development of a packaging concept															
Task 4.1 Optimised MA conditions for mixed product & package design	7	18	12												
Milestone: Selection of suitable packaging materials															
Deliverable 8: Report on the repiration properties of the selected fruits and vegetables															
Task 4.2 Technical implementation of application pattern	19	30	12												
Deliverable 9 A packaging concept															
Task 4.4 Packaging trials for single product under optimal / sub-optimal conditions	25	34	9												
Task 4.5 Packaging trials for mixed product under optimal / sub-optimal conditions	25	34	9												
Deliverable 10 Assessment of the performance of the packaging concept															
WP5: Legislative aspects for natural antimicrobials in food packaging															
Task 5.1 Survey of the current state & necessary steps	7	18	12												
Task 5,2 Communication on legal premises of the use of novel preservation techniques	13	34	21												
Deliverable 11 Report on legislative aspects and necessary future steps															

WP5, WP6

Task	Start date	End date	Duration	1. year				2. year				3. year			
				1. -3.	4. -6.	7. - 9.	10. - 12.	13. -15.	16. 18.	19. - 21.	22. - 24.	25. -27.	28. -30.	31. - 33.	34. - 36.
WP 6: Consumer attitudes towards MA and natural antimicrobials in food															
Task 6.1 Investigating consumer acceptance	7	24	18												
Task 6.2 Investigating the sensory impact on product quality and the consumer's response to it	13	34	21												
Task 6.3 Investigating risks and benefits which the consumer perceives	7	24	18												
Task 6.4 Determining attitudes obstructing / promoting the new technique	13	34	21												
Deliverable 12 A report on consumer's acceptance of the technique															◆
Deliverable 13 A report on necessary information for the consumer in order to introduce the technique															◆
WP7: Guidelines document															
Task 7.1 Dissemination of results	31	36	6												
Task 7.2 Exploitation plan	31	36	6												
Deliverable 14 Final project report															◆

Pert Diagram

The pert diagram shows the relation between the different workpackages. The diagram on the following page indicates how the work is distributed between the different product groups.



Product: Seafood

WP0: Specification LAB cultures, peptides, and state of the art of MA packaging.

WP1: In vitro testing of individual / combined action of LAB cultures & peptides

WP2: In situ testing of combined action of MA, LAB cultures & peptides.

Product: Vegetables

WP0: Specification LAB cultures, volatiles, and state of the art of MA packaging.

WP1: In vitro testing of individual / combined action of LAB cultures & volatiles

WP2: In situ testing of combined action of MA, LAB cultures & volatiles.

Product: Fruit

WP0: Specification LAB cultures, volatiles, and state of the art of MA packaging.

WP1: In vitro testing of individual / combined action of LAB cultures & volatiles

WP2: In situ testing of combined action of MA, LAB cultures & volatiles.

WP3: In situ testing of combined action of MA and natural antimicrobials on mixed product (seafood & vegetable)

WP3: In situ testing of combined action of MA and natural antimicrobials on mixed product (vegetables & fruit)

WP4: Development of a packaging concept for the combined action of MA, volatiles, peptides, and LAB cultures for each product (WP2) and mixed products (WP3).

WP5: Legal aspects for applying natural antimicrobials in MA food packaging.

WP6: Consumer attitudes towards applying MA and natural antimicrobials in food packaging

WP7: Guidelines document & exploitation planning.

List of work packages

No. Work package	Workpackage Title	Responsible Participant	Person months	Start month	End month	Deliverables No.
0	Specification	1	13.5	1	12	1,2,3
1	In vitro screening	2	63	4	18	4,5
2	Combined action on single product	1	43	13	24	6
3	Combined action on mixed product	1	29	13	24	7
4	Packaging Technology	1	61	7	34	8,9,10
5	Legislative aspects	6	8	7	34	11
6	Consumer acceptance	6	36	7	34	12,13
7	Guidelines document	1	14.5	31	36	14

Table B1

Deliverables list

Deliverable No.	Deliverable Title	Delivery Date (month)	Nature	Dissemi-nation level
1	Survey of the distribution chain	12	R	RE
2	Review of the current state of the art of modified atmosphere technology for the selected types of product	6	R	PU
3	Review of the current state of the art of combined hurdle technology for the selected types of product	6	R	PU
4	A rapid detection and enumeration technique for lactic acid bacteria	12	P	CO
5	Suitable combinations of natural antimicrobials and their synergetic effect	18	R	RE
6	Report on the optimal combination an application pattern of th combined hurdles for single product	24	R	RE
7	Report on the optimal combination an application pattern of th combined hurdles for mixed product	24	R	RE
8	Report on respiration properties of the selected product with / without influence of the combined hurdles	18	R	RE
9	A packaging concept which integrates MA and natural antimicrobials	24	P	CO
10	An assessment of the performance of the packaging concept under optimal / sub-optimal storage conditions	34	R	RE
11	A Report on legislative aspects and possible necessary future steps for the introduction of the technique	34	R	RE
12	A report on consumer's acceptance of the technique	34	R	RE
13	A report on necessary information for the consumer in order to introduce the technique	34	R	RE
14	The final project report (confidential: 14a, public, 14b)	36	R	CO/PU

Table B2

Detailed project description

WP 0: Specification of product, natural antimicrobials, and state of the art of modified atmosphere packaging (MAP)

Start date or starting event: Month 1
N° of the partner responsible: 1
N°s of other partners involved: 2, 3, 4, 5, 6, 7
Person-months per partner: 1(4.5pm), 2(2pm), 3(0.5pm), 4(2pm), 5(0.5 pm), 6(1pm), 7(3pm)

Objectives:
The main objective of this workpackage is to define the type of products, the 'natural antimicrobials' (LAB, plant volatiles, and extracts of animal origin), and the state of the art of packaging technology (MAP).

Description of work:
Products from the product groups seafood, vegetables, and fruit will be selected from both a consumer / market and technical perspective on the basis of a promising combined approach of MA and natural antimicrobials and adopted by all partners. The conditions in the logistic chain for these food products will be investigated in order to determine the boundary conditions (transportation / storage periods, temperature, relative humidity) under which a packaging concept has to function which will be developed in WP4 (Task 0.1).
Based on a literature survey / previous experimental work

- Relevant food borne pathogens and spoilage micro-organisms for the selected types of product will be identified (Task 0.2);
- A survey of MA conditions for individual and mixed food items will be carried out, including different packaging techniques (MA packaging and equilibrium MA packaging), and the material properties (gas and water vapour permeability) of the necessary packaging materials (Task 0.3);
- Suitable plant volatiles and antimicrobial extracts from animal origin will be selected from a group of food approved compounds and a group of novel compounds (Task 0.4);
- Based on pervious work, a reference culture collection of lactic acid bacteria with antagonistic activity against food-borne pathogens and spoilage micro-organisms will be set up, preserved centrally and distributed to all the partners.

Deliverables:
Deliverable 1: A survey of the conditions in the logistic chain of the selected food products (report).
Deliverable 2: Review of the currents state of art MA packaging of the selected product items and mixtures of these items (report).
Deliverable 3: A survey on the currents state of art of applications of hurdle technology with a focus on the natural antimicrobials which will be applied in the course of the project (report).

Milestones and expected results:
The main milestone of workpackage 0 is the selection of the food products, the natural antimicrobials, and the food borne pathogens and spoilage micro-organisms which will be used and studied in the course of the project. The boundary condition which are needed to develop a packaging concept are determined in this phase.

WP 1: In vitro screening of the individual and combined action natural antimicrobials on pathogens and spoilage micro-organisms

Start date or starting event: Month 4
N° of the partner responsible: 2
N°s of other partners involved: 4, 6, 7
Person-months per partner: 2(17pm), 4(12pm), 6(20pm), 7(14pm)

Objectives:
Aim of this workpackage is to determine the efficacy of the selected antimicrobials (LAB, antimicrobial extracts of animal origin, plant volatiles) on the selected food borne pathogens and spoilage micro-organisms. Focus of the research is to determine the tolerance levels of LAB cultures for plant volatiles and antimicrobial extracts of animal origin (micro-active proteins) as well as the synergetic effect which possibly can be achieved by a combined action of LAB and plant volatiles / mollusc peptides.
Another objective of this workpackage is the development and application of a rapid detection and enumeration method for viable LAB.

Description of work:
The action of natural antimicrobials on food borne pathogens and spoilage micro-organisms and the interaction of plant volatiles and antimicrobial extracts of animal origin with LAB cultures will be tested '*in vitro*' (i.e. on substrates resembling the chosen products in WP0). The vitality of pathogens, spoilage micro-organisms, and LAB cultures will be monitored by lux genes and a rapid detection and an enumeration method for LAB cultures. A novel detection and enumeration technique based on fluorescence techniques (fluorescence microscopy, flow cytometry) for testing the viability of LAB cultures used in different applications will be developed and tested in Task 1.1.
In Task 1.2, the effect of plant volatiles and antimicrobial extracts of animal origin on the vitality of LAB cultures will be investigated in order to determine threshold values for concentrations which do not negatively influence the vitality of the LAB cultures.
The efficacy of the individual action of natural antimicrobials on food-borne pathogens and spoilage micro-organisms will be tested in Task 1.3. In Task 1.4, the synergetic effect of a combined action of natural antimicrobials on spoilage micro-organisms and food borne pathogens will be determined. If necessary, experiments will be also carried out under modified atmosphere conditions (e.g. for seafood).

Deliverables:
Deliverable 4: A rapid detection and enumeration of viable LAB. (Prototype)
Deliverable 5: A report on suitable combinations of natural antimicrobials and their synergetic antimicrobial effect. (Report)

Milestones and expected results:
The main milestones in this workpackage is the development of robust combinations of plant volatiles / peptides and LAB cultures which show a synergetic antimicrobial effect on the selected food borne pathogens and spoilage micro-organisms. The antimicrobial activity of the selected natural antimicrobials will be evaluated in individual and in combined action in order to assess synergetic effects.

WP 2: In situ testing of the combined action of natural antimicrobials and MA on pathogens and spoilage micro-organisms on a *single* product.

Start date or starting event: Month 13
N° of the partner responsible: 1
N°s of other partners involved: 2, 3, 4, 6, 7
Person-months per partner: 1(10pm), 2(2pm), 3(5pm), 4(14pm), 6 (6pm), 7 (8pm)

Objectives:
The main objective of this workpackage is investigate the efficacy of a combined action of natural antimicrobials and modified atmosphere on a *single* product. The optimal combination of natural antimicrobials and MAP should guarantee food safety, prolong the shelf life, and maintain the sensorial quality of the food items.

Description of work:
The vitality of LAB cultures on the selected products is investigated by techniques used and developed in WP1 *without the influence of other natural antimicrobials or MAP*. The spatial distribution (e.g. as a function of the application technique, spraying, washing step, etc.), and the time development of the vitality of the LAB cultures will be determined (Task 2.1).
In Task 2.2, the study of the vitality of the LAB cultures in Task 2.1 will be repeated *when other natural antimicrobials and a modified atmosphere are present.* Starting point for the concentrations of natural antimicrobials will be results summarised in deliverable 6. Depending on the vitality of the LAB, the concentrations will be adjusted.
In Task 2.3, the *combined effect of natural antimicrobials and MA on selected food borne pathogens and spoilage micro-organisms* is tested. Optimal combinations of natural antimicrobials and MA are determined which assure food safety and prolonged shelf life with minimal or no impact on the sensorial quality of the food items. The sensorial quality is determined by a proof panel.
The effect of *different application patterns* (e.g. initial high dosage vs. continuous slow release) of volatile antimicrobials on the vitality of LAB cultures, the antimicrobial effect and the sensorial quality of the food items is determined in Task 2.4. A possible application pattern of volatiles and LAB would be to use the antimicrobial effect of the volatile in the beginning phase; and the antimicrobial effect of LAB cultures in the end phase of the storage period.

Deliverables:

Deliverable 6 a, b, c	A report on the optimal combination and application patterns of natural antimicrobials and MA for a combined hurdle approach on single product (6 a: seafood, 6 b: vegetables, 6 c: fruit).

Milestones and expected results:
This workpackage defines the boundary conditions of the application of natural antimicrobials (vitality LAB cultures versus concentration plant volatiles / antimicrobial extracts of animal origin under MA conditions) in food packaging for *single* products. Milestones are optimised threshold values (i.e. minimised concentrations) for the application of the hurdles and the study of the dynamics of the antimicrobial action will yield insight into the viability of different modes of applications of (volatile) antimicrobials which will be further implemented in workpackage 4. The dosages of the natural antimicrobials are also necessary results for workpackage 5 and workpackage 6.

WP 3: In situ testing of the combined action of natural antimicrobials and MA on pathogens and spoilage micro-organisms on *mixed* products.

Start date or starting event: Month 13
N° of the partner responsible: 1
N°s of other partners involved: 2, 3, 4, 7
Person-months per partner: 1(8 pm), 2(2 pm), 3(5 pm), 4 (6 pm), 7(6 pm)

Objectives:
The main objective of this workpackage is investigate the efficacy of a combined action of natural antimicrobials and modified atmosphere on *mixed* products. The optimal combination of natural antimicrobials and MAP should guarantee food safety, prolong the shelf life, and maintain the sensorial quality of the food items.

Description of work:
The vitality of LAB cultures on mixed products (seafood / vegetable; vegetable / fruit) is investigated by techniques used and developed in WP1 *without the influence of other natural antimicrobials or MAP*. The spatial distribution (e.g. as a function of the application technique, spraying, washing step, etc.), and the time development of the vitality of the LAB cultures will be determined (Task 3.1).
The absorption of volatile antimicrobials by different food items and the migration of non-volatile antimicrobials between different food items is investigated in Task 3.2.
In Task 3.3, the study of the vitality of the LAB cultures in Task 3.1 will be repeated *when other natural antimicrobials and a modified atmosphere are present*. Starting point for the concentrations of natural antimicrobials will be results summarised in deliverable 6 a-c. Depending on the vitality of the LAB, the concentrations will be adjusted.
Cross-contamination of food borne pathogens and spoilage micro-organisms between different components of the mixed products is investigated in Task 3.4.
In Task 3.5, the *combined effect of natural antimicrobials and MA on selected food borne pathogens and spoilage micro-organisms* is tested. Optimal combinations of natural antimicrobials and MA are determined which assure food safety and prolonged shelf life with minimal or no impact on the sensorial quality of the food items. The sensorial quality is determined by a sensory panel.
The effect of *different application patterns* of volatile antimicrobials on the vitality of LAB cultures, the antimicrobial effect and the sensorial quality of the food items is determined in Task 3.6.

Deliverables:

Deliverable 7 a, b	A report on the optimal combination and application patterns of natural antimicrobials and MA for a combined hurdle approach on mixed product (7 a: seafood / vegetable, 7 b: vegetables / fruit).

Milestones and expected results:
This workpackage defines the boundary conditions of the application of natural antimicrobials (vitality LAB cultures versus concentration plant volatiles / antimicrobial extracts of animal origin under MA conditions) in food packaging for *mixed* products. Milestones are optimised threshold values (i.e. minimised concentrations) for the application of the hurdles and the study of the dynamics of the antimicrobial action will yield insight into the viability of different modes of applications of (volatile) antimicrobials which will be further implemented in workpackage 4. The dosages of the natural antimicrobials are also necessary results for workpackage 5 and workpackage 6.

WP4: Development of a packaging concept for the combined application of natural antimicrobials and modified atmosphere which improves product quality and food safety.

Start date or starting event: Month 7
N° of the partner responsible: 1
N°s of other partners involved: 3, 5, 7
Person-months per partner: 1(30 pm), 3(10 pm), 5 (7pm), 7 (6 pm)

Objectives: The main objective of this workpackage is to integrate the in WP2 and WP3 optimised application of natural antimicrobials and modified atmosphere conditions into a packaging concept.

Description of work:
The knowledge on a combined hurdle approach (MA and natural antimicrobials) which was gained in the previous workpackages will be applied in a packaging concept which will be developed in WP4.
In Task 4.1 suitable MA conditions of single and mixed products are investigated, if the survey in WP 0 (Task 0.4) did not already yield the necessary results. An important issue is the effect of natural antimicrobials on the respiration rates of respiring product (vegetables and fruit). In addition, the packaging materials are tested for suitable barrier properties and selected.
The application of natural antimicrobials in the packaging is investigated in Task 4.2. This research is based on the results of task 2.4 and 3.6 and will focus on applying volatile antimicrobials either in a gas- or flow packer (initial dose) or by a controlled release system (continuous release). Non-volatiles can be integrated into an active packaging material.
The previous tasks will lead to a packaging concept which will be tested under optimal / sub-optimal storage and transport conditions (based on the results from task 0.1) for single products (Task 4.3) and mixed products (Task 4.4). In these experiments the MA conditions and volatile concentrations are monitored, and the antimicrobial action on selected pathogens and spoilage micro-organisms is determined. In addition, the sensorial quality of the products (spoilage as well as possible off-flavours Caused by the antimicrobials and MA) is tested.
The interaction between product and headspace (metabolisation and/or absorption of environmental gases and antimicrobial volatiles), and the gas exchange between environment and headspace through the packaging material is simulated by a mathematical model which can be used to extend the developed techniques to other types of product.
The developed technique is finally tested by partner 5 in a production environment.

Deliverables:

Deliverable 8:	A report on the respiration properties and optimal MA conditions for the selected fruits and vegetables and their combinations (report).
Deliverable 9:	A packaging concept for the selected food items which applies an optimised combination of natural antimicrobials and modified atmosphere (prototype, report).
Deliverable 10:	An assessment of the stability of the packaging concept under sub-optimal storage conditions. (report)

Milestones and expected results:
The major result of this work package will be prototypes for food packages for the selected types of product and mixtures of these products which utilise the knowledge which is gained in WP 1, WP2, and WP3. A milestone which is necessary to develop the packaging concept is the investigation and selection of suitable packaging materials.

WP5: Investigating the legal aspects for applying plant volatiles in food packaging.

Start date or starting event: Month 7
N° of the partner responsible: 6
N°s of other partners involved:
Person-months per partner: 6 (8 pm)

Objectives:
The aim of this work package is to investigate on a European scale the legal aspects of applying plant volatiles (plant essences, purified plant essences, synthetically produced) and natural antimicrobial peptides (mollusc extracts) in food preservation by means of packaging. Furthermore, this workpackage focuses on the terms and conditions on a European level to allow the safe use of plant volatiles in food packaging.

Description of work:
The current state of the legislative situation will be determined and legal hurdles for an approval of the application of plant volatiles in packaging will be identified in task 5.1. In addition, necessary steps in order to obtain an approval for use of plant volatiles in food packaging will be investigated.
Task 5.2 will focus on the communication with experts and authorities in various countries, and working groups on the legal premises of the use of plant volatiles in food packaging in order to create a potential basis for the development of novel methods of food preservation for European companies.

Deliverables:

Deliverable 11:	A detailed report on the current legislative aspects regarding the application of plant volatiles / antimicrobial peptides in food packaging and describing the necessary steps for the approval of the use of plant volatiles in food packaging.

Milestones and expected results:
The research activities in this workpackage will result in a final report covering the legislative aspects ar describing the necessary steps for the approval of the use of plant volatiles in food packaging.

WP 6: Consumer attitudes towards using MA, LAB cultures and plant volatiles in foods

Start date or starting event: Month 7
N° of the partner responsible: 6
N°s of other partners involved: 1, 2
Person-months per partner: 1(9 pm), 2(2 pm), 6(25 pm)

Objectives:
The acceptance by consumers is a hurdle all new processing and packaging techniques have to clear before they can be successfully applied in food products. Often consumers are suspicious towards new techniques which may be due to several factors such as lack of knowledge, uncertainty of the safety or negative attitudes towards new techniques in general. Understanding the reasons that in consumers mind promote or hold back the acceptability of these techniques is therefore important.

Description of work:
The willingness of the consumer to accept the use of MA, LAB cultures and plant volatiles in food products and differences in the acceptability among different product categories chosen for the study are investigated in Task 6.1.
In Task 6.2 is investigated whether consumers detect differences in product characteristics when the new techniques have been applied and if this effects consumer acceptability (e.g. improved quality in a positive manner, possible off-flavours in a negative manner).
The benefits and risks consumers associate with these new techniques are studied in task 6.3, and attitudes which promote or obstruct the acceptability of these new techniques will be studied in Task 6.4.
Acceptability of use of MA, LAB cultures and plant volatiles in food products will be studied by applying sensory methods using both a trained laboratory panel and consumer panels. The perceived benefits and risks of these packaging techniques and consumer attitudes related to their acceptance will be assessed by qualitative interviews and quantitative questionnaires.

Deliverables:

Deliverable 12:	A report which describes product category related factors which promote or obstruct the acceptability of the combined use of natural antimicrobials and modified atmosphere techniques in packaging among consumers.
Deliverable 13:	A report with recommendations of factors that need to be considered and information that is needed when consumers are approached with these new techniques.

Milestones and expected results:
The results obtained in this workpackage will help to exploit the results which were obtained in the project by introducing the developed techniques for products where the consumer sees an added value of the technique and trusts the technique

WP 7: Guidelines document and exploitation plan

Start date or starting event: Month 31
N° of the partner responsible: 1
N°s of other partners involved: 2, 3, 4, 5, 6, 7
Person-months per partner: 1(5.5 pm), 2(1 pm), 3(0.5 pm), 4(1 pm), 5(0.5pm), 6(3 pm), 7(3 pm)

Objectives:
The objective of this workpackage is to disseminate the information about the project and the planning of the exploitation of the results obtained during the project.

Description of work:
A progress report and will be published and a preliminary planning of a symposium / workshop on the combined use of natural antimicrobials and MA packaging will be carried out (Task 7.1).
For the workshop / symposium an application will be prepared for a grant for an accompanying measure from the European commission.
Possible business activities which are based on the results of the project, and possible future research activities continuing on the results obtained in the project will be planned in Task 7.2. Possibilities for the up-scaling of the processing techniques for plant volatiles will be evaluated. In addition, possibilities are investigated to protect intellectual properties by patenting.

Deliverables:
Deliverable 14: The final project report

Milestones and expected results:
The result of workpackage 7 will be the appropriate dissemination of the results of the whole project, and a plan for the future research and/or development of business activities.

C1. Title Page

Proposal Full Title:

A combined hurdle approach using natural antimicrobials and modified atmosphere packaging to assure food safety and product quality

Proposal acronym: HURDLEPACK

Date: 12 November, 1999

This proposal is not part of a cluster

C2 Table of contents

C3 Management and Resources

C3.1 Project management

Project management structure

The proposed project will be co-ordinated by ATO-DLO. Project co-ordinator will be Dr. Arco Berkenbosch, and projects assistant Dr. Raimund Jaeger. The project co-ordinator will guide the communication flow to ensure that all partners receive the information they need. He maintains the financial and scientific communication with the EC-project officer and will be responsible for the overall financial management and all activities related to intellectual property rights. He will receive administrative support from the Administrative and Financial Department of ATO-DLO which has long-standing experience with EC-project management and financial statements according to the requirements of the EC. The project manager will monitor the general progress of the project, and – in an event that adjustments are necessary – discuss necessary measures with the management team. The co-ordinator is responsible for maintaining the contract obligations towards the European Commission and for the organisation of management meetings.
In the management team of the project each participating partner will be represented. The management team will consist of the scientists who have the main responsibility for the project within their institute / company. The team members will be provide the financial statements of their institutes / companies to the project co-ordinator according to the indications of the EC.

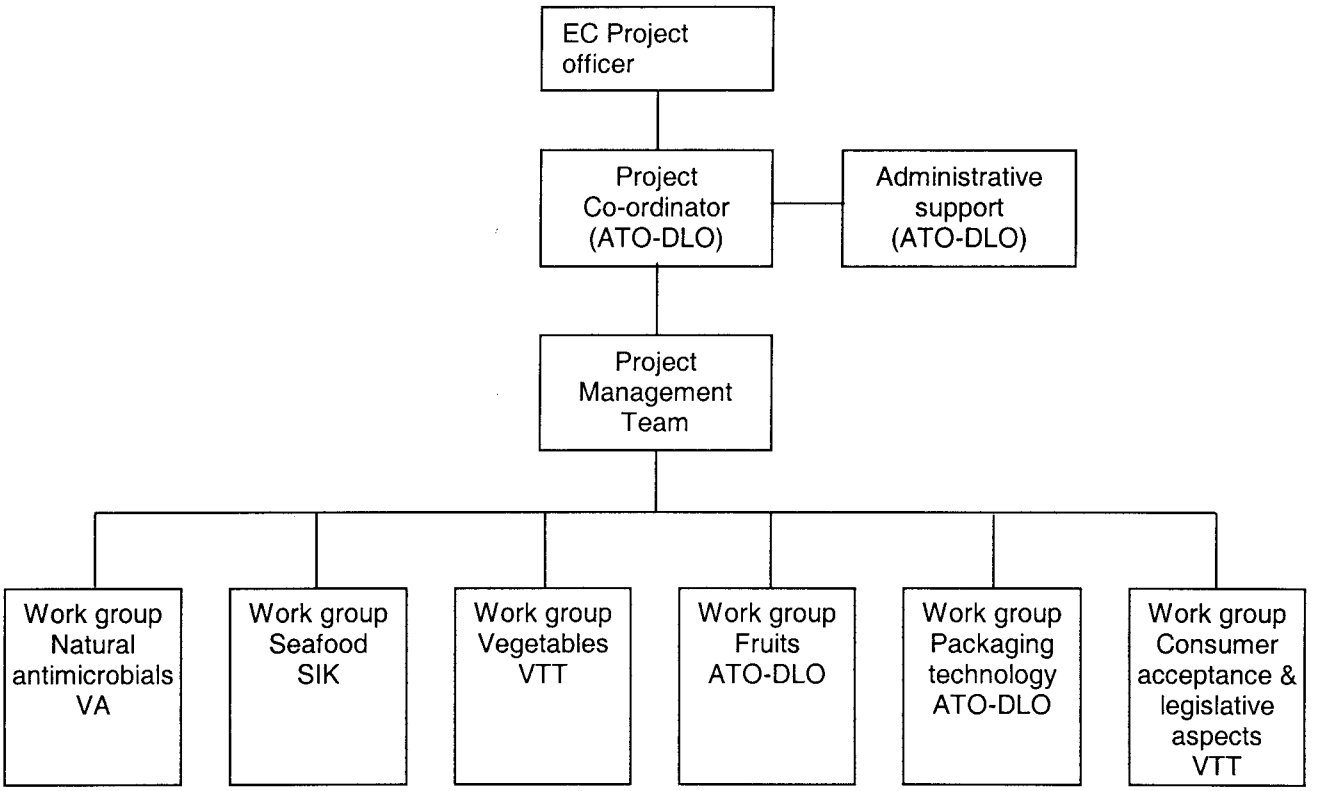


Figure C1: Management structure of the HURDLEPACK project

The co-ordination of the individual research activities will be carried out by work groups. We defined six work groups:

1. Work group 'Natural Antimicrobials' (focus on deliverables WP1);
2. Work group 'Seafood' (focus on deliverables 6a, 7a);
3. Work group 'Vegetables' (focus on deliverables 6b, 7a,b);
4. Work group 'Fruit' (focus on deliverables 6c, 7b);;
5. Work group 'Packaging Technology' (focus on deliverables WP4);
6. Work group 'Consumer Acceptance & Legislative Aspects' (focus on deliverables WP5, WP6)

The product-specific activities in WP2 and WP3 were organised in work groups for seafood, vegetables, and fruit since this research is localised in certain institutes / regions (e.g. seafood: Northern Germany, Sweden). Creating these work groups makes the flow of communication more direct and facilitates a result oriented project management. The work groups provide the responsible for the work package with the necessary deliverables.
The leader of each work group will ensure progress and quality of the work assigned to the corresponding work packages, including the planning and control of milestones and deliverables, as well as the preparation of progress reports. Work group meetings are organised by the work group leaders and planned in consultation with the project co-ordinator.

Meetings

The management team and the work groups will meet at least twice a year, starting with a kick-off meeting in order to co-ordinate the research activities in the work packages. Once a year, the management team meeting will be combined with an annual project meeting, when all involved researchers will participate. During the combined meeting, the progress made by all work groups will be presented, and validated against the milestones and expected deliverables indicated in the project work plan.

Reporting

The communication to the European Commission is the responsibility of the project co-ordinator. He will compile and disseminate the reports to the commission and to the partners in the consortium. Reports and other documents listed in table C1 will be generated and sent to the commission during the project.

Legal aspects
The scientists forming the management team are each responsible for the strict adherence to national and international safety aspects of the research carried out at their institutes. In order to avoid a potential conflict of interest between the different partners with respect to intellectual property rights and exploitation of the results, a consortium agreement is signed at the beginning of the project, and technology implementation plans are prepared by the partners in the beginning phase of the project.

Document	Time of preparation	Responsibility
Consortium agreement	Before the start of the project	Each contractor
Individual progress report	Every six months	Each contractor, compiled by work group leader and project co-ordinator
Technology implementation plan	During the project	Each contractor
Yearly reports containing the cost statements and the technical progress reports	Every twelve months	Each contractor, compiled by work group leader and / or project co-ordinator
Minutes of management team and work group meetings	After each management team and work group meeting	Project co-ordinator and leader of the work groups
Final project report	2 months after the end of the project	Each work group, compilation by the co-ordinator
Separate, publishable final project reports (if necessary)	2 months after the end of the project	Each work group, compilation by the co-ordinator

Table C1: List of documents generated and sent to the European Commission.

C3.2 The partnership

The partners participating in the proposed project (see table C2) represent a wide expertise in the area of food packaging, food microbiology, food processing, food preservation techniques, and consumer / legislative research.

Partner no.	Partner	Address	Contact
1	ATO (NL)	Agrotechnological Research Institute (ATO) Department Packaging, Transport & Logistics Department Applied Microbiology Department Market Research and Sensory Scienes Bornsesteeg 59 P.O. Box 17 NL-6700 AA Wageningen, The Netherlands Tel: +31 317 470000 Fax: +31 317 475347	Dr. Raimund Jaeger Dept. Packaging, Transport & Logistics Tel: +31 317 475168, Fax: +31 317 475347, e-mail: r.jaeger@ato.wag-ur.nl
2	VA (IT)	Veneto Agricoltura Istituto per la Qualità e le Tecnologie Agroalimentari via S. Gaetano 74, I-36016 Thiene (VI), Italy Contact: Angiolella Lombardi Tel +39-445-802300, Fax: +39-445-802301	Dr. Angiolella Lombardi Tel: +39-445-802300, Fax: +39-445-802301, e-mail: istitutothiene.09.venetoagricoltura@mail.regione.veneto.it
3	Wisby (DE)	Wisby GmbH & Co. KG Busch-Johannsen-Straße 1 Tel: +49 4661 602-274 Fax: +49 4661 602-289	Dr. Dieter Elsser Tel: +49 4661 602-274 Fax: +49 4661 602-289e-mail: Delsser@wisby.de
4	UHFI (HU)	University of Horticulture and Food Industry Department of Refrigeration and Livestock Products Technology Ménesi út 45 H-1118 Budapest, Hungary Tel: +36 1 372 6303, Fax: +36 1 372 6321	Prof. J. Farkas, Tel: +36 1 372 6303, Fax: +36 1 372 6321
5	Johma (NL)	Johma Nederland b.v. P.O. Box 182 NL-7580 AD Losser Tel: +31 5 5373400, Fax: +31 53 5385845 e-mail: ppeelen@johma.com	Ing. P. Peelen Tel: +31 5 5373400, Fax: +31 53 5385845 e-mail: ppeelen@johma.com
6	VTT (FI)	VTT Biotechnology and Food Research Tietotie 2, P.O. Box 1500, 02044 VTT, Finland Tel. +358 9 456 5201, Fax +358 9 455 2103	Dr. Liisa Nohynek Tel +358 9 4561, Fax +358 9 455 2103, E-mail: liisa.nohynek@vtt.fi
7	SIK (SE)	The Swedish Inst. for Food and Biotechnology P.O. Box 5401 (Frans Persons väg 6), S-40229 Göteborg, Sweden Tel: +46 31 3355600 Fax: +46 31 833782	Dr. Ulf Rönner Tel: +46 31 3355600 Fax: +46 31 833782 e-mail: ur@sik.se, anders.pettersson@sik.se-

Table C2: Partners participating in the project.

The roles of the partners and their activities in the project is shown in figure C2 and table B3.

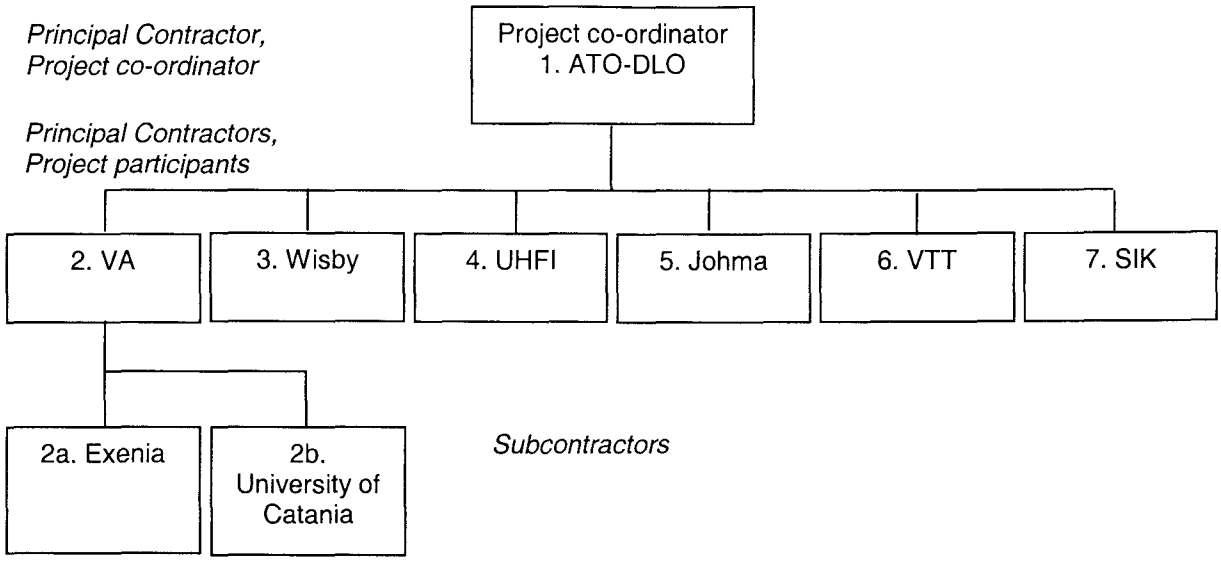


Figure C2: The partnership in the HURDLEPACK project

Partner	Activity / input in WP0 Specification	Activity / input in WP1 In vitro	Activity / input in WP2 In situ single	Activity / input in WP3 In situ mixed	Activity / input in WP4 Packaging Technology	Activity / input in WP5 Legislative aspects	Activity / input in WP6 Consumer attitudes	Activity / input in WP7 Dissemination	Total input
1. ATO CO	Selection nat.l antimicrobials State of the art MA, hurdle technology Survey chain **4.5 pm**		Effect of plant volatiles, MA on pathogens and micro-organisms **8 pm**	Effect of plant volatiles, MA on pathogens and micro-organisms **8 pm**	MA conditions resp. product, Development packaging concept, Packaging trials **38 pm**		Field work consumer attitudes NL **9 pm**	Information dissemination, IP rights, Planning further activities, Exploitation **5.5 pm**	73 pm
2. VA CR	Selection natural antimicrobials Establishment ref. cult. coll.. **2 pm**	Indiv. / comb. action antimicrobials **17 pm**	Monitoring colonisation of food samples with LAB / pathogens **2 pm**	Monitoring colonisation of food samples with LAB / pathogens **2 pm**			Field work consumer attitudes IT **2 pm**	Information dissemination, Exploitation planning **1 pm**	26 pm
3. Wisby CR	Selection natural antimicrobials **0.5 pm**		Effect of combined hurdles on pathogens **5 pm**	Effect of combined hurdles on pathogens **5 pm**	Packaging trials **10 pm**			Information dissemination, Exploitation planning **0.5 pm**	21 pm
4. UHFI CR	Selection natural antimicrobials State of the art hurd. tech. **2 pm**	Vitality of lab cultures / pathogens in vitro **12 pm**	Vitality of lab cultures / pathogens in vitro **14 pm**	Vitality of lab cultures / pathogens in vitro **6 pm**				Information dissemination, Planning further activities **1 pm**	35 pm
5. Johma CR	Selection natural antimicrobials **0.5 pm**				Packaging trials **7 pm**			Information dissemination, Exploitation planning **0.5 pm**	8 pm
6. VTT CR	Selection nat. antimicrobials **1 pm**	Development rapid det. method, Indiv / comb. action antimicr. on pathogens 20 pm	Effect of combined hurdles on pathogens **6 pm**			Investigating legislative aspects on an EU level **8 pm**	Research into consumer attitudes and acceptance, perceived benefits / risks **25 pm**	Information dissemination, Exploitation planning **3 pm**	63 pm
7. SIK CR	Selection nat. antimicrobials, State of the art MA, hurd. tech. LAB collection **3 pm**	Effect of combined hurdles on pathogens **14 pm**	Effect of combined hurdles on pathogens **8 pm**	Effect of comb. hurdles on pathogens, Cross-contamination **8 pm**	Determining MA seafood, Packaging trials 6 pm			Information dissemination, Exploitation planning **3 pm**	42 pm

Table B3: Activities of the partners

PARTNER NO. 1

Agrotechnological Research Institute (ATO-DLO)
P.O. Box 17, NL-6700 AA, Wageningen, The Netherlands
Tel (31-317) 475000, Fax (31-317) 475347,
E-mail: r.jaeger@ato.wag-ur.nl

Details of the organisation

The agrotechnological research institute ATO-DLO is a multidiciplinary research institute which investigates post-harvest technology and plays a prominent role in enhancing the expertise and technology level of agribusiness, trade, and industry. ATO-DLO co-operates with a great variety of enterprises, including multinationals, cooperatives, auctions, food processing industry, chemical industry, and trade and export enterprises. The institute is involved in various EU research programs. ATO-DLO comprises a staff of over 450 employees, including 225 scientists. The institute's facilities include 2500 m^2 technology halls, 2500 m^2 climate controlled rooms, and advanced equipment such as NMR, S(T)EM, XRD, GCMS, FTIR, DSC.

ATO-DLO has a broad experience in the research on the quality and shelf life of perishable products. The ***Department Packaging Transport & Logistics*** carries out research on novel packaging concepts. Focus of the research activities is to develop and characterise the new packaging concepts taking chain realistic conditions into account; i.e. packaging concepts are tested under optimal and sub-optimal conditions (temperature, humidity, dynamic and static mechanical stresses). Commonly investigated packaging techniques are gas packaging, modified atmosphere packaging, and active packaging. The department Packaging Technology participated or participates in the EU funded projects AIR2-CT-1326 ("Modified atmosphere systems in varying temperature regimes"), FAIR 951104 ("Novel high oxygen and noble gas modified atmosphere packaging (MAP) for extending the quality shelf life of fresh prepared produce").The ***Department Market Research & Sensory Sciences*** carries out research into the sensory perception of fresh and processed foods and its relationship to consumer appreciation. Within this department too research is carried out into flavour components and their relationship to sensory perceived flavour. Sensory research is carried out using trained panels in a fully equipped sensory laboratorium. Depending on the research question, a range of evaluation techniques are implemented, including difference tests, Quantitative Descriptive Analysis® and time-intensity analysis. Advanced multivariate statistical techniques are used to relate the sensory data to processing and storage data, consumer preference data and instrumental measurements. The Market Research & Sensory Sciences Department is a participant in the COST 96 action "Interaction of food matrix with small ligands influencing flavour and texture". The ***Department of Applied Microbiology*** develops and implements methods to improve the microbial safety and quality of agricultural and horticultural products. The department obtains its strength from the unique mixture of a practical and scientific approach of research. The main strategy for research and development is based on the integration of mild preservation techniques (Hurdle Technology) with natural preservatives and food additives. Both strategies comply with current trends in food related microbiological research such as minimal processing and health foods.

Scientific and management team

Dr. Arco Berkenbosch, Senior Research Scientist, Head of the Department Packaging, Transport & Logistics,
Dr. Raimund Jaeger, Research Scientist Packaging Technology
Dr. Ulphard Thoden van Velzen, Research Scientist Packaging Technology
Ir Henry Boerrigter, Research Scientist, thematic leader Packaging of Agro-Products
Dr. Eddy Smid, Senior Research Scientist, Head of the Department Applied Microbiology.
Dr. E. Kets, Senior Researcher Applied Microbiology.
Dr. ir. Carina Ponne, Senior Research Scientist, thematic leader Sensory Sciences
Dr. Sorel Muresan, Research Scientist Sensory Sciences
Clare Wilkinson M.Sc. Research Scientist Sensory Sciences
Ir. A. Poelman, Research Scientist Market Research
Technicians will be involved in laboratory experiments.

Role and contribution of the participant

ATO-DLO will be the *co-ordinator of the project* and will carry out research in the following workpackages:

- Survey of the logistic chain (WP0)
- Effect of plant volatiles / MA on growth kinetics and mode of action of pathogens and moulds (WP2, WP3)
- Determination of targets of plant volatiles / MA on pathogens and moulds (WP2, WP3)
- Determining optimal MA conditions for mixed products (WP4)
- Developing and assessing the functionality a packaging concept which integrates the combined hurdles (WP4)
- Determining the sensory quality of the food products (WP2 – WP4)
- Participation in the field work for consumer acceptance (WP6)

Most relevant publications

- R. Jaeger, R.G.M. van der Sman, A.C. Berkenbosch, (1999) Developing an active packaging concept for perishable products – an integrated approach. Verpackungsrundschau, Interpack 99 Special, pp 56 – 58.
- M.A.R Snel, R.W.N. Bakker, A.C. Berkenbosch (1998) "Packaging of fish", in "Modern Food Packaging", ed. M.C. Dordi, Indian Institute of Packaging, Mumbai, India.
- A. Ultee, E.P.W. Kets, E.J. Smid, (1999) Mechanisms of Action of Carvacrol on the Food-Borne Pathogen *Bacillus cereus* Applied and Environmental Microbiology, Vol. 65, pp. 4606 – 4610
- Pol, I.E. and E.J. Smid. 1999. Combined action of nisin and carvacrol on *Bacillus cereus* and *Listeria monocytogenes.* Letters in Applied Microbiology (In press)
- Nijhuis, H.H., Torringa, H.M., Muresan, S., Yuksel, D., Leguijt, C., Kloek, W. (1998) Approaches to improving the quality of dried fruit and vegetables, *Trends in Food Science & Technology*, 9: 13-20.

PARTNER NO. 2

Veneto Agricoltura – Istituto per la Qualità e le Tecnologie Agroalimentari, (VA)
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Details of the organisation and expertise

The Istituto per la Qualità e le Tecnologie Agroalimentari is the Agrofood Section of Veneto Agricoltura, the board of Veneto Region for Agriculture, Forestry and Food. The Institute that is presently participating to regional, national and EU projects has long-term expertise in projects aimed to the isolation, characterisation and selection of lactic acid bacteria and yeasts to be used as starter in the agrofood industry for the manufacture of fermented food and beverages such as cheeses, meat, wine and food for zootechnics. In addition, studies on the application of lactic acid bacteria as protective cultures in the biopreservation of various food products, in particular ready-to-use vegetables and fresh meat products, are well established.
The group has acquired good expertise in using molecular techniques and phenotypic methods for the detection, characterisation and taxonomy of micro-organisms. Molecular methods, such as RAPD-PCR, PFGE, species-specific PCR, are routinely carried out for the identification of micro-organisms and for the monitoring of bacterial populations in different food systems. VA was or is presently involved in the EU projects

- Cost Action 95 "Improvement of quality of cheeses made with raw milk"
- FAIR project CT97-3078 "Enterococci in food fermentation. Functional and safety aspects"

Scientific and management team

Dr Angiolella Lombardi, (contact person). Head of the Biotechnology Section, scientific responsible of the project. Expertise: Food microbiology, lactic acid bacteria characterisation, development of starter cultures
Dr Christian Andrighetto, research scientist. Expertise: genetic and biochemical characterisation of lactic acid bacteria, food microbiology
Scientific collaborator: to be hired for the project (24 man/months)

Collaborations: Veneto Agricoltura will work together with prof. Sandra Torriani from University of Catania (Catania, Italy) and Exenia S.r.l (Albignasego, Padova, Italy), as sub-contractors. Their work will form our expenses of external services. University of Catania will be involved in the selection of lactic acid bacteria strains to be used as protective cultures in ready-to use vegetables, while Exenia S.r.l will provide different plant extract and volatiles extracted by the supercritical fluid technology.

Role and contribution of the participant

VA will be *principal contractor*, the following research activities will be carried out:

- Selection of lactic acid bacteria cultures and plant extracts (WP0).
- Establishment of the reference culture collection. Distribution of the strains to the different partners (WP0).
- In vitro testing of individual/combined action of LAB cultures and plant peptides/volatiles (WP1).
- Monitoring the presence and colonisation of the food samples by the lactic acid bacteria cultures and the pathogens/spoilage micro-organisms (WP2, WP3).

Most relevant publications

- Zezza N., Pasini G., Lombardi A., Mercenier A., Spettoli P., Zamorani A. Nuti M.P. (1993). Production of a bacteriocin active on lactate-fermenting clostridia by *Lactococcus lactis* subsp. *lactis* immobilized in coated alginate beads. *Journal of Dairy Research* 60:581-591.
- Giacomini A., Lombardi A., Ferro P., Squartini A., Nuti M.P. (1993).Molecular cloning and preliminary characterization of a *Pediococcus pentosaceus* plasmid encoding bacteriocin activity. Proceedings of the meeting "Biotechnology and molecular biology of lactic acid bacteria for the improvements of food and feed quality". Portici 23-24 febbraio 1993: p396-398
- Andrighetto C., De Dea P., Lombardi A., Neviani E., Rossetti L., Giraffa G. (1998). Molecular identification and cluster analysis of homofermentative thermophilic lactobacilli isolated from dairy products. *Research in Microbiology*,149:631-643.
- Vescovo M., Orsi C., Scolari G., Torriani S. (1995). Inhibitory effect of selected lactic acid bacteria on microflora associated with ready-to-use vegetables. *Letters in Applied Microbiology*, 21:121-125.
- Torriani S., Orsi C., Vescovo M. (1997). Potential of *Lactobacillus casei*, Culture Permeate, and Lactic Acid To Control Micro-organisms in Ready-To-Use Vegetables. *Journal of Food.*

PARTNER NO 3:
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Details of the organisation and expertise:

Wisby is a major supplier of cultures, starter culture media and probiotics to the international dairy and meat industry. Wisby produces cultures and starter culture media at plants in Germany, Denmark and the USA. The products are sold to the dairy and meat industry in more than 90 countries through own sales companies and a network of agents or distributers. The company has approximately 270 employees.
Wisby is a daughter of Danisco Ingredients. The product portfolio of Danisco Ingredients includes emulsifiers, hydrocollids, flavours, stabiliser blends, enzymes, and antioxidants.
Wisby is partner of the following **EU project**: CRAFT Project on the fermentation of whole muscle meats (FAIR-CT98-9506)

Scientific and management team

Dr. Dieter Elsser (Responsible Scientist) is food technologist and working as a microbiologist at the Wisby R&D. He obtained his PhD in Food microbiology at Technical University Munich. He worked for five years as scientist at the Fraunhofer Institut for Food technology and Packaging (Munich) in the Department of Technical Microbiology. Since two years Mr. Elsser is responsible for the safety laboratory at Wisby. His working field at Wisby comprises the development of protective cultures for dairy and meat products and starter cultures for fermented meat products.
Dr. Björn Wiese is also working at the Wisby R&D as a microbiologist. He is biologist and obtained his graduations at the University of Hannover (Germany). His PhD thesis was focused on the micro-flora of sourdough and its impact on the aroma components of wheat bread. He started his work for Wisby in 1996, with responsibility for the safety and technology laboratories. Now he is responsible for the general development of new cultures apart from the dairy field.
Dr. Gerhard Schwarz is the responsible Application Manager for non-dairy cultures at Wisby. His practical PhD work was carried out at University Hohenheim (Germany) with the Department of Meat Technology. His special focus was on functional ingredients in emulsion type sausages. He worked as a research scientist for two years at University College Cork (Ireland) in the field of fermented whole muscle meats, fermented dried sausages and dried muscle meats. At Wisby he is responsible for the application of bacteria, mould and yeast to fermented meats.

Role and contribution of the participant

Wisby will be *principal contractor*, and will contribute to WP2, WP3, and WP4. Focus of Wisby's research will be the investigation and optimisation of the antimicrobial action of protective LAB cultures in combination with MA and other antimicrobial agents. The research will be centred on implementing the developed techniques on a packaging level in WP4. In addition, preparatory research for WP4 will be carried out by Wisby in WP2 and WP3. Wisby will participate in the evaluation of the impact of the combined hurdle approach (i.e. microbial quality, shelf life, and sensory quality of the treated / packed food items). The research activities will focus on seafood.

PARTNER NO 4
University of Horticulture and Food Industry (UHFI)
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Details of the organisation and expertise

The University of Horticulture and Food Industry, provides education in horticultural sciences and production of horticultural crops, food sciences and food technology. It is well suited to study interdisciplinary subjects such as aimed in the present proposal through a co-operation of two of its departments. Relevant research experience at the *Department of Refrigeration and Livestock Products' Technology* includes combination and optimization of effects preservation treatments, interactions of physical and environmental stress factors on growth, survival and inactivation of food-borne micro-organisms, and testing antimicrobial substances of microbial origin. The *Department of Microbiology and Biotechnology* covers a broad field of basic and applied microbiology, physiology of lactic acid bacteria, food processing and microbial ecology of foods.

Scientific and management team

Prof. J. Farkas, Hungarian team leader in the proposed Project, has wide experience and extensive publication activities on combined methods of food preservation, food microbiology with emphasis on interaction of physical and chemical factors on growth, survival and destruction of food-borne micro-organisms as well as safety and quality of combined-treated foods. He has been or is still involved in several international cooperative actions and projects such as COST Actions 914; 97, and FAIR CT97-3129.

Dr. Cs. Mohácsi-Farkas, field of research is microbiology and quality assurance of preserved foods. She is involved in several projects studying growth, growth-inhibition and destruction of micro-organisms in model systems and food as affected by environmental stress factors and their interactions.

Mr. L. Mészáros, has wide experience in food engineering, physical methods of food preservation, mathematical modelling and instrumental methods of quality assessment of food. He was M.C. member of Copernicus Concerted Action of CIPA-CT 94

Prof. T. Sáray's main field of research is chilling and deep-freezing of food products and has developed CA and MAP storage technologies of vegetables and fruits.

Dr. Cs. Balla's field of research is refrigeration of foods. He is involved in the investigation of the ripening process of cold-stored fresh produces.

Two postdoctoral research assistants will be recruited specifically for the duration of the proposed project.

Role and contribution of the participant

UHFI will be *principal contractor*; the research activities will focus on investigating the vitality of pathogens (*Listeria monocytogenes)* and LAB cultures (*Lactococus lactis, Lactobacillus casei, Lactobacillus plantarum)* in vitro and in situ if other natural antimicrobials and MA are applied (WP1, WP2, WP3). UHFI intends to buy a fluorometric system specifically for the proposed project for the detection of test organisms marked with a 'green fluorescent protein'.

Most relevant publications

- Mohácsi-Farkas, Cs., G. Kiskó, J. Farkas, L. Mészáros & T. Sáray: Assessment of antibacterial effects of essential oils by automated impedimetry and preliminary studies on their utility as biopreservatives. In: A.C.J. Tuitelaars et al. (eds.) *Food Microbiology and Food Safety into the Next Millenium.* Proceedings of the Seventeenth International Conference of the ICFMH, Veldhoven, The Netherlands, 13-17 Sept. 1999. pp. 279-281. Foundation Food Micro '99, TNO, Zeist, 1999.
- Farkas, J., L. Mészáros, Cs. Mohácsi-Farkas, T. Sáray & :É. Andrássy: The role of ionizing radiation in minimal processing of pre-cut vegetables with particular reference to the control of *Listeria monocytogenes.* In: F.A.R. Oliveira et al. (eds.) *Processing Foods; Quality Optimization and Process Assessment.* pp. 373-387. CRC Press, Boca Raton, etc., 1999.
- Körmendy, I. & L. Mészáros: Modelling of quality attribute variations in food under heat treatment conditions. Important aspects. In: V. Gaukel & W.E.L. Spiess (eds.) *3rd Karlsruhe Nutrition Symposium; European Research towards Safer and Better Food.* Proceedings Part 2: Posters. pp. 312 - 321. Bundesforschungsanstalt für Ernährung, Karlsruhe, 1998.
- Farkas, J., Sáray, Cs. Mohácsi-Farkas, K. Horti & É. Andrássy: Effects of low-dose gamma radiation on shelf-life and microbiological safety of pre-cut/prepared vegetables. *Adv. Food Sci. (CMTL),* 19 (3/4): 111-119 (1997)
- Balla, Cs., Sáray, T., Horti, K., Polyák, K., Koncz, Á. (1998): Study of the colour development of Hungarian paprika during post harvest handling. *Sixth International Symposium of COST 94, The post-harvest treatment of fruit and vegetables - Current status and future prospects", 19-22 October 1994, Oosterbeek, Proceedings,* Brussels, 525-529

PARTNER NO 5

Johma Nederland b.v. (Johma)
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Details of the organisation and expertise

Johma Nederland B.V. is a chilled food factory located in Losser, The Netherlands, with about 370 employees. The company belongs to Johma Holding International B.V. group and has been active in the field of production, marketing and sales of fresh salads, dressings and sauces for over 20 years Since two years, Johma is active in roles and sandwiches. The current product range includes vegetable, meat, chicken, fish, fruit salads with permissible preservatives. In addition, the company produces vegetable salads, fruit salads, roles, sandwiches and dressings without preservatives with a shelf-life of max. three weeks at refrigerated temperatures. Parallel to the booming fresh salad market, Johma increased in size from a one family artisan undertaking to a professional food company without compromising on product quality. Produces are marketed in retail, catering and speciality shops. Johma is the current market leader in the area of salads and dressings, with a market share of 55%. The consumer's demand for more freshness, quality and health of foods is the main lead for product development and marketing.
The R&D/QA department involved in the project has the challenging task to develop on one hand new ready-to-eat, fresh-like food vegetable and fruit based products, and on the other to constantly assure the high quality standard of Johma's end products. One important current R&D effort is devoted to the design of preservative free salads and dressing. The proposal at hand will yield valuable expertise in this respect. At present, some 1000 basic ingredients and raw materials are processed into about 350 salads, sauces and other products. The department has very adequate laboratory facilities and well trained personnel (food technologists, microbiologist, processing engineers) to cope with this task. Johma has tasting panels and product experts available for various categories of end product.

Scientific and management team

Ing. Piet Peelen, director R&D/QA department will supervise the work at the company (1 pm)
Ing. Renate Oude Velthuis (food technologist), will be responsible for the food processing and packaging. (3 pm)
Ing. Henk Van Oijen (processing engineer), will be responsible for the processing. (2 pm)
Mrs. Janine Lammers (microbiologist), will be responsible for microbiological analyses during trials in the company. (2 pm)

A team of product experts is available in the R&D/QA department to evaluate the organoleptic sensory quality of processed foods. They will be involved on a case bases and the resource input will be balanced to the above total.

Role and contribution of the participant

Johma will be *principal contractor*; the research activities will be focused in WP4, packaging technology. Johma will test the optimised application of combined hurdles and the developed packaging concept in their production facilities and will contribute to the assessment of the microbial quality, the shelf life, and sensory quality of the packed products. The contribution of Johma will yield essential information for a practical implementation of the developed techniques.

PARTNER NO. 6

VTT Biotechnology and Food Research
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Details of the organisation

VTT (Technical Research Centre of Finland) is an independent, contract research organisation with staff of 2,700 and a turnover of EUR 191 Million. It is an impartial expert organisation that carries out technical and technoeconomic research and development work. VTT Biotechnology and Food Research (VTT BFR) is one of the nine research institutes of VTT. Its main target is to develop processes and product innovations based on biological materials. VTT BFR has extensive expertise in minimal processing of foods, packaging, biopreservation by natural antimicrobial mechanisms and sensory quality and acceptability. This expertise has been utilized in several EU-funded projects, including Novel MAP for fresh produce (*FAIR - CT95-1104, 1996-1999*), Nisin^{Plus} (*FAIR-CT96-1148*, 1996-1999), Nutripea (*FAIR-CT95-0193*, 1996-1999), Green chemicals (*FAIR CT97-0722*, 1995-1999), Actipak (*FAIR CT98-4170, 1999 - 2001*) and SMT4-CL98-2227 project "International Guidelines for Proficiency Testing".

Scientific and management team

Dr. Liisa Nohynek, PhD (microbiology), a research scientist specialised on viability studies of lactic acid bacteria, Project leader at VTT. **(WP1), 9 manmonths**
Dr. Ilkka M. Helander, PhD a senior research scientist, specialised on Gram-negative bacterial cell surface, **(WP2), 5 manmonths**
Eija Skyttä, MSc, a research scientist, has a long experience in food microbiology with a special focus on natural antimicrobials, biopreservation and protective cultures. **(WP1, WP2), 4 manmonths**
Thea Sipiläinen-Malm, M.Sc. (Tech.), a senior research scientist, specialised in food and packaging legislation. **(WP5, WP7), 9 manmonths**
Dr. Liisa Lähteenmäki, PhD (Psychology) 1991 MSc (Nutrition) 1985, Head of the Sensory Quality and Acceptability group at VTT. **(WP6, WP7), 6 manmonths**
Anne Arvola, MSc (Social Psychology), a research scientist, several years experience in consumer / behavioral research. (**WP6, WP7**), **12 manmonths**
Technicians will be involved in laboratory experiments, as well as organising and conducting consumer studies. **(WP1, WP2, WP3, WP6), 18 manmonths**
Possible subcontractor. If needed, a subcontractor may be used for the routine work related to sample selection and data collection.

Role and contribution of the participant

VTT will participate as *principal contractor.* The research activities which VTT will carry out will include the

- Development and application of rapid detection and enumeration methods based on fluorescence techniques (fluorescence microscopy, flow cytometry) for assessing the viability of lactic acid bacteria (LAB) in different applications (WP1)
- Testing of potential of LAB as protective cultures in sprout production to inhibit *enterobacteria*, in particular of *Salmonella* and *enterohemorragic E. coli* O157:H7. (WP1, WP2)
- Effects of MA, plant volatiles and LAB metabolites on Gram negative bacteria (WP2, WP2)
- Investigating the legal aspects for applying plant volatiles in food packaging (WP5)
- Consumer attitudes towards using MA, LAB cultures and plant volatiles in foods (WP6)

Most relevant publications

- Helander, I.M., H. Alakomi, K. Latva-Kala, T. Mattila-Sandholm, I. Pol, E.J. Smid, L.G.M. Gorris & A. von Wright. 1998. Characterization of the action of selected essential oil components on Gram-negative bacteria. *Journal of Agricultural and Food Chemistry* 46, 3590-3595.
- Nohynek, L., Hallamaa, K., Leppämäki, S., Laitila, A., Saarela, M. & Mattila-Sandholm, T. 1999. Fluorescence techniques in viability studies of lactic acid bacteria used as probiotics. Sixth Symposium on Lactic Acid Bacteria: Genetics, Metabolism and Applications,Veldhoeven , September 18-23, 1999. Book of Abstracts, J-18 .
- Sipiläinen-Malm, T., Latva-Kala, K., Tikkanen, L., Suihko, M-L. & Skyttä, E., Purity of recycled fibre-based materials. Food Additives and Contaminants, Vol. 14 (1997) 6-7, 695-703.
- Mikkola, V., Lähteenmäki, L., Hurme, E., Heiniö R.-L., Järvi-Kääriäinen, T. & Ahvenainen, R. (1997). Consumer attitudes towards oxygen absorbers in food packages. VTT Research Notes 1858. VTT, Espoo.
- Arvola, A., Lähteenmäki, L., Tuorila, H. (1999) Predicting the Intent to Purchase Unfamiliar and Familiar Cheeses: The effects of Attitudes, Expected Liking and Food Neophobia. Appetite 32: 113-126.

PARTNER NO. 7:

SIK – The Swedish Inst. for Food and Biotechnology
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Details of the organisation and expertise

A general description of SIK as an organisation is a private, non-profit, industrial research institute, owned by SIK Members´ Association (70%) and IRECO AB, a holding company jointly owned by the Swedish State and the KK Foundation, (30%). The purpose of the institute is to strengthen the competitiveness of its member companies. The head office is in Gothenburg, with regional offices in Lund and Uppsala. The number of employees is approx. 120, most whom are university graduates. SIK disseminates the knowledge by consultancy and education mainly members companies in HACCP and Microbiological Product Safety. In the research SIK is studying Combination processes (hurdle technology) to limit growth and survival of micro-organisms, including MAP, non-thermal processes, microbiological competition/bacteriocines. Also the role of the packaging in microbiological safety and shelf-life are included.
Facilities at SIK includes microbiological laboratories for various analyses. We have a specialised laboratory only for work with modified atmosphere including possibility to work also with novel gases. When working with modified atmosphere during past years, we included specialised instruments , for example a coulemeter for CO2 measurements in the product. We have ongoing projects (PhD-student) working with fermentation (LAB) on vegetables, where screening of natural LAB (wt) strains for antagonistic effect against spoilage micro-organisms using Bioscreen are used. During the last few years work on consultant basis have also included preservation effects from antimicrobial peptides.
As a partner we have a strong background in the product safety area. Personnel from the scientific team has been involved both in European as well as Nordic and National research projects in the past, e.g. " Food Safety and Quality based on the Application of Combined Processes and Hazard Analysis Critical Control Point (HACCP) "
A FLAIR project. " Food preservation by combined processes, was another Flair project. Most recently is the Fair CT96 – 1104 " Novel high oxygen and noble gas modified atmosphere packaging (MAP) for extending the quality shelf-life of fresh prepared produce. Nordic activities we are involved in is a Nordic network on Minimal processing, (arranging workshops) which includes the basis of this application, LAB (bacteriocins), MA (Modified Atmosphere) and antimicrobial substances.

Scientific and management team

Ass. Prof. Ulf Rönner, project manager, scientific responsibility
Anders Pettersson, appointed as project leader, administrative responsibility
Research staff: NN1, engineer with expertise in microbiological methods,
NN 2, PhD student working with LAB (lactic acid bacteria).
The entire team is employed at SIK

Role and contribution of the participant

SIK will be *principal contractor.*
SIK will mainly work with combination of peptides , LAB and MA on products of sea food and vegetables (WP1, WP2, WP3, and WP4). The optimal combination will guarantee food safety and prolong shelf life. On spoilage or pathogenic flora, focus will be on Listeria spp.

Most relevant publications and/or patents:

- Rönner U 1994. Food preservation by ultrahigh pressure. In : Food Preservation by Combined precesses eds: Leistner L. and Gorris G.M. EUR 15776.

- Rönner U 1994. Modified Atmosphere packaging of non-respiring foods. In: Food Preservation by Combined processes eds: Leistner L. and Gorris G.M. EUR 15776.

- Löwenadler J. and Rönner U. 1994. Growth inhibition of Yersinia enterocolitica by dissolved CO2 concentrations at chill temperatures. Lett. In Applied Microbiology 18, 285 – 288.

- Rönner U and Andersson A . 1995. Emerging microbial risks in processes case. How serious is Bacillus cereus? In: New shelf life technologies and safety assessments. VTT Symposium 148. P. 193 – 194.

- Samuelsson A-C. 1999. Preservation effects by lactic acid fermentation. A literature review. SIK –report nr 658.

C4 Community added value and contribution to EU policies

In recent years, one can observe a clear market trend towards value added food products, healthy and nutritious quickly to prepare meals, commonly referred to as 'convenience food'. At the same time, one observes an integration of the European food industry: Food processing companies and retail chains operate EU-wide, and the EU is the basic market for many European agricultural and fishery products. The distribution chain for food products links therefore all regions of Europe and in particular connects less developed regions which often supply agricultural and fishery products with further developed regions which are a market for these products. Considering the European dimension of the agro- and fisheries chain, it is advantageously to carry out research which improves the performance of this chain by novel preservation and packaging techniques in an European framework.
The consortium for the proposed project covers regions which are main European producers of food products: in particular Scandinavia will expect significant growth rates for farmed fish (salmon), and The Netherlands and the Mediterranean countries have a strong agricultural sector.
The introduction of a new packaging concept for food products has to be in agreement with EU-rules for food safety and packaging & processing of food items. The proposed project will address legislative aspects of the developed technology on an EU-level and will identify necessary steps for the introduction of the technique. This is in agreement with the aim of the EU to find a homogeneous legislation in the food safety and processing sector.
A market introduction of a novel preservation and packaging technique depends strongly on its consumer acceptance. Since the food industry operates EU-wide, a successful research into consumer attitudes has to take into account cultural differences between different regions in the EU: the consumer research which we propose covers several regions of the EU.

C5 Contribution to community social objectives

One can argue that the disposal of packaging materials will have an obvious environmental impact (compared to a fictive situation where no packaging is used). However, a realistic analysis has to take the whole agro- and industrial chain of food production into account. Although in recent years considerable efforts are undertaken to reduce the environmental impact of agriculture and fishery, a remaining influence on the environment of these industries will be unavoidable. At the same time, a significant percentage of the harvested agricultural products and caught fish never reach the consumer due to spoilage (in average 30% of fruits and vegetables are rejected [20]; estimations of product losses for fish range between 10% up to 50% [21]). Reducing these food losses by improved packaging and preservation techniques will decrease the environmental impact *per food item which reaches the consumer* significantly [22].
The development of an improved packaging concept will not only reduce food losses, but will also lead to a more flexible distribution chain: products can be transported over longer distances before the shelf life period will exceeded, and new markets for agro- and fishery products can be reached. This will enhance employment opportunities of all enterprises involved in the production- and distribution chain. In addition, the production of value-added convenience food is a quickly growing market: providing an improved production- and distribution chain will have positive influences on employment possibilities in the agro- and fishery sector of less developed regions of Europe.
The proposed project focuses on assuring food safety of fresh prepared meals: providing the consumer with healthy and nutritious diet while minimising the chances of food borne infection will contribute to the health and well-being of the EU-citizen. A case which is addressed in this project is the contamination of organically farmed bean sprouts with *Salmonella*: providing a solution for this problem will improve food safety of organically farmed products and therefore contribute to sustainable farming and healthy diets.

C6 Economic development and scientific and technological prospects

We expect that the developed technique can have a significant impact on future developments in packaging and preservation of perishable products: the combined hurdle technique is broadly applicable (e.g. also on meat, poultry, dairy, and bakery products [13]). The consumer research carried out during the project will provide further insight into possible product areas, where the consumer accepts and desires the application of the combined hurdle technology.

Two companies, which are active in the field of convenience food (Johma) and protective LAB cultures (Wisby) participate in the project, and will be able to apply the obtained results. In addition, the participating research institutes and universities are involved through research collaboration with industrial partners in the technology transfer to industry. The non-confidential results gained in the project will be published and presented in scientific and professional journals or conferences.
At the end of the project the planning for a symposium or workshop is carried out which will to increase the knowledge of food manufacturers, wholesalers, retailers and consumers about the possibilities and developments in packaging and hurdle technology. . The planning of this workshop will be done as part of project, but financing for the workshop will be applied from the commission at a later stage as an accompanying measure.

The Consortium Agreement, which is signed at the beginning of the project, will define the agreements on user rights and on the exploitation of results. Intellectual Property Rights (IPR) will be protected by patent applications filed by the one or more partners who have generated the result to be patented. Each principal contractor of the project will present to the Commission during the project a Technology implementation plan describing the plans and the actions for the IPR protection together with the partners own exploitation plan. Exploitation plans will be summarised also in the final project report.

C7 Ethical aspects

The proposed research does **not** involve:
– Human embryos or foetus,
– Use of human embryonic or foetal tissue,
– Use of other human tissue,
– Research on persons,
– Use of non-human primates,
– Use of trans-genic animals,
– Use of other animals,
– Genetic modification of animals,
– Genetic modification of plants.

C8 Safety provisions

By implementing the proposed research we will strictly adhere to all national and international ethical and safety provisions, applicable in the countries where the work will be carried out. Particularly, we shall conform to the relevant safety regulations concerning the contained use of GMOs (Directive 90/219/EEC) and the deliberate release into the environment of GMOs (Directive 90/220/EEC). Genetically modified organisms will only be used in the laboratories, and each group will exercise the most stringent precautions to avoid their release into the environment, according to existing regulation obeyed by all partners.

National regulations will also be adhered to: In the Netherlands - the Genetically Modified Organisms Decree (GMOD) of March 1, 1990 and the subsequent amendment which deals with contained use of GMOs, of October 1, 1993, covering micro-organisms, animals and plants. All participants will adhere to any changes in legislation that affect the work outlined in this project, both in their specific countries, or any changes to EU legislation.

C9 Ongoing projects and previous proposals

Similar applications have not been made by the involved partners within previous programmes of the European Union.

References

1. M.H.J. Bennink, PhD thesis. Agricultural University Wageningen, 1997
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For guidelines see in relevant "Guide for Proposers"

Proposal submission forms for financial support from the EC for shared-cost RTD actions: research and technology development projects, demonstration projects, and combined projects

If possible, these forms should be prepared using the Proposal Preparation Tool (ProTool), which is available via the Commission Internet site http://www.cordis.lu/fp5, by E-mail or on CD-ROM. Use of the Proposal Preparation Tool is preferred by the Commission. However applicants may also use the forms in the Guide for Proposers. Using the ProTool, forms may be submitted electronically, or printed out and returned on paper.

Information on the Proposal [1]

Proposal Full Name	A combined hurdle approach using natural antimicrobials and modified atmosphere packaging to assure food safety and product quality			
Proposal Acronym [5]	HURDLEPACK		Proposal No [6]	
Call Identifier [3]	1999/C 64/14			
Research Programme(s) [2]	1.1.1.	1.1.1.	1.1.1.	
Thematic priorities [2]	1.1.1.-1.1.2.	1.1.1.-1.2.3.	1.1.1.-1:3.4.	

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A1. Proposal Administrative Overview [1]

Thematic priorities [2]	1.1.1.-1.1.2. 1.1.1.-1.2.3. 1.1.1.-1.3.4.
Type of Action [4]	RS
Proposal Full Name	A combined hurdle approach using natural antimicrobials and modified atmosphere packaging to assure food safety and product quality

Contact person for the proposal(s) [7]

Title (Dr, Prof., ...)	Dr.	Gender [8]	F		M	X
Family Name	Jaeger					
First Name	Raimund					
Organisation Legal Name [9]	Agrotechnological Research Institute (as part of the 'Stichting DLO' a foundation according to Dutch Law)					
Department / Institute Name [10]	Department of Packaging, Transport & Logistics					
PO Box [11]	17					
Street Name and Number	Bornsesteeg 59					
Post Code [12]	6700 AA	Cedex [13]				
Town/City	Wageningen					
Country Code [14]	NL	Country Name [14]	Netherlands			
Telephone No [15]	(31-0317)475168	Fax No [15]	(31-0317)475347			
E-mail	r.jaeger@ato.wag-ur.nl					

Proposal abstract (maximum 1000 characters) [16]

Aim of the proposed project is to develop a packaging concept which integrates a combined hurdle approach of natural antimicrobials (lactic acid bacteria, plant volatiles, antimicrobial extracts of animal origin) and modified atmosphere (MA) which assures food safety, shelf life and sensory quality of packed convenience food. The project will focus on seafood, vegetables, fruit, and combinations of these products. Goal of the research is to find optimal combinations of natural antimicrobials and MA which show a synergetic antimicrobial effects, assure food safety, and keep the fresh characteristics of the product. Initial research will be carried out on a 'in vitro' level, followed by research on the actual product, and ultimately on the packaging level. Parallel to the technological development, research is done into consumer acceptance and legislative aspects of the packaging technique on an EU level.

Duration (in Months) [17]	36	Total Eligible Cost (in euro) [18]	2415850	EC Contribution requested (in euro) [19]	1334325
Keywords [20]	Combined Hurdles	Packaging concept	Food safety		

Have you or any of your partners, previously or currently, submitted this proposal or one similar in content to any Community Programme? If yes, please give details of the proposal [21]				Y		N X
Programme Name		Year		Proposal No		

Duly authorised by the consortium partners to send this proposal to the Commission, I certify that the description of this proposal and the information on forms A1, A2, A3 and A4 is accurate and agreed to by the consortium partners and that the consortium collectively agrees to carry out a project as described herein.

Date (DD/MM/YYYY)	12/11/1999
Signature of person authorised to submit a proposal in the co-ordinating organisation	

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A2. Proposal Summary [22]

Objectives (maximum 1000 characters)

The consumer's demand for prepared healthy and nutritious food with fresh characteristics (convenience food) is steadily increasing. At the same time, the consumer develops a increasingly suspicious attitude towards artificial preservatives which guarantee the food safety of convenience food. Objective of the research is (1) to develop and optimise a combined application of natural antimicrobials (lactic acid bacteria (LAB), plant volatiles, extracts of animal origin) and modified atmosphere (MA) packaging (i.e. a 'combined hurdle approach') for single and mixed products (seafood, vegetables, fruit) to assure food safety, shelf life, and sensory quality of the food; (2) to develop and optimise a packaging concept which implements this combined hurdle approach; (3) to study consumer attitudes towards the novel packaging concept, and (4) to survey the legal framework which is necessary to introduce this packaging concept in the EU.

Description of the work (maximum 2000 characters)

Research is carried out in the areas food safety & microbiology, packaging technology, and legislative aspects & consumer acceptance. The food safety & microbiology work ranges from in vitro screenings and research on the product level to research on the packaging level. Action of individual / combined application of natural antimicrobials and MA on pathogens and micro-organisms will be investigated (e.g. vitality / growth kinetics of pathogens, mode of action and targets of MA and antimicrobials on pathogens). In addition, interactions between hurdles, product, and packaging will be determined (e.g. effect of MA & antimicrobials on the vitality & growth kinetics of LAB cultures and sensory quality of the product). The combined application of the hurdles will be optimised w.r.t. microbial safety, shelf life and sensory quality of the food. The basis of packaging technology research forms a survey of the conditions under which the packaging has to function, the selection of optimal packaging materials (barrier properties) and modified atmosphere conditions (based on the respiration of the product and the protecting action of the modified atmosphere). Research will focus on the of application of volatile antimicrobials in the headspace of the packaging during a gas packaging step or by a controled release system. Non-volatile antimicrobials are applied on the product or on an active packaging material. The performance of prototypes of the packaging concept is tested under optimal and sub-optimal conditions; field tests are carried out by an industrial partner (partner 5). Consumer attitudes and perceived benefits and risks will be determined in 3 countries of the EU by qualitative interviews and quantitative questionnaires. Legislative aspects for the introduction of the developed technique on an EU level will be surveyed by communication with experts, authorities, and work groups.

Milestones and expected results (maximum 500 characters)

The expected result is a protoype for a packaging concept which integrates the combined hurdle technology, and a survey of the legislative aspects and consumer attitudes w.r.t. the use of the developed technology. Important milestones to reach these results are the selection of robust and efficient combinations of the hurdles, the determination of optimal MA conditions, packaging materials and techniques, and the understanding of the factors which promote or obstruct consumer acceptance.

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A3. Participant Profile/Information (1 form per participant) [23]

Legal information on the participating organisation

Participant Role [24]	CO	Participant No [25]	1	Assistant to Contractor No [26]	
Registration No with the European Commission's Research Programmes [27]					
Organisation Legal Name [28]	Agrotechnological Research Institute (as part of the 'Stichting DLO' a foundation according to Dutch Law)				
Short Name [29]	ATO-DLO			Legal Registration No [30]	09098104
Activity Type [31]	RPN	Legal Status [32]	PNP	If 'PRC', Specify [33]	
Business Area [34] (NACE)	73	User/Supplier [35] (U / S)	S	Cost Basis [36] (FC / FF / AC)	FC

Organisation details [37]

Annual turnover [38]	T2	Annual Balance Sheet Total [39]	B2	Number of employees [40]	S5

Is Your Organisation independent [41]?	Y	X	N	
If No, please indicate legal name(s) of owner(s) who own 25 % or more [42]				
Is Your Organisation affiliated to any other participant(s) in the proposal [43]?	Y		N	X
If Yes, please indicate Participant No, Short Name(s) and character of affiliations(s) (D / I) [44]				

Address of the main department carrying out the work [45]

Department/ Institute Name [10]	Agrotechnological Research Institute (as part of the 'Stichting DLO' a foundation according to Dutch Law)		
PO Box [11]	17		
Street Name and Number	Bornsesteeg 59		
Post Code [12]	6700 AA	Cedex [13]	
Town/City	Wageningen		
Country Code [14]	NL	Country Name [14]	Netherlands

Authorised person [46]

Title (Dr, Prof., ...)	Dr.			Gender [8]	F		M	X
Family Name	Huizing							
First Name	Henk							
Telephone No [15]	(31-0317)475000	Fax No [15]	(31-0317)475347					
E-mail	h.j.huizing@ato.wag-ur.nl							

I certify that the above information is accurate and that my organisation has agreed to participate in this proposal.

Date (DD/MM/YYYY)	09/11/1999
Signature of authorised person	

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A3. Participant Profile/Information (1 form per participant) [23]

Legal information on the participating organisation

Participant Role [24]	CR	Participant No [25]	2	Assistant to Contractor No [26]	
Registration No with the European Commission's Research Programmes [27]					
Organisation Legal Name [28]	Veneto Agricoltura				
Short Name [29]	VA			Legal Registration No [30]	
Activity Type [31]	REC	Legal Status [32]	GOV	If 'PRC', Specify [33]	
Business Area [34] (NACE)	01	User/Supplier [35] (U / S)	S	Cost Basis [36] (FC / FF / AC)	AC

Organisation details [37]

Annual turnover [38]	NA	Annual Balance Sheet Total [39]	NA	Number of employees [40]	S4

Is Your Organisation independent [41]?	Y	X	N	
If No, please indicate legal name(s) of owner(s) who own 25 % or more [42]				
Is Your Organisation affiliated to any other participant(s) in the proposal [43]?	Y		N	X
If Yes, please indicate Participant No, Short Name(s) and character of affiliations(s) (D / I) [44]				

Address of the main department carrying out the work [45]

Department/ Institute Name [10]	Veneto Agricoltura - Istituto per la Qualità e le Tecnologie Agroalimentari		
PO Box [11]			
Street Name and Number	via S. Gaetano 74		
Post Code [12]	36016	Cedex [13]	
Town/City	Thiene (VI)		
Country Code [14]	I	Country Name [14]	Italy

Authorised person [46]

Title (Dr, Prof., ...)	Dr.			Gender [8]	F		M X
Family Name	Disegna						
First Name	Luigino						
Telephone No [15]	(39-0445)802300	Fax No [15]	(39-0445)802301				
E-mail							

I certify that the above information is accurate and that my organisation has agreed to participate in this proposal.

Date (DD/MM/YYYY)	03/11/1999
Signature of authorised person	Luigino Disegna

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A3. Participant Profile/Information (1 form per participant) [23]

Legal information on the participating organisation

Participant Role [24]	CR	Participant No [25]	3	Assistant to Contractor No [26]			
Registration No with the European Commission's Research Programmes [27]							
Organisation Legal Name [28]	Wisby GmBH & Co.KG, Starter Cultures and Media						
Short Name [29]	Wisby			Legal Registration No [30]	HRA 84		
Activity Type [31]	OTH	Legal Status [32]	PRC	If 'PRC', Specify [33]	GmbH & Co.KG		
Business Area [34] (NACE)	15	User/Supplier [35] (U / S)	U	Cost Basis [36] (FC / FF / AC)	FC		

Organisation details [37]

Annual turnover [38]	T2	Annual Balance Sheet Total [39]	B2	Number of employees [40]	S4

Is Your Organisation independent [41]?	Y		N	X
If No, please indicate legal name(s) of owner(s) who own 25 % or more [42]	Danisco Wisby Beteiligungsgesellschaft mBH			
Is Your Organisation affiliated to any other participant(s) in the proposal [43]?	Y		N	X

If Yes, please indicate Participant No, Short Name(s) and character of affiliations(s) (D / I) [44]			

Address of the main department carrying out the work [45]

Department/ Institute Name [10]	R & D department		
PO Box [11]			
Street Name and Number	Busch-Johannsen-Str. 1		
Post Code [12]	25899	Cedex [13]	
Town/City	Niebuell		
Country Code [14]	D	Country Name [14]	Germany

Authorised person [46]

Title (Dr, Prof., ...)		Gender [8]	F		M	X
Family Name	Grow				
First Name	Klaus D.				
Telephone No [15]	(+49-4661) 6020	Fax No [15]	(+49-4661) 602107		
E-mail	grow@wisby.de				

I certify that the above information is accurate and that my organisation has agreed to participate in this proposal.

Date (DD/MM/YYYY)	10.11.1999
Signature of authorised person	

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Proposal Acronym [5]	HYDROLEPACK	Proposal No [6]	

A3. Participant Profile/Information (1 form per participant) [23]

Legal information on the participating organisation

Participant Role [24]	CR	Participant No [25]	4	Assistant to Contractor No [26]	
Registration No with the European Commission's Research Programmes [27]					
Organisation Legal Name [28]	University of Horticulture and Food Industry				
Short Name [29]	UHFI			Legal Registration No [30]	
Activity Type [31]	HES	Legal Status [32]	GOV	If 'PRC', Specify [33]	
Business Area [34] (NACE)	80	User/Supplier [35] (U / S)	S	Cost Basis [36] (FC / FF / AC)	AC

Organisation details [37]

Annual turnover [38]	N/A	Annual Balance Sheet Total [39]	N/A	Number of employees [40]	56

Is Your Organisation Independent [41]?	Y	X	N	
If No, please indicate legal name(s) of owner(s) who own 25 % or more [42]				

Is Your Organisation affiliated to any other participant(s) in the proposal [43]?	Y		N	X
If Yes, please indicate Participant No, Short Name(s) and character of affiliations(s) (D / I) [44]				

Address of the main department carrying out the work [45]

Department/ Institute Name [10]	Department of Rerrigeration and Livestock Products Technology		
PO Box [11]	53		
Street Name and Number	Ménesi út 45.		
Post Code [12]	1118	Cedex [13]	
Town/City	Budapest		
Country Code [14]	HU	Country Name [14]	HUNGARY

Authorised person [46]

Title (Dr, Prof., ...)	Prof.			Gender [8]	F		M	X
Family Name	FEKETE							
First Name	ANDRÁS							
Telephone No [15]	(36-1) 3726206	Fax No [15]	(36-1) 3726334					
E-mail	H10835FEK a ELLA.HU							

I certify that the above information is accurate and that my organisation has agreed to participate in this proposal.

Date (DD/MM/YYYY)	5 October 1999
Signature of authorised person	

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Proposal Acronym [5]	HURDLEPACK	Proposal No [6]	

A3. Participant Profile/Information (1 form per participant) [23]

Legal information on the participating organisation

Participant Role [24]	CR	Participant No [25]	5	Assistant to Contractor No [26]	
Registration No with the European Commission's Research Programmes [27]					
Organisation Legal Name [28]	Johma Holding International B.V.				
Short Name [29]	Johma	Legal Registration No [30]	06044803		
Activity Type [31]	OTH	Legal Status [32]	PRC	If 'PRC', Specify [33]	SA
Business Area [34] (NACE)	15	User/Supplier [35] (U / S)	U	Cost Basis [36] (FC / FF / AC)	FC

Organisation details [37]

Annual turnover [38]	T3	Annual Balance Sheet Total [39]	B3	Number of employees [40]	S5

Is Your Organisation independent [41]?	Y		N	X
If No, please indicate legal name(s) of owner(s) who own 25 % or more [42]	Unigate PLC			
Is Your Organisation affiliated to any other participant(s) in the proposal [43]?	Y		N	X
If Yes, please indicate Participant No, Short Name(s) and character of affiliations(s) (D / I) [44]				

Address of the main department carrying out the work [45]

Department/ Institute Name [10]	Johma Nederland B.V.		
PO Box [11]	P.O. Box 182		
Street Name and Number	Industrieterrein 'de Pol' 35		
Post Code [12]	7581	Cedex [13]	CZ
Town/City	Losser		
Country Code [14]	NL	Country Name [14]	The Netherlands

Authorised person [46]

Title (Dr, Prof., ...)	ING. P.H.M. Peelen	Gender [8]	F		M	X
Family Name	Peelen				
First Name	Piet				
Telephone No [15]	053 - 53 73 400	Fax No [15]	050 - 53 85 845		
E-mail	ppeelen@johma.com				

I certify that the above information is accurate and that my organisation has agreed to participate in this proposal.

Date (DD/MM/YYYY)	11/11/1999
Signature of authorised person	