

## Technical Annex

### Scientific description of the project

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**Title:**           **Organic Aquaculture – the linkage between sustainable production and superior products**

**Acronym:**   **ORAQUA**

**Duration:**   **4 years, from January 2007 to December 2010**

**Participating scientists:**

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## English summary

Recently, organic fish farming has been established in several European countries but this niche production has not been firmly established in Denmark yet. Five trout farms have received official certification of organic status. Certified organic fish feed has been available since 1<sup>st</sup> March 2005, and are produced at the Danish Technological Institute due to request of too low quantities (about 120 tonnes per year) to be commercially interesting for the feed companies. The first Danish trout with a red Ø label was introduced to the market on 6<sup>th</sup> September 2005. There is, therefore, almost no practical experience of the challenges related to the rearing and sale of organic fish in Denmark. This project will contribute to the successful establishment of organic fish farming in Denmark with research upon the most critical areas in the chain that links between organic feed production, organic fish rearing, and the consumer.

The main focus will be on organic fish feeds in which non-renewable fish meals are replaced with sustainable organic vegetable proteins of Danish origin. Special emphasis will be on the need for competitive vegetable protein sources with high protein content. To stimulate the research in that area available scientific and technical knowledge within the animal- and the fish feed sector will be collected and synthesised with regard of improving the protein content of plant ingredients in organic fish feed. Optimized feed compositions and processing methods will be refined to maximise feed protein quality with relevant plant ingredients. The quality of the organic feed recipes will be studied in terms of their digestibility and nutrient availability. These studies, in turn, will be related to analyses of fish performance indicators such as feed conversion and growth as well as health and welfare performance. Case studies are carried out to optimize current production systems. The studies will also include field studies of a selected experimental feed from the pilot experiments as well as monitoring of general health and welfare status of the fish.

The impact of organic feed recipes upon product quality will be investigated, to ensure that organic fish are of high quality. This will comprise objective sensory and biochemical analyses of the flesh, to obtain an overall picture of their eating quality.

The results of the project will be disseminated to the aquaculture community, consumers, regulatory authorities and the scientific community through publications in the scientific, industrial and popular literature and participation in thematic meetings.

The results of the project will represent a concrete contribution to the development of Danish organic aquaculture, and so allow organic fish farming to respond more effectively to the challenges it faces.

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## **A.0 Introduction, state of the art and objectives of the project**

### ***Introduction***

The global production of fish in aquaculture amounts to about 50 million tonnes (Globefish, 2005). The wild catch amounts to about 95 million tonnes, of which fish for human consumption accounts for about 60 million tons ([www.aquafeed.com/9\\_september\\_2006](http://www.aquafeed.com/9_september_2006)), which means, that about 45 % of the consumed fish is produced in aquaculture. FAO estimates, that the request for farmed fish will further increase with about 40 million tonnes in year 2030. Aquaculture is thus growing more rapidly than all other animal food producing sectors due to increasing demand and a concurrent decline in wild capture fisheries.

The Danish aquaculture production amounts to about 32,000 tonnes rainbow trout in fresh water, about 9,000 tonnes rainbow trout (incl. roe) in saltwater and about 2,000 tonnes of European eel in recirculated fresh water. The organic production amounts to about 150 tonnes trout in fresh water. For the time being there are no productions of organic eel in Denmark (Jokumsen et al., 2006).

Recently, a communication from the Commission to the Council and the European Parliament “*A Strategy for a Sustainable Development of the European Aquaculture*” (COM, 2002), encouraged the further development of such aspects as environmental impact, production ethics, fish welfare, and safe, high quality products. “Fish products are important sources of polyunsaturated fatty acids, proteins, phosphorous, iron, selenium, iodine and vitamins. Consumers should take advantage of these qualities and at the same time feel confident that aquaculture products are hygienic and safe” (COM, 2002).

The Commission to the Council and the European Parliament (COM, 2002) highlighted certified organic fish farms as a production sector with innovative prospects. In particular, because the application of organic principles to aquaculture meets consumer demands for fish farming practices that are sustainable and ethically superior to conventional production (Council Regulation No. 2092/91; Brister, 2001; Pelletier, 2004). Organic aquaculture is a recent development in Europe (Bergleiter, 2003; Fairbrother, 2004) that went through a fairly long initial phase, certified production has now been consolidated in several European countries (Hilge & Halwart, 2004; Jokumsen et al., 2006). However, given the limited experience of organic aquaculture in Europe, there is little empirical evidence to identify challenges for the organic fish farmer (Perrot, 2003), but various different stages in the production and distribution cycle can be identified.

### ***State of the art***

The paradigm of organic aquaculture in Denmark was originally described in DFU-rapport 69-99, based on recommendations from an expert committee (Anonym, 1999). Successively, two standards were prepared (Bjerregård, 2001), submitted to national NGO and ratified by the EU, and came into force in March 2004.

In 2002 the Danish Aquaculture Organisation and DIFRES initiated a project to demonstrate the potential of organic trout culture to the fish farming sector (Pedersen et al., 2005). Organic standards were implemented at four trout farms in Denmark, resulting in considerable rebuilding, improved rearing conditions and alterations to management practices. Subsequently, in 2006 the fifth trout farm has received official certification of organic status. Certified organic fish feed has been available since 1<sup>st</sup> March 2005, but are currently produced at the Danish Technological Institute due to request of too low quantities (about 120 tonnes per year) to be commercially interesting for the feed companies. The first Danish trout with a red Ø label was introduced to the market on 6<sup>th</sup> September 2005. Therefore, there are only few practical experiences of the challenges related to the rearing and sale of organic fish in Denmark.

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This research project will address some of the major challenges to the successful future development of organic fish farming in Denmark. Initially, a synthesis of science has been prepared during 2006 to up date the knowledge of organic fish farming in Europe including the different national regulations currently at work and to identify the most important fields of research to stimulate progress in organic fish farming in Denmark (Jokumsen et al., 2006).

The most important obstacles for a sustainable development of Danish organic aquaculture relates to organic fish feed and to the anti-competitive differences between the Danish organic regulations and the corresponding regulations in other European countries (Jokumsen et al., 2006).

Specifically, there are a need for competitive vegetable protein sources with a high protein content (preferably up to  $\pm 70$  % protein) and relevant amino acid composition compared to that in fish meal (72 % protein). This need is also expressed by the industry of feeding stuffs and to stimulate the research and development within the field of vegetable high protein sources common efforts between the agricultural -, feeding stuff - and the aquaculture sector is called upon and will be concretized through communication with relevant scientific and technical resource persons from the sectors.

Pointing forward a sustainable development of organic aquaculture in Denmark is dependant on:

- Availability of relevant organic produced vegetables with high protein content, including the possibilities of concentrating the protein fraction of existing protein sources with relevant amino acid profile compared to that of fish meal, a high digestibility and competitive price (taking into account organic principles)
- The effect of the organic vegetable protein sources on growth and digestibility in rainbow trout
- The influence of organic protein and –oil on eating quality
- The influence of organic vegetables on the health and welfare of farmed fish
- Optimizing the production by case studies of organic systems of production
- Harmonizing the European regulations for organic aquaculture

Fish feed is an important issue for several reasons. It is widely anticipated that global aquaculture expansion will encounter an inevitable future shortfall of non-renewable resources such as fishmeal and fish oil, necessitating the exploration of alternative strategies for fish feeds (Watanabe, 2002). The principles of organic aquaculture encourage the development of feeds that do not deplete global fish stocks. Fish discard and cut-offs have been proposed as potential alternative components, but such ingredients conflict environmental regulations because of their high phosphorous content. Intuitively, substitution of fishmeal and fish oil by sustainable organic plant protein and oil sources seems a good alternative, since fish feed (including organic) contains more than 60% fishmeal on a fat free basis. Candidate sources include peas, lupine, fava beans, rape and wheat (Watanabe, 2002). Organic rape and pea are available in Denmark and organic lupine can be imported. The substitution of fish meal has, however, constraints because of the low protein content in suitable vegetable products. Trout, furthermore, are carnivorous (piscivorous) and alternative plant proteins may have a negative impact upon feed digestibility (Neji and de la Noue 1998) and fish health and welfare (Sanden et al. 2005, Sanden et al., 2006).

These changes in feed quality may have significant “knock-on” effects on various elements of rearing and production. Reduced feed digestibility may have a negative effect upon the environment (effluent quality), and the reduced nutrient availability may have a negative impact upon feed conversion and growth performance.

Health status and disease susceptibility may also be affected, if altered feed composition (replacement of fish meal with vegetable sources) is insufficient with regard to essential nutrients

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(particularly amino acids) and vitamins or may harm the digestive tract of the fish (Sanden et al. 2005, Sanden et al., 2006). This latter consideration is of particular relevance because the production of organic rainbow trout allows the usage of only one antibiotic treatment in a full production cycle. That is, between the time the fish enter the farms at approximately 25 g mass until their slaughter. This requires attention to husbandry/production practices that improve fish welfare and prevent diseases. In particular, prophylactic measures such as vaccination may be important in organic production. Enteric red mouth disease caused by *Yersinia ruckeri* can be expected to be one of the major pathogens of concern in organic trout farming in Denmark. In particular, the effects of antibiotic treatment of fry against *Flavobacterium psychrophilum*, the aetiological agent of rainbow trout fry syndrome (RTFS), may influence the effectiveness of subsequent vaccinations.

The substitution of fish feed with high amounts of plant ingredients may also affect flesh quality and taste, and it is important to ensure that organic product quality remains good. An on-going project at DIFRES is comparing the eating quality of trout fed with six different feeds. When eating quality was assessed by objective sensory analysis, there were variations in both taste and texture. It is therefore important to investigate the influence of feeds made from different vegetables on eating quality.

The substitution of marine feed components with components of vegetable origin will influence both the lipid and the protein composition of the fish itself. Fish meal contains 10 % marine lipids, so the substitution of fish meal with vegetable protein sources will elicit an unavoidable reduction in the content of nutritionally valuable marine lipids, unless this reduction is compensated for by increasing the content of fish oil in the fish feed. Substitution of highly polyunsaturated marine lipids with less unsaturated lipids of vegetable origin may in fact impart a significant improvement in the oxidative stability of the fish. Moreover, previous studies have shown that oxidised lipids may interact with intact proteins and vice versa during storage (Saeed and Howell 2002). Thus, the lipid content and oxidative stability of products from organic farming are important parameters to investigate.

One of the most powerful tools to identify and understand the basis for differences in taste and texture is functional genomics by proteome analysis. This provides an overall characterisation of the muscle of fish which, when related to the characterisation by sensory and lipid analyses, provides an overall picture of product quality. Unfortunately, due to limited funding it will not be possible to make proteome analysis in this project. However, samples will be taken from the fish and stored at  $-80^{\circ}\text{C}$  and analysis will wait for later funding.

The use of colour pigment (i.e. astaxanthin) is prohibited by the national guidelines for organic fish feed. This may have consequences for fish welfare (astaxanthin is an ordinary ingredient in natural prey such as crustaceans, and is an important precursor for vitamin A) but will also result in fish products with pale flesh. How consumers will respond to a pale organic fish as compared to a conventional coloured fish remains an open question, which may have significant impact on the future success of organic fish farming in Denmark.

Organic fish farming is a new form of food production in Denmark, and new science and know how is needed for improvements of the production. A close cooperation between relevant research institutions as well as farming sector is needed.

### **Objectives**

This project aims to contribute to the successful development of organic trout farming in Denmark by investigating critical issues. Specific objectives are:

- Availability of relevant organic produced vegetables with high protein content, including the possibilities of concentrating the protein fraction of existing protein sources with relevant

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amino acid profile compared to that of fish meal, a high digestibility and competitive price (taking into account organic principles)

- The effect of the organic vegetable protein sources on growth and digestibility in rainbow trout
- The influence of organic protein and –oil on eating quality
- The influence of organic vegetables on the health and welfare of farmed fish
- Optimizing the production by case studies of organic systems of production
- To disseminate the results of the project to the aquaculture industry, consumers, regulatory authorities and the scientific community.

The results of the project will represent a concrete contribution to the development of Danish organic aquaculture, and so allow organic fish farming to respond more effectively to the challenges it faces.

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## A.1 Relevance for DARCOF III and argumentation for the subject

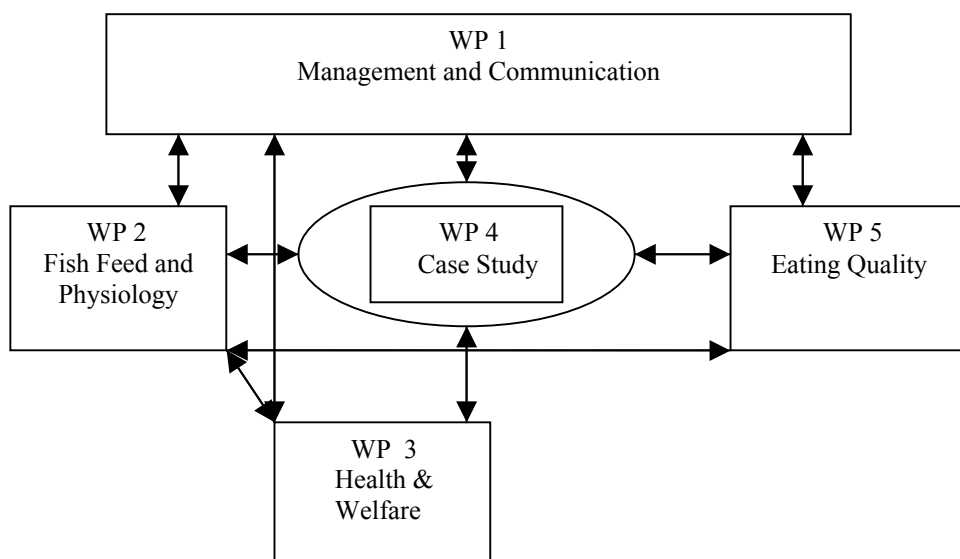
The research activities in this project have been designed to respond closely to the research priorities for organic fish farming outlined in DARCOFF III. It is aimed to provide valid and reliable information about the critical issues for organic aquaculture and organic fish products of high eating quality. These include investigations into the extent to which fish feeds can be based upon sustainable organic vegetable products (produced in accordance with national requirements in notification no. 115 of 23/2 2004), and how to optimise the inclusion of these.

The availability and digestibility of these organic nutrients shall be investigated, as well as effects of organic feeds on product quality.

The case studies will investigate options for rearing systems (including the current production systems, feed and feeding) that secure sustainable production, health and welfare in organic fish production.

## A.2 Technical content of the research activity

This collaborative multidisciplinary project is organized into 5 complementary work packages (WP) that follow the chain starting with the optimization of knowledge about vegetable protein with high protein content/value (WP 1), then production of organic test feeds, on to an analysis of their digestibility and effects upon fish performance (WP 2) and Health and welfare (WP 3), and product quality (WP 5). The studies are further extended to include case studies on organic farms (WP 4). The flow diagram (below) shows this chain structure and the interrelations of the component WP's. Each WP or part of is under the responsibility of a participating partner, a named scientist will ensure progress and completion of relevant activities, as detailed in the Work Package List below.



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WP 1 includes project management and communication. Communication involves establishments of contacts in the agricultural - and fish feed sector and related companies/institutions with respect to optimization of knowledge about vegetable protein with high protein content/value as well as dissemination of the results and know-how obtained in the project. This will involve communications with the aquaculture industry as well as publications in the international scientific literature.

WP 2 involves protein enrichment to produce a vegetable fraction high in protein and searching for relevant new vegetable crops for organic fish feed. Based upon that organic fish feed is produced, where fishmeal is substituted for relevant candidate sources of Danish vegetable protein. Following investigations of the digestibility of the diets and related effects upon fish performance (feed conversion, growth) in carried out in controlled experiments. Finally WP 2 includes modelling aspects of the feed production process.

Interrelated with WP 2 health and welfare aspects are studied in WP 3.

The case studies in WP4 will include comparison of different organic feeds, management protocols including veterinarian advisory and fish health (WP 3) in selected commercial organic fish farms. The eating quality of fish fed the different organic diets will be assessed in WP 5. This will comprise lipid analyses and objective sensory characteristics of organic trout.

## Project Timetable

ORAQUA	Year 2007				Year 2008				Year 2009				Year 2010			
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
WP 1 Management and Communication	■															
WP 2 Fish Feed/ Performance	■															
WP 3 Fish health/ Welfare	■															
WP 4 Case study	■															
WP 5 Product quality	■															
Meetings	■		■			■			■			■		■		
Reports				■			■				■				■	

### Work Package List

WP No.	WP title	Responsible	Budget - DKK* 1000	Start (Month)	End (Month)	Deliverable No.
1	Management and communication	Alfred Jokumsen	923	1	48	D1.1-D1.4
2	Feed	Alfred Jokumsen	3.718	3	38	D2.1-D2.11
3	Health/Welfare	Inger Dalsgaard	717	6	38	D3.1-D3.4
4	Case study	Villy Juul Larsen	578	4	38	D4.1-D4.4
5	Quality	Henrik Hauch Nielsen	1.064	10	42	D5.1-D5.6
<b>Total</b>			<b>7.000</b>			

## Deliverables list

Deliverable No	Deliverable title	Lead scientist	Delivery date	Allocated scientific person months	Type of deliverable
D1.1	Preparation of annual reports	A. Jokumsen	Months 12,24,36,48	7	R
D1.2	Preparation of presentations for the industry	A. Jokumsen/ All partners	Months 12, 24, 36, 48	1	C
D1.3	Dissemination of results and information through websites	A. Jokumsen/ All partners	Months 12,24,36,48	1	O, P
D1.4	Publication of project results in the literature	All partners	Month 48+	6	S, P
D2.1	Procedure for production of high protein fraction of selected strains of crop	J. Kold	Month 14	5	O
D2.2	New potential strains of crop protein have been characterised for process ability	J. Kold	Month 18	5	O
D2.3	Standard organic recipe and new recipes available for feed experiments	P. Jessen	Month 6	BioMar	O
D2.4	Organic feeds produced	J. Kold	Month 8-16-28	2	O
D2.5	Digestibility of organic fish feed recipes	A. Jokumsen	Months 8 – 38	4	R
D2.6	Performance of trout fed organic fish feed recipes	A. Jokumsen	Months 6 – 38	7	R
D2.7	Delivery of trout samples for WP 3 & WP 5	A. Jokumsen	Months 12 – 36	1	O
D2.8	Model has been developed for production process	J. Kold	Month 18	3	R
D2.9	Model optimised for evaluation of production procedure for new potential crops	J. Kold	Month 24	3	R
D2.10	Annual reports about WP results and progress	A. Jokumsen/ All	Month 12, 24,36	4	R
D2.11	Scientific article produced on modified protein sources, technological and nutritional aspects.	J. Kold	Month 30	4	S
D3.1	Health and welfare data of trout fed organic fish feed recipes	I. Dalsgaard	Month 42	4	R
D3.2	Challenge protocols for rainbow trout with <i>Yersinia ruckeri</i>	I. Dalsgaard	Month 42	2	R
D3.3	Data on health and welfare of organic rainbow trout in case studies (cf. WP 4)	I. Dalsgaard	Month 42	2	R
D3.4	Annual reports about WP results and	I.	Months	2	R

	progress	Dalsgaard	12-24-36		
D4.1	Comparison of Danish organic production systems	V.J. Larsen	Month 42	1,5	R
D4.2	Health and welfare in Danish organic fish farms	I. Dalsgaard	Month 42	Cf. D3.3	R
D4.3	Comparison of two organic feed types in 2 Danish organic fish farms	V.J. Larsen/A. Jokumsen	Month 42	2	R
D4.4	Annual reports about WP results and progress	V.J. Larsen	Months 12-24-36	2	R
D5.1	Scientific report on sensory analyses	G. Hyldig	Month 42	2	R
D5.2	Presentation of sensory data on meetings/workshop for the industry	G. Hyldig	Month 42	1	C
D5.3	Scientific report on lipid analysis	C. Jacobsen	Month 42	1	R
D5.4	Presentation of lipid data on meeting/workshop for the industry	C. Jacobsen	Month 42	1	C
D5.5	Sensory characterisation of organic trout	G. Hyldig	Month 42	2	S
D5.6	Annual reports about WP results and progress	H.H. Nielsen	Months 12-24-36	1	R

\*) The nature of the deliverables:

S = publication in scientific journal with peer review;

P = publication in journals without peer review;

R = reports;

C = presentation at meetings and congresses

O = other types of deliverables, e.g., prototypes, models, websites, etc..

**Partner id.**

- DFU-HØKa: Danish Institute for Fisheries Research, DIFRES, HØK, Hirtshals
- DFU-HØKb: Danish Institute for Fisheries Research, DIFRES, HØK, Frederiksberg
- DFU-FF : Danish Institute for Fisheries Research, DIFRES, FF, Lyngby
- BioMar : BioMar A/S, Brande
- TI : Technological Institute, Kolding
- DAO : Danish Aquaculture Organisation, Silkeborg

## Milestones list

Milestone No	Deliverable title	Lead scientist	Delivery date
M1.1	Publication of results in reports	A. Jokumsen	Months 12,24,36,48
M1.2	Dissemination of results for the industry	A. Jokumsen/ All partners	Months 12, 24, 36, 48
M1.3	Dissemination of results to organic/aquaculture websites	A. Jokumsen/ All partners	Months 12,24,36,48
M1.4	Publication of results in the literature	All partners	Month 48+
M2.1	Initial batch of organic fish feed for initial feed experiment completed	J. Kold	Month 8
M2.2	New potential crops selected for analysis	J. Kold	Month 18
M2.3	Procedure for high protein fraction and selected crops completed	J. Kold	Month 18
M2.4	Proteins have been characterised and processed	J. Kold	Month 18
M2.5	Trial batches have been produced for evaluation	J. Kold	Months 8-16-28
M2.6	Trial batches produced for validation of models	J. Kold	Months 18
M2.7	Digestibility experiments completed	A. Jokumsen	Months 38
M2.8	Performance experiments completed	A. Jokumsen	Month 38
M2.9	Fish provided to other work packages	A. Jokumsen	Month 12-36
M3.1	Identification of health and welfare status of rainbow trout used in feed experiments	I. Dalsgaard	Month 42
M3.2	Identification of disease status in organic rainbow trout in case studies	I. Dalsgaard	Month 42
M4.1	Identification of characteristics in Danish organic production systems	V.J. Larsen	Month 42
M4.2	Identification of health and welfare in Danish organic fish farms	I. Dalsgaard	Month 42
M4.3	Feed experiments with two organic feed types in 2 Danish organic fish farms completed	V.J. Larsen/A. Jokumsen	Month 42
M5.1	Development of sensory vocabulary finished	G. Hyldig	Months 24
M5.2	Sensory profiling of samples completed	G. Hyldig	Month 42
M5.3	Data analysis of sensory data completed	G. Hyldig	Month 42
M5.4	Analysis of lipid composition and oxidative stability of samples completed	C. Jacobsen	Month 42
M5.5	Data analysis of lipid data completed	C. Jacobsen	Months 42
M5.6	Multivariate data analysis of biochemical and sensory data completed	G. Hyldig	Month 42

Partner id.	DFU-HØKa	DFU-HØKb	DFU-FF	BioMar	TI	DAO	SUM
Person- VIP: Months TAP:	8	2	2	*)	1	1	14 <u>0</u> 14
<b>Total VIP-PM</b>			<b>14</b>				
*) cf. Cooperation Agreement							

**Objectives:**

- Overall management of the project
- Communication with the agricultural- and fish feed sector and related companies/institutions regarding high protein vegetable sources for organic fish feed
- Project management meetings (Responsible of WP's)
- Communications with the advisory group
- Collate the combined data from the various work packages, prepare reports/scientific papers
- Dissemination of results through workshops/meetings etc.
- Provide information to organic websites (f.ex.: [www.eco-aquafish.dk](http://www.eco-aquafish.dk); [www.darcof.dk](http://www.darcof.dk).)

**Description of work:**

Project management meetings with the responsible of each WP will be held once to twice a year or when needed and normally include the advisory group. At these meetings the progress for each WP is presented and related to “deliverables”, “milestones” and “budget”, and plans for the ensuing 6 – 12 months are outlined. If deviations from the original plan occurs this should be explained.

Connected to WP 2 contacts will be established with the agricultural - and fish feed sector and related companies/institutions with respect to optimization of knowledge about vegetable protein with high protein content/value.

The project manager will collate reports provided by individual participants and provide annual reports. The results of the project will be disseminated to the industry through participation in workshops, meetings, and articles in magazines etc. Data collected during the project will be published in the international peer-reviewed scientific literature. Further, background information and progress of the project as well as results will be disseminated through organic/aquaculture websites (f.ex.: [www.eco-aquafish.dk](http://www.eco-aquafish.dk); [www.darcof.dk](http://www.darcof.dk)).

**Deliverables:**

- D1.1 Preparation of annual reports Months 12, 24, 36, 48; including reports from the contacts with the agricultural - and fish feed sector and related companies/institutions regarding organic vegetable protein with high protein content/value.
- D1.2 Preparation of presentations for the industry Months 12, 24, 36, 48
- D1.3 Dissemination of results and information through websites Months 12, 24, 36, 48
- D1.4 Publication of project results in the literature Month 48+

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**Milestones:**

M1.1 Publication of results in reports

M1.2 Dissemination of results for the industry

M1.3 Dissemination of results to organic/aquaculture websites

M1.4 Publication of results in the literature

Partner id.	DFU-HØKa	DFU-HØKb	DFU-FF	BioMar	TI	DAO	SUM
Person- VIP:	16			*)	22		38
Months TAP:	14				10		<u>24</u>
							62
<b>Total VIP-PM</b>			<b>38</b>				
*) Company contribution cf. Cooperation Agreement							

**Objectives:**

- Provide new protein sources for organic fish feed
- Provide protein rich fractions of organic vegetable protein
- Production of experimental fish feed with optimized level of organic vegetable protein of Danish origin, in order to reduce the use of the limited available fish meal
- Evaluate digestibility of the experimental fish feeds
- Evaluate performance (feed conversion ratio, specific growth rate) with organic fish feeds, under controlled experimental conditions and in case studies (WP 4)
- Provide fish populations/samples to WP 3 and WP 5
- Develop a model that can predict the performance of high protein fractions of organic crops in the manufacturing of organic fish feed
- Investigate the correlations between the protein fractions, processing parameters and the properties of the fish feed pellets

**Description of work:**

Pilot production of experimental organic fish feeds for experimental evaluation.

**2.1 Protein enrichment**

Based on existing know how and experience in the agricultural - and fish feed sector and related companies/institutions possibilities to produce a vegetable fraction high in protein and low in fibre and carbohydrate will be investigated. The experimental work will be carried out in appropriate facilities aiming the specific enrichment procedure i.e. at Danish Technological Institute (TI) or other facilities with relevant equipment and experience. However, wherever the work is carried out (as decided by the project management) the total costs of the protein enrichment activities are included in the budget of TI. The protein fraction will be analysed, characterised for the specific production procedure used in the fish feed manufacturing.

The provided protein-rich fractions should be tested in protein-rich diets, with concomitant lowered inclusion of fish meal, for studies of digestibility and growth performance as well as providing samples for physiological analysis and for WP 3 and WP 5.

**2.2. New organic protein crop**

In cooperation with the agricultural - and fish feed sector and related companies/institutions relevant new vegetable crops with potential good nutritional value for fish feed will be searched for. The potential new crops will be evaluated and characterised using selected method(s) in 2.1. Procedures for concentrating the protein fraction of the specific crops will be investigated (cf. 2.1) and if possible the product will be used in a fish feed formula for testing in studies of digestibility and growth performance as well as providing samples for physiological analysis and for WP 3 and WP 5.

High protein fractions will be evaluated for process-ability and fish feed pellet quality.

**2.3. Procedure for production of high protein fraction**

2 crops will be selected for detailed processing evaluation as model for future work.

#### **2.4. Model for production process and optimized for predicting the new protein sources performance**

A model for the production process will be developed in order to predict the performance of the final fish feed performance, based on the protein characteristic analysed in 2.1. The model is further developed for estimating quality parameters necessary when selecting new crops.

The Food Production Engineering group (FPE) at BioCentrum-The Technical University of Denmark (DTU) will be responsible for this subtask.

FPE has strong competencies in modelling of interactions between physical behaviour of biological material and processing equipment. The emphasis has been mainly on food products; however the actual studies have often been carried out utilising standardised model fluids which are representative for a wider range of biological materials. Much work has involved heat processing and transport of highly viscous products in a variety of processing equipment and therefore the study of thermo rheological properties of complex fluids has been an integral part of the work.

Current work includes processing of highly viscous pastes in a new type of scraped surface heat exchanger and studies of extrusion of various cereal based products. These studies have a strong focus on description of the interaction between the physical characteristics of the products and the processing conditions in order to make improvements to the production process. The approach is to identify a limited set of parameters and interactions which control the major behaviour of the production process. In other words the work aims to tell as much as possible with a limited investigation. This also means that the models developed aims at practical usage rather than being merely academic studies for the sake of modelling an industrial case. However, the aim is still to produce sound research which is publishable in peer-reviewed journals. The latest achievement has been development of a model describing an extrusion process in collaboration with a feed producer.

FPE will be responsible for making a versatile model of the applied extrusion process and will take part in designing and evaluating the rheological measurements and production studies necessary for this work. The experimental part will be conducted by the Technological Institute but equipment will be made available from FPE to the extent it is necessary. Also FPE will be the main responsible for the actual optimisation of the model in terms of the computational work and data analysis in a tight collaboration with the Technological Institute. FPE will be responsible for production of one peer-reviewed paper in month 30 covering the interaction between protein sources, physical behaviour of extrudates, the extrusion process and the characteristics of the final product. The paper will include combined results from the work of both FPE and the Technological Institute.

The budget required from the project will be DKK 200. Furthermore FPE will participate with 2.5 month of senior researchers over the 2½ years from Associate Professors Alan Friis and Bo Jensen and Professor Jens Adler-Nissen.

**2.5 Feed production** Experimental diets required are formulated in cooperation with BioMar A/S and produced along with a standard organic fish feed based upon fish meal (2007-2009). Selected diets will be provided for the digestibility and growth studies (incl. case studies – WP 4) and providing samples for physiological and health and welfare analyses (WP 3) as well as a selection of samples for quality assessment WP 5.

#### **2.6 Digestibility**

Digestibility of the experimental feeds will be investigated using the DIFRES digestibility systems in triplicate experimental designs.

### **2.7 Performance: growth and feed conversion**

Controlled growth experiments will be performed, in replicate experimental designs at the DIFRES facilities. The organic recipes will be compared in sequential trials, to measure specific growth rate, feed conversion, condition factor, size distribution and visual condition upon populations of fish. Growth performance with selected feed types is as well investigated in case studies (WP 4).

**2.8 Provision of fish** Animals from the controlled experiments will be analysed in WP 3 for their health and welfare and in WP 5 the flesh quality will be assessed.

### **Deliverables:**

- D2.1 Procedure for production of high protein fraction of selected strains of crop Month 18
- D2.2 New potential strains of crop protein have been characterised for process ability Month 18
- D2.3 Standard organic recipe and new recipes available for feed experiments Month 6
- D2.4 Organic feeds produced Month 8-16-28
- D2.5 Digestibility of organic fish feed recipes Months 8 – 38
- D2.6 Performance of trout fed organic fish feed recipes Months 6 – 38
- D2.7 Delivery of trout samples for WP 3 & WP5 Months 12 – 36
- D2.8. Model has been developed for production process Month 18
- D2.9 Model optimised for evaluation of production procedure for new potential crops. Month 24
- D2.10 Annual reports about WP results and progress
- D2.11 Scientific article produced on modified protein sources, technological and nutritional aspects Month 30.  
Working title of deliverable (“S”): Nutritional and technological aspects of using modified protein sources in organic fish feed .

### **Milestones:**

- M2.1 Initial batch of organic fish feed for initial feed experiment completed
- M2.2 New potential crops selected for analysis
- M2.3 Procedure for high protein fraction and selected crops completed
- M2.4 Proteins have been characterised and processed
- M2.5 Trial batches have been produced for evaluation
- M2.6 Trial batches produced for validation of models
- M2.7 Digestibility experiments completed
- M2.8 Performance experiments completed
- M2.9 Fish provided to other work packages

Partner id.	DFU-HØKa	DFU-HØKb	DFU-FF	BioMar	TI	DAO	SUM
Person- VIP:	4	6					10
Months TAP:		2					<u>2</u>
<b>Total VIP-PM</b>			<b>10</b>				<b>12</b>

**Objectives:**

- To evaluate health and welfare status of rainbow trout during feed experiments
- To follow health and welfare status of rainbow trout during case studies under organic farm conditions (cf. WP 4)

**Description of work:**

The health and welfare status of rainbow trout used in the organic diet experiments will be studied. The health status of the experimental fish populations will be monitored. Moribund and dead fish will be examined for pathogens.

The effect of the different diets will be tested with an experimental challenge with the fish pathogen *Yersinia ruckeri*. A challenge model has been established with juvenile fish and a model will be established with larger fish.

As a pilot experiment samples from the distal intestine of the fish exposed to the different diets will be collected for future histological examination.

Information about disease status, prophylactic and treatment practices will be collected together with the veterinarian in charge of the organic farms (case study).

Physiological methods will be used monitoring the welfare status of the fish. Classical indicators of stress (cortisol, osmolarity, glucose, lactate) will be measured in plasma samples.

**Deliverables:**

D3.1 Health and welfare data of trout fed organic fish feed recipes Month 42

D3.2 Challenge protocols for rainbow trout with *Yersinia ruckeri* Month 42

D3.3 Data on health and welfare of organic rainbow trout in case studies Month 42 (cf. WP 4)

D3.4 Annual reports about WP results and progress

Working title of deliverable (“S/P”): Health and welfare of trout fed organic feed high in plant protein content (combined with WP 4).

**Milestones:**

M3.1 Identification of health and welfare status of rainbow trout used in feed experiments

M3.2 Identification of disease status in organic rainbow trout in case studies

Partner id.	DFU-HØKa	DFU-HØKb	DFU-FF	BioMar	TI	DAO	SUM
Person- VIP:	2					3,5	5,5
Months TAP:							<u>0</u>
<b>Total VIP-PM</b>			<b>5,5</b>				<b>5,5</b>

**Objectives:**

- Comparison of Danish organic fish farming systems (pond lay-out, water flow, shelter, water quality, fish density, production strategy, feed storage etc.)
- Monitoring of health and welfare, sampling for diagnosis/investigations (combined with WP 3)
- Comparison of two feed types: Current organic fish feed (Control) and a new experimental fish feed with high content of plant protein in 2 organic fish farms (2 ponds per feed type).

**Description of work:**

Selected Danish organic fish farms will be described through field studies. Focus will be on aspects that distinct the organic farms from traditional trout farms. The studies will include production strategy and fish welfare as well as marketing strategies.

The health and welfare of the fish populations will be monitored and samples taken for analysis. Information about disease status, prophylactic and treatment practices will be collected together with the veterinarian in charge of the organic farms (combined with WP 3).

Feed experiments will be carried out in 2 selected farms with a control feed compared to a new feed type with high inclusion of vegetable protein.

Due to the currently limited feed supply and practical and economical implications in producing the relatively limited amounts of organic feed (120 t per year), the feed is produced in relatively big batches resulting in long storage time. This implies a risk of degradation of feed ingredients resulting in lowered feed quality. Following the case study will also be focusing this issue.

**Deliverables:**

D4.1 Comparison of Danish organic production systems Month 42

D4.2 Health and welfare in Danish organic fish farms Month 42

D4.3 Comparison of two organic feed types in 2 Danish organic fish farms Month 42

D4.4 Annual reports about WP results and progress

Working title of deliverable (“S/P”): Comparison of Danish Organic Production Systems (combined with WP 3).

**Milestones:**

M4.1 Identification of characteristics in Danish organic production systems

M4.2 Identification of health and welfare in Danish organic fish farms

M4.3 Feed experiments with two organic feed types in 2 Danish organic fish farms completed

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**WP No.: 5 Sensory and biochemical characterisation of quality of organic fish**

Start date: Month 10

Partner id.	DFU-HØKa	DFU-HØKb	DFU-FF	BioMar	TI	DAO	SUM
Person- VIP:			8				8
Months TAP:			5				<u>5</u>
<b>Total VIP-PM</b>			<b>8</b>				<b>13</b>

**Objectives:**

- To analyse organic fish fed with different vegetable feeds by objective sensory and biochemical analysis

**Description of work:**

The work package is divided into three tasks:

1. Sensory analysis
2. Analysis of lipid composition and oxidative stability
3. Data analysis

The effect of four different feeding regimes on sensory characteristics, lipid composition, oxidative stability will be determined. An ice storage experiment will be carried out and samples will be taken three times from day 0 to day 14.

**Sensory analysis**

Fish quality parameters of the 4 different codes stored on ice from 1 to 10 days will be characterised by objective descriptive sensory methods. Samples will be analysed after 1 day and after ten days the objective sensory profiling will be carried out by a trained panel. A series of words for attributes will be developed to describe the sensory characteristics describing appearance, smell, taste and texture. Furthermore the panel will be trained using a scale describing the intensity of the attributes ensuring that all experimental conditions are represented. The biochemical and sensory data will be correlated to understand the effects of feeding regime and environmental factors on the eating quality.

**Analysis of lipid composition and oxidative stability**

The following parameters will be analysed on samples taken three times between 0 and 14 days: Peroxide values, secondary volatile oxidation products (dynamic headspace GC-FID/MS), free fatty acids and tocopherol levels. Finally, the fatty acid composition will be determined after 0 and 14 days of storage.

**Data analysis**

All results from the two tasks will be evaluated separately and multivariate data analysis will be used to find any correlation between data from sensory and lipid analyses. Correlations between lipid and sensory data will be investigated in order to understand how feeding regimes affect lipid composition and oxidative stability, and in turn the eating quality. Furthermore muscle samples for possible proteome analysis in future projects, will be taken and kept at -80°C.

**Deliverables:**

- D5.1 Scientific report on sensory analyses Month 42
- D5.2 Presentation of sensory data on workshop for the industry Month 42

- D5.3 Scientific report on lipid analyses Month 42
- D5.4 Presentation of lipid data on workshop for the industry Month 42
- D5.5 Sensory characterisation of organic trout Month 42
- D5.6 Annual work package report  
Working title of deliverable “S”: Sensory characterisation of organic trout.

**Milestones:**

- M5.1 Development of sensory vocabulary finished
- M5.2 Sensory profiling of samples completed
- M5.3 Data analysis of sensory data completed
- M5.4 Analysis of lipid composition and oxidative stability of samples completed
- M5.5 Data analysis of lipid data completed
- M5.6 Multivariate data analysis of biochemical and sensory data completed

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### A.3 Project resources and budget overview

The project will be managed by an executive group including the contact persons at the participating institutes, with Senior Advisory Scientist Alfred Jokumsen at DIFRES as coordinator. To the group will be affiliated an advisory group, which will be invited to progress meetings. The scientific work plan has been structured into five work packages and major participants in each work package responsible will ensure the progress of the included activities.

Progress meetings will be held every 6-9 months and include presentation and discussion of results and research strategies, as well as detailed project planning.

Continual inter group communication will take place by e-mail, phone, etc. The administrative management will be undertaken by the administration at DIFRES in collaboration with the administrations at the other partners. DIFRES will handle all contact to FØJO.

#### DIFRES-HØK

*The Dept. of Marine Ecology and Aquaculture* Aquaculture Section in Hirtshals conducts applied research and counselling in the aquaculture sector. With a staff of about 10 people, current research projects include environmental impacts of fish farming, general fish and feed physiology, fish welfare and aquaculture management, etc. The group has been profoundly involved in legislating and implementing organic fish farming in Denmark. The department has full scale rearing facilities, including four separate recirculation systems, digestibility tanks, plus analytical laboratory facilities.

*The Dept. of Marine Ecology and Aquaculture* Fish disease Laboratory (FDL), situated in Frederiksberg conducts research in the field of diagnosis and prevention of diseases both in farmed and wild fish and provides advisory services to the government and industry. FDL has a staff of about 8 people, involved in research and diagnostics in the field of fish bacteriology. FDL has access to wide range of facilities for studies of fish pathology, including for (1) the cultivation and identification of bacterial fish pathogens, (2) molecular microbiology, (3) histology, and (4) challenge experiments, as well as access to experimental fish tanks.

#### DIFRES-FF

*The Dept. of Seafood Research* is situated at the Technical University of Denmark in Lyngby, and carries out research and development into handling, storage, preservation and other industrial utilisation of fish, shellfish and fish products. The raw material, process and product (RPP) research area involves 6 research groups (lipid-, protein-, process-, sensory-, water- and analytical methodology group). The RPP group focus on the strategic research areas: Quality and utilisation of resources for food and feed, safety, health and sensory quality and chain management, traceability and documentation systems. The area consists of a Research Coordinator, a Chief Adviser, 5 Senior Scientists, 8 Research Scientists, 7 Ph.D. students and 11 technicians.

#### The Danish Technological Institute (TI)

*The Center for Process Innovation* in Kolding carries out research and development projects in the field of feed and food production related to farmed raw materials. The center has a unique knowledge of basic milling-, conditioning- and extrusion technology used for feed and food production. The center exploits these technologies in new modifications or combinations to achieve frontier products and processes. The department has a staff of app. 6 persons involved in various projects. The department has pilot plant with an extensive range of processing equipment for both test production and small production runs. The center is part of and supported by a larger TI laboratory facility in Kolding.

#### The Danish Aquaculture Organisation (DAO)

The DAO was established in June 22, 2004, by merging the Danish Fish Farming Association and the Danish Sea Farming Association. DAO also includes members of the Danish Eel Producers

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Association, processing plants and fish feed companies. The organisation provides counselling (implementing regulations, production design etc.) for members, and participates in various aquacultures related projects. The sector has an annual turnover of approximately 1 billion DKr. and provides work for more than two thousand employees.

#### BIOMAR A/S

The BioMar group is the third largest supplier of fish feed to the aquaculture industry. The main business areas are feed for salmon, trout and Coho in Chile, Norway and the UK, and for freshwater trout, sea-bass and sea-bream in the rest of Europe.

The BioMar group supplies feed to around 50 countries and for more than 25 different fish species, which in addition to the above include cod, eel, turbot, halibut, sturgeon, etc.

The BioMar group has modern production facilities in Chile, Norway, Scotland, Greece, France and Denmark. The Danish production facilities also include a TechCenter with a pilot feed extruder for experimental purposes. The group has a turnover in excess of 500 million USD and has approx. 500 employees.

BioMar Holding A/S was founded in 1896 and is listed on the Copenhagen Stock Exchange.

BioMar Holding A/S is majority owned by Aktieselskabet Schouw & Co. who owns 68.82% of the shares.

**Table of person months allocated to WP's and partners**

<b>Partner WP</b>	<b>DFU- HØKa</b>	<b>DFU- HØKb</b>	<b>DFU- FF</b>	<b>BioMar</b>	<b>TI</b>	<b>DAO</b>	<b>Total</b>
<b>WP1</b>	8	2	2	*)	1	1	14
<b>WP2</b>	30			*)	32		62
<b>WP3</b>	4	8					12
<b>WP4</b>	2					3,5	5,5
<b>WP5</b>			13				13
	44	10	15	0	33	4,5	<b>106,5</b>

\*) cf. Cooperation Agreement.

**Table for break down of total budget by partners and different cost categories**

<b>Partner</b>	<b>Respon- sible</b>	<b>Salaries</b>		<b>Operational expenses</b>	<b>Subcont.+ Others</b>	<b>Total budget DKK</b>
		<b>Acad.</b>	<b>Tech.</b>			
<b>DFU- HØKa</b>	A. Jokumsen	1.742.520	548.470	204.000	147.055	2.642.045
<b>DFU- HØKb</b>	I. Dalsgaard	471.640	79.820	24.000	52.800	628.260
<b>DFU-FF</b>	H.H. Nielsen	582.075	193.635	336.000	66.000	1.177.710
<b>TI</b>	J. Kold	1.401.960	395.560	72.000	164.000	2.033.520
<b>DAO</b>	V.J. Larsen	265.265		205.200	48.000	518.465
<b>TOTAL</b>		4.463.460	1.217.485	841.200	477.855	<b>7.000.000</b>

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#### **A4. Dissemination of scientific results**

- *Communication of results. Publication strategy, contributions to national or international workshops etc.*

DIFRES will try to initiate a Ph.D. study including the research task dealing with lipid composition and oxidative stability in the newly started project at DIFRES “Healthy, nutritious and tasty fish for the future” If this succeed the task in WP 5 dealing with lipid analyses will be part of this Ph.D study.

Articles will be published in popular magazines but also as peer-reviewed publications in the international scientific literature. However, due to the limited funding it is foreseeable that the aim of one “S” deliverable per WP can only be achieved if further funding and/or synergy with other related projects is obtained. Working titles of expected deliverables (“S/P”) is given in each WP. Furthermore, overall information of project progress and results will be disseminated at meetings/workshops etc. and be available on relevant websites.

#### **A.5. Scientific collaborations**

- *Collaboration with other research institutes*

Grethe Hyldig is the leader of workpackage 2 and workpackage 3 in the SEAPOODplus project 2.2 “Improved Seafood Sensory Quality for the consumer”. The objective of the project is to develop and apply a consumer oriented Seafood Sensory Quality Model, which will enable the seafood industry to improve the eating quality of seafood available to consumers.

The specific objective of workpackage 2 is to develop and establish Seafood Sensory Quality Models that relate consumers’ perceptions of eating quality with sensory characteristics perceived by key quality decision makers at each point in the fish chain, from catch or slaughter, through handling and distribution to final consumption. In workpackage 3 the Seafood Sensory Quality Models will be applied in studies of environmental factors affecting seafood eating quality, including fish species, packaging, transport, processing and others. Main collaborators are: Emíliá Martinsdóttir Icelandic Fisheries Laboratories, Rian Schelvis-Smit Netherlands Institute for Fisheries Research.

DIFRES, Dep. of Seafood Research collaborates in studies on relations between the features of live fish (mainly Rainbow trout and Salmon) and the quality of food produced from them, with special interest on the influence of stressors, feeds, growth rates and heredity.

Main collaborators are: Emøke Bendixen (DJF, Foulum) and Vibeke Barkholt (BioCentrum, DTU).

Strong links between the quality part of the present project and the LIPIDTEXT project under the SEAFOODPlus programme will be established. The LIPIDTEXT project aims at preventing lipid oxidation and texture softening in fish products. Likewise, strong connections to a newly granted EU Marie Curie project on oxidation in surimi and fish paste will be made. Finally, the research will be closely coordinated with an on-going DFFE project on protein and lipid oxidation in frozen rainbow trout. Charlotte Jacobsen is the project leader of these three projects.

- *Co-ordination with other projects*

The project will be coordinated with an ongoing project within the DIFRES Department of Marine Ecology and Aquaculture, entitled “Strategies to improve health and welfare in rainbow trout farming” (Ministry of Food, Agriculture and Fisheries, Directorate for Food, Fisheries and Agri

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Business, Department of Research and Development, project manager Alfred Jokumsen/David McKenzie).

The project will be co-ordinated with five ongoing projects at the Department of Seafood Research on rainbow trout: 1) “Healthy, nutritious and tasty fish for the future” (project coordinator Henrik Hauch Nielsen), 2) “Prediction of technological and sensory quality of trout” (J.nr. FSK03-DFU-11, project coordinator Flemming Jessen) funded by DFFE in the programme “Food technology, safety and quality”, 3) “Protein- og lipidoxidation i frossen fisk” (project coordinator Charlotte Jacobsen) and 4) ”Stressfaktorer i dambrugsfisk” (J.nr. 3310-04-00104, project coordinator Flemming Jessen) funded by DFFE in the programme ”Forskning og fisk”, 5) Akvakultur fiskeproduktion: Fra fiskemel til opdrætsfisk – proteinoxidation som kvalitetsparameter (project coordinator Inger Vibeke Kjærsgård).

As mentioned in WP 5, effort will be made to subsequently to get further funding or establish collaboration with other related projects to carry out proteome analysis. Functional genomics by proteome analysis is one of the most powerful tools to identify and understand the basis for differences in taste and texture. When related to the characterisation by sensory and lipid analyses, an overall picture of product quality can be obtained.

- *Collaboration with private business partners or networks*

The project will involve collaboration with a feed manufacturer (BioMar A/S), the existing Danish organic trout farms (Skravad Mølle Dambrug, Todbøl Dambrug and Åbro Dambrug). Please see the attached cooperation agreements.

#### **A.6 Other issues**

The project involves collaboration with participants committed to comply with Danish standards of organic aquaculture (No. 114 of Feb 23. 2004) and fish feed for organic aquaculture (No. 115 of Feb 23. 2004). This will include certified organic commercial fish farms where experiments and monitoring will be performed, as well as fish feed manufacturer.

Part of the experiments will be performed in controlled laboratory and/or aquaculture facilities without accreditation of organic aquaculture. All research involving fish will be conducted in accordance to *Guidelines for the Use of Animals in Research* published in *Animal Behaviour* 55, 251–257 (1998), taking ethics and fish welfare into account.

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## A.8 Curriculum vitae

### **CURRICULUM VITAE**

**Name: Alfred Jokumsen**

**Position: Biologist, Senior Advisory Scientist, Project Manager**

**Nationality:** Danish

**Date of birth:** 7 March 1951

**Education:**

Master of Science in Biology and Fish Physiology 1979, University of Aarhus.

Supplementary education in chemistry, Odense University, 1981-83.

Supplementary education in fish diseases in aquaculture, University of Bergen, Norway, 1986.

Supplementary education in statistical test design, Technical University of Denmark, 1990.

**Countries of work**

**experience:**

Denmark, Norway, Belgium, Egypt, Ireland, Italy, Philippines, P.R. China, Taiwan, Iran, Thailand, Singapore, Indonesia.

**Key qualifications:**

Extensive experience in biological and technical aspects of aquaculture with specific knowledge on and experience in farming of salmonids in fresh and sea water including breeding of rainbow trout. Extensive knowledge on fish physiology and specifically knowledge on fish nutrition and feed composition for various species as well as knowledge on and experience in fish meal and fish oil production. Specific knowledge on fish disease diagnostics, prevention, and treatment. Extensive experience in fish farming in recirculation systems including management experience from P.R.China and Indonesia and experience with environmental aspects of aquaculture. Teaching experience in aquaculture including physiological and nutritional aspects in fish farming.

**Memberships of professional societies and appointments:**

2002 – : **Norway:** Referee for evaluation of project proposals to the Research Council of Norway.

2000 - 2004: **Europe:** National Representative of Denmark in the European Aquaculture Society (EAS). Elected by the danish members of EAS.

1997 - 1998: **Denmark.** Member of the Board of directors of the Danish Institute for Fisheries Technology and Aquaculture (DIFTA). Elected as a representative for the staff members of DIFTA.

1997: **The EEC.** Appointed member of expert panel to evaluate proposals for research and technological development projects within the framework of the Agriculture and Fisheries/Aquaculture programme managed by the Commission of the European Communities DG XIV Research Unit.

1996-: **Denmark.** Member of the Environmental Appeal Board. Appointed by the Danish Ministry of Environment as expert on farming of Rainbow Trout.

1985-: **Denmark.** Officially appointed external examiner at the University of Odense, Denmark.

**Employment record:**

1999 – present: Senior Advisory Scientist, Dept. of Marine Ecology and Aquaculture, Danish Institute for Fisheries Research (DIFRES).

1994-99: Project manager, Aquaculture Department, Danish Institute for Fisheries Technology and Aquaculture. (DIFTA).

1989-94: Head of Aquaculture Department, Association of Danish Fish Meal and Fish Oil Manufacturers.

1983-89: Researcher (Acting Head of Freshwater Department 1987-89). Danish Institute for Fisheries and Marine Research.

1980-83: Research assistant, Dep. of Ecophysiology, University of Odense.

1979-80: Research assistant. Dep. of Animal Physiology, University of Bergen, Norway.

1979 : High school teacher, Toender Statsskole.

**Selected publications:**

Xie, S. & Jokumsen, A. (1997): "Incorporation of Potato Protein Concentrate in Diets for Rainbow Trout: Effect on Feed Intake, Growth and Feed Utilization", *Aquaculture Nutrition* 1997, 3, p. 223-226.

Jensen, C., Birk, E., Jokumsen, A., Skibsted, L.H., Bertelsen, G. (1998): "Effect of dietary levels of fat,  $\alpha$ -tocopherol and astaxanthin on colour and lipid oxidation during storage of frozen rainbow trout (*Oncorhynchus mykiss*) and during chill storage of smoked trout", *Zeitschrift Lebensmittel Untersuchung Forschung A* (1998), 207, p. 189-196.

Xie, S. & Jokumsen, A. (1998): "Effects of dietary incorporation of potato protein concentrate and supplementation of methionine on growth and feed utilization of rainbow trout", *Aquaculture Nutrition* 1998, 4, p. 183-186.

Henryon, M., Jokumsen, A., Berg, P., Lund, I., Bovbjerg Pedersen, P., Olesen, N.J. and Schlierendrecht, W.J. (2002): Genetic variation for growth rate, feed conversion efficiency, and disease resistance exists within farmed population of rainbow trout. *Aquaculture*, Vol. 209, no. 1-4, 59-76.

Henryon, M., Jokumsen, A., Berg, P., Lund, I., Bovbjerg Pedersen, P., Olesen, N.J. and Schlierendrecht, W.J. (2003): Erratum to "Genetic variation for growth rate, feed conversion efficiency, and disease resistance exists within farmed population of rainbow trout. *Aquaculture*, Vol. 209, no. 1-4, 59-76." *Aquaculture*, Vol. 216, 389-390.

Jokumsen, A. (2005): La production aquacole durable au Danemark. *Aquafilia*, no.7, pp. 5-8 (Translated into French

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by Armand Lautraite).

- Henryon, M., Berg, P., Olesen, N.J., Kjær, T.E., Slierendrecht, V., Jokumsen, A. and Lund, I (2005).. Selective breeding provides an approach to increase resistance of rainbow trout (*Oncorhynchus mykiss*) to the diseases, enteric redmouth disease, rainbow trout fry syndrome, and viral haemorrhagic septicaemia. *Aquaculture*, Volume 250, Issues 3-4, pp.621-636.
- McKenzie, D.J.; Pedersen, P. Bovbjerg and Jokumsen, A.(2006): Physiological correlates of diversity in size-at-age and condition factor in rainbow trout (*Oncorhynchus mykiss*) families. *Aquaculture* (in press).
- Jokumsen, A., Lund, I., Henryon, M., Berg, P., Nielsen, T., Madsen, S.B., Jensen, T.F. og Faber, P. (2006): Avlsprogram for regnbueørred i Danmark. DFU-rapport nr. 162-06 + 162a (Bilag).
- Jokumsen, A. (2006): Gennembrud for økologiske fisk. *Økologisk Jordbrug*, 1. september 2006.
- Jokumsen, A. (red.), Larsen, V.J., Dalsgaard, I., Nielsen, H.H., Jessen, P. and Kold, J. (2006): Vidensyntese om økologisk fiskeopdræt.
- Jokumsen, A., Nielsen, T., Madsen, S.B., Henryon, M. og Berg, P.(2006): Perspektiver for avlsarbejde i Danmark. *Dansk Akvakultur*, september 2006 og *Ferskvandsfiskeribladet*, 4, Okt./Nov. 2006; 14-16.

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## **CURRICULUM VITAE**

**Name: Peter Bell Jessen**

**Position: Eurosupport Manager**

**Nationality:** Danish

**Date of birth:** January 17<sup>th</sup> 1958

### **Position:**

EuroSupport Manager

BioMar A/S

M. Erichsensvej 35, 7330 Brande

Ph. + 45 9718 0722 Fax. + 45 9718 3012

Email: [pbj@biomar.dk](mailto:pbj@biomar.dk)

### **Training:**

1983            *Diploma of agricultural management* (Nordic Agricultural Academy, Odense, Denmark)

### **Positions held:**

1983 – 1987    Sales consultant, Den Lokale Andel, Brædstrup

1987 – 1992    Sales consultant, BioMar A/S, Brande

1992 – 1999    Sales manager, BioMar A/S, Brande

1999 –           EuroSupport Manager, BioMar A/S, Brande

### **Professional experiences**

An initial background in agriculture has via various jobs functions developed into more technical oriented functions. Peter B. Jessen (PBJ) is today responsible for product strategy of BioMar A/S and for technical support for BioMar A/S staff and for costumers in a major part of Europe.

PBJ has represented BioMar A/S, the fish feed industry and / or the aquaculture industry in various groups and task forces. He has consequently a comprehensive knowledge of aquaculture industry in Denmark as well as abroad.

BioMar A/S is the only feed company, which has activities within feed for fish produced according to the Danish legislation for organic production. PBJ is responsible for the activities of BioMar A/S within this area.

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## **CURRICULUM VITAE**

**Name:** Kold, John J.H.  
**Born:** 1949, 2. december

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### Education

1968-1974: M.Sc. (chemistry), The Technical University of Denmark (DTH)  
1990: B.Com. (Organisation)

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### Employment, Experience

2004- The Danish Technological Institute. Head of Centre, Product Innovation. In charge of the Hygienic Design Group and the Pilot Plant at Sdr. Stenderup. Responsibilities: Preparation of budgets, establishing the department's strategies and goals, project planning and co-ordination, marketing, personnel administration.

2001-2004 Biotechnological Institute, Kolding. Head of Dept., Product Innovation. In charge of the Hygienic Design Group and the Pilot Plant at Sdr. Stenderup. Responsibilities: Preparation of budgets, establishing the department's strategies and goals, project planning and co-ordination, marketing, personnel administration.

2000-2001: Skjern Tekniske Skole (Techn. School, Skjern). Instructor HTX and EUD sections: Chemistry, biology, physics, mathematics, natural science and holding of courses on quality awareness.

1995-1999: Løven Petfood A/S, Vrå. Head of Product Development and Quality Management. Quality control in compliance with HACCP routines for producing wet feed (in aluminium foil cups and cans) for cats and dogs. Several development assignments in establishing production and quality assurance procedures.

1992-1995: Tulip International A/S. Project-oriented tasks within product extension/transference, new products, process development involving co-ordination between production, development and technical departments.

1990-1992: Tulip International A/S, Brabrand. Operation Manager.

1988-1990: Royal Dane - Quality A/S, Holstebro. Head of Product Development and Quality Control.

1987-1988: Plumrose Venezuela. Manager, Development of Meat Processing.

1981-1987: Plumrose's company in Elkhart, USA and VIGO in Ebeltoft. Responsible for quality control and product development.

1979-1981: Grindsted Produkt A/S, Vitamin B-1 factory. Production of a complex series of organic-chemical reactions, distillation and purification stages. Responsible for production out-put, personnel management, safety and budget control of a department consisting of 35 hourly-paid and 4 monthly-paid employees.

### Supplementary Courses

2003 EHEDG 2 days symposia between certification authorised institutions for Cleanability test and evaluation of equipment for hygienic design. Held at Technische Universität München.

2001 European Hygienic Equipment Design Group: "Post-Congress Training Course on Hygienic Engineering held at the Instituto Tecnológico Agroalimentario - AINIA, Paterna, Valencia, Spain" (1-day course).

2001 European Hygienic Equipment Design Group: "Food in Europe: Building in Safety Congress held at the Meeting and Congress Centre of the Technologic Park of Paterna, Valencia, Spain" (2-day congress).

1993 Veterinærdirektoratet (Veterinary Services): Hygiene and Microbiology. Contents of Course: Microbiology, personal hygiene, cleaning and disinfection, legislation/regulations and motivation.

1983 American Meat Institute, Center for Continuing Education: "Quality Assurance Short Course" (1-day course).

1982 American Meat Institute, Center for Continuing Education: "Cured Meats Short Course" (1-day course).

1981 Purdue University, West Lafayette, Indiana: "Better Process Control (FDA prescribed areas: Acidified Foods, Hydrostatic Retorts, Discontinuous Agitating Retorts, Metal Container Closures, Still Retorts, Steam & Water, Continuous Agitating Retorts, Aseptic Processing, Glass Container Closures)" (4-day course).

### Publications

2003 Article in International Biodeterioration & Biodegradation 52, 175-185: "Influence of surface roughness of stainless steel on microbial adhesion and corrosion resistance" (co-authors: Lisbeth R. Hilbert, Dorthe Bagge-Ravn, Lone Gram)

2002 Article in Plus Proces: "Hvad er virksomhedernes omkostninger ved manglende hygiejnisk design?" (Danish translation of title: What a lack of hygienic design can cost a company). (In-press)

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## CURRICULUM VITAE

### Inger Dalsgaard

Designation: Senior scientist, D.V.M., Ph.D.

Address: Danish Institute for Fisheries Research, Fish Disease Laboratory, Royal Veterinary and Agricultural University, Stigbøjlen 4, DK-1870 Frederiksberg C, Denmark.

Tlf.: +45 35282712; Fax.: +45 35282711; E-mail: id@dfu.min.dk

**Education:** Degree of Veterinary Medicine (DVM.), Royal Veterinary and Agricultural University (RVAU), 1973.

**Postgraduate education:** 12th term's course in Microbiology for Veterinarians, RVAU, 1973.

Ph.D. thesis: Bacteriological studies of the natural flora of cattle- and pig slurry. RVAU, 1982.

**Positions held:** Associate professor at Institute of Hygiene and Microbiology, Royal Veterinary and Agricultural University (RVAU), Aug. 73 - Aug. 76.

Ph.D. student in Veterinary Microbiology (RVAU), Sept. 76 - March 79.

Scientist at RVAU, research project on relationship of marine *Vibrio* species to pollution components, particularly carbohydrate pollution in marine biotopes, March 79 - May 81.

Scientist at Danish Institute for Fisheries Research (DIFRES) (Fish Disease Laboratory), June 81 - 94.

Senior scientist at DIFRES, Febr. 1994 -.

Affiliated Professor at the Royal Veterinary and Agricultural University, May 2003.

**Scientific focus and professional experiences:** *Scientific focus:* Fish diseases in aquaculture and in wild populations. Bacterial fish pathogens: isolation, pheno- and genotypic characterization, antibiotic sensitivity testing, epidemiology, virulence factors, pathogenicity studies with focus on *Flavobacterium psychrophilum*, atypical *Aeromonas salmonicida* and *Vibrio vulnificus*. Prevention of fish diseases.

*Professional experiences:*

Member of the Danish Agricultural and Veterinary Research Council, 1997 – 2003.

Member of Advisory Council for Fishery, Aquaculture, Innovation and Research, Directorate for Food, Fisheries and AgriBusiness, 2001-.

Member of the external examiner corps in veterinary science at RVAU, 1998 -.

Referee for the Research Council of Norway (fish diseases), 2000 -

Member of the Research Council of Norway: Large scale programmes: Havbruk, 2004 -

Ad hoc referee for the journals: Dis. Aqua. Org., Appl. Environm. Microbiol., J. Fish Dis., Aquaculture, Veterinary Research, Microbiol. Research, Bull.Eur.Ass.Fish.Path., J. Microbiol., FEMS Microbiol. Lett..

**Postgraduate education activities:** Acted as supervisor for special projects and final year project students, and performed supervision (co-supervisor) of 4 Ph.D. students at RVAU. Used as external examiner (censor) both at RVAU and at universities in other countries, including assessment of Ph.D. degrees.

### Selected publications:

1) Wiklund, T., L. Madsen, M.S. Bruun & I. Dalsgaard, 2000: Detection of *Flavobacterium psychrophilum* from fish tissue and water samples by PCR amplification. J. Appl. Microbiol., 87, 299-307.

2) Dalsgaard, I. & L. Madsen, 2000: Bacterial pathogens in rainbow trout *Oncorhynchus mykiss* reared at Danish freshwater farms. J. Fish Dis., 23, 199-209.

3) Madsen, L. & I. Dalsgaard, 2000: Comparative studies of Danish *Flavobacterium psychrophilum* strains concerning ribotypes, plasmid profiles, serotypes and virulence. J. Fish Dis., 23, 211-218.

4) Dalsgaard, I., 2001: Selection of media for antimicrobial sensitivity determination of fish pathogenic bacteria. Aquaculture, 196, 267-275.

5) Madetoja, J., I. Dalsgaard & T. Wiklund, 2002: Occurrence of *Flavobacterium psychrophilum* in fish farming environments. Dis. Aquat. Org., 52, 109-118.

6) Madsen L., J.D. Møller & I. Dalsgaard, 2005: *Flavobacterium psychrophilum* in rainbow trout *Oncorhynchus mykiss* (Walbaum) hatcheries: studies on broodstock, eggs, fry and environment. J. Fish Dis., 28, 39-47.

**Publications in total:** 68 peer reviewed; 2 submitted; 34 non peer reviewed; 28 reports; 59 abstracts;  
1 Ph.D. thesis.

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## CURRICULUM VITAE

### Lone Madsen

Designation: Research scientist, DVM, PhD

Nationality: Danish

Address: Danish Institute for Fisheries Research, Fish Disease Laboratory, Stigbøjlen 4, DK-1870 Frederiksberg C, Denmark

Phone +45 35 28 27 63; fax: +45 35 28 27 11; e-mail: lm@dfu.min.dk

#### Education:

1993: Degree in veterinary medicine (DVM), the Royal Veterinary and Agricultural University (RVAU), Copenhagen, Denmark

#### Postgraduate education:

2001: PhD degree in fish diseases (thesis title: *Flavobacterium psychrophilum* pheno- and genotypic characterization, experimental infection methods, and role in spinal deformities)

#### Positions held:

1993-1994: Veterinarian at the Danish Food Laboratory in Haderslev, Denmark (Levneds-middelkontrollen i Sønderjylland I/S)

1994-1995: Research assistant on the project "Continued investigations of Rainbow Trout Fry Syndrome (RTFS) in rainbow trout", part B, "Investigations concerning the causes of deformities in fish" at Fish Disease Laboratory, Danish Institute for Fisheries Research (DIFRES)

1995-1999: PhD student at Fish Disease Laboratory, DIFRES

1999-2001: Research assistant at Fish Disease Laboratory, DIFRES

2001-present: Research scientist at Fish Disease Laboratory, DIFRES

#### PhD thesis:

Madsen L (2000). *Flavobacterium psychrophilum* pheno- and genotypic characterization, experimental infection methods, and role in spinal deformities. Fish Disease Laboratory, Danish Institute for Fisheries Research & Laboratory of Fish Diseases, Department of Veterinary Microbiology, The Royal Veterinary and Agricultural University, Frederiksberg, Denmark.

#### Publications in international journals:

Madsen L & Dalsgaard I (1998). Characterization of *Flavobacterium psychrophilum*; comparison of proteolytic activity and virulence of strains isolated from rainbow trout (*Oncorhynchus mykiss*). In *Methodology in Fish Diseases Research* (eds. A.C. Barnes, G.A. Davidson, M.P. Hiney & D. McIntosh). Fisheries Research Services, Aberdeen, Scotland. pp. 45-52

Madsen L & Dalsgaard I (1999). Vertebral column deformities in farmed rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* **171**, 41-48

Madsen L & Dalsgaard I (1999). Reproducible methods for experimental infection with *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*). *Diseases of Aquatic Organisms* **36**, 169-176

Wiklund T, Madsen L, Bruun MS & Dalsgaard I (2000). Detection of *Flavobacterium psychrophilum* from fish tissue and water samples by PCR amplification. *Journal of Applied Microbiology* **88**, 299-307

Bruun MS, Schmidt AS, Madsen L & Dalsgaard I (2000). Antimicrobial resistance patterns in Danish isolates of *Flavobacterium psychrophilum*. *Aquaculture* **187**, 201-212

Dalsgaard I & Madsen L (2000). Bacterial pathogens in rainbow trout, *Oncorhynchus mykiss* (Walbaum), reared at Danish freshwater farms. *Journal of Fish Diseases* **23**, 199-209

Madsen L & Dalsgaard I. (2000). Comparative studies of Danish *Flavobacterium psychrophilum* isolates: ribotypes, plasmid profiles, serotypes and virulence. *Journal of Fish Diseases* **23**, 211-218

Madsen L, Arnbjerg J & Dalsgaard I (2000). Spinal deformities in triploid all-female rainbow trout (*Oncorhynchus mykiss*). *Bulletin of the European Association of Fish Pathologists* **20**, 206-208

Madsen L, Arnbjerg J & Dalsgaard I (2001). Radiological examination of the spinal column in farmed rainbow trout *Oncorhynchus mykiss* (Walbaum): experiments with *Flavobacterium psychrophilum* and oxytetracycline. *Aquaculture Research* **32**, 235-242

Bruun MS, Madsen L & Dalsgaard I (2003). Efficiency of oxytetracycline treatment in rainbow trout experimentally infected with *Flavobacterium psychrophilum* strains having different in vitro antibiotic susceptibilities. *Aquaculture* **215**, 11-20

Møller JD, Larsen JL, Madsen L & Dalsgaard I (2003). Involvement of a sialic acid-binding lectin with hemagglutination and hydrophobicity of *Flavobacterium psychrophilum*. *Applied and Environmental Microbiology* **69**, 5275-5280

Madsen L, Møller JD & Dalsgaard (2004). *Flavobacterium psychrophilum* in rainbow trout *Oncorhynchus mykiss* (Walbaum) hatcheries: studies on broodstock, eggs, fry and environment. *Journal of Fish Diseases* (submitted)

Publications and reports on Danish:

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## CURRICULUM VITAE

Henrik Hauch Nielsen

### Educational degree:

1982: Laboratory assistant from Laborantskolen i Hovedstadsområdet, Krimsvej 29 - 2300 København S  
1990 Master in Food Science, The Royal and Veterinary University, Frederiksberg  
June 1996 Ph.D. Technical University of Denmark, Department of Biotechnology and Danish Institute for Fisheries Research

### Employments:

April 03 - Senior research scientist, Danish Institute for Fisheries Research, Dept. of Seafood Research  
Oct 96 – March 03 Research scientist, Danish Institute for Fisheries Research, Dept. of seafood Research  
Oct 93 – Oct 96 Project research scientist, Danish Institute for Fisheries Research, Dept. of Seafood Research  
April 91 – Oct 93 Ph.D. student, The Centre for Food Research, Technical University of Denmark  
March 90 - April 91 Research assistant The Marine Biotechnology Centre, Technological Laboratory, Danish Ministry of Fisheries (now Danish Institute for Fisheries Research, Dept. of Seafood Research)

### Research areas/competencies:

- Post mortem proteolysis in fish muscle tissue
- Purification and characterisation of proteolytic enzymes
- Analysis of small peptides and free amino acids
- Utilisation of marine by-products for health food

### Project management/coordination (recent projects):

- Healthy, nutritious and tasty fish for the future (2006 -) 4 year Interdisciplinary national research project funded by Directorate for Food Fisheries and Agri Business.
- Improved quality of herring for humans. (2003 -) 3 year Nordic collaboration project funded by Nordic Industry Fund Participants: Danish Institute for Fisheries Research, IceTec (Iceland), Chalmers University (Sweden), Institute for Marine Research (Norway)
- Herring – A living resource – A good product (2001-2004). Interdisciplinary research project funded by Directorate for Food Fisheries and Agri Business
- Optimising monitoring processes in the food industry using multi-block and multi-way methods (2001 -) Collaboration project funded by Directorate for Food Fisheries and Agri Business. Participants: Danish Institute for Fisheries Research, The Royal and Veterinary University, Arla Foods and Lykkeberg A/S
- Pelagic fish – New possibilities (1998-2001) Nordic network project funded by Nordic Industry Fund
- Influence of peptides and free amino acids on the quality of salted fish products (1997 – 1999). Research project funded by Directorate for Food Fisheries and Agri Business
- Collection and analysis of research results and industrial experience on salting and ripening of herring within the Nordic countries” (CARRIE), (1996 – 1999) Nordic collaboration project funded by Nordic Council of Ministers.

### Other academic activities:

Referee: J. Sci. Food Agric., Comp Biochem. Physiol., Eur. Food Res. Tech., J. Aquatic Pro., Lebensm.-Wiss. U. Technol, The Research Council of Norway.

### Courses in project management:

2002: Project leader course module 1, PWC Consulting; The Danish Directorate for Food, Fisheries and Agri Business.  
2002: Project leader course module 2, PWC Consulting; The Danish Directorate for Food, Fisheries and Agri Business.  
2004: Management of research groups and research programmes Module 1, 2 and 3. PRODEVO aps, Team/training, The Danish Directorate for Food, Fisheries and Agri Business.  
2004: Personal leadership, Tindborg Sparring/LMI Leadership Management International.

### Publications

18 peer-viewed publications in international journals, 1 book chapter, 15 conference proceedings, Nordic and national publications and reports, 23 oral and poster contributions to national and international conferences.

### Selected publications

Nielsen L.B. and Nielsen, H.H.: (2001) Purification and Characterization of Cathepsin D from Herring (*Clupea harengus*). *Comp. Biochem. Physiol. B*, 128, 351-363.  
Engvang K. and Nielsen, H.H.: Proteolysis in fresh and cold-smoked salmon during cold storage at 0°C. (2001) *J.f Food Biochem.* 25, 379-95.  
Bro, R., Nielsen, H.H., Stefansson, G., Skåra, T. (2002) A Phenomenological Study of Ripening of Salted Herring. Assessing homogeneity of data from different countries and laboratories. *Journal of Chemometrics*, 16, 81-88.  
Svensson, V.T.; Nielsen H.H.; Bro R. (2004) Determination of the protein content in brine from salted herring using near-infrared spectroscopy. *Lebensm.-Wiss. U. Technol.* 37. 803-809.  
Birkeland S., Sivertsvik M., Nielsen H.H. and Skåra T. (2005) Effects of brining conditions on weight gain in herring (*Clupea harengus*) filets. *J. Food Sci.* Vol. 70 nr. 7, E418-E424.  
Godiksen H. and Nielsen H.H. (2006) New method to discriminate between cathepsin B and cathepsin L in crude extracts from fish muscle based on a simple acidification procedure. *International Journal of Food Science and Technology*.

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## CURRICULUM VITAE

### Grethe Hyldig

Senior Research Scientist

Department of Seafood Research

Danish Institute for Fisheries Research (DIFRES)

**Date of birth:** 160359

**Citizenship:** Danish

Training:

1985 Cand. lact. The Royal Veterinary and Agricultural University.

1993 Ph.D. Rheological studies of protein gels. The Royal Veterinary and Agricultural University.

Positions held:

1985 – 1990 Research Scientist at The Danish Government Research Institute for Dairy Industry, Hillerød.

1990 – 1992 Research Assistant at the Dairy- and Food Institute at The Royal Veterinary and Agricultural University (KVL).

1992 – 1994 Amanuensis in Dairy technology at the Dairy- and Food Institute at KVL.

1994 – 1996 Research Scientist at the Institute for Dairy Research at KVL.

1996 - Senior Research Scientist at the Danish Institute for Fisheries Research (DIFRES), Department of Seafood Research, Denmark. Responsible senior scientist for sensory analysis carried out at DIFRES.

Scientific focus and professional experiences:

#### *Scientific focus*

Sensory and texture of fish and fish products. Extensive experienced within the area of sensory quality of fish and fish products. Research in Quality Index Method (QIM) developing schemes for different fish species and fish products.

#### *Project management/coordination*

QIM Eurofish (2001-2006).

SEAFOODplus Project 2.2; Improved Seafood Sensory Quality for the Consumers (2004-2008).

Quality assurance and optimal utilisation of descriptive sensory data (2005-2009).

Sensory research for fish (On going).

#### *Other academic activities*

Member of the Nordic Committee on Food Analysis (NMKL). Member of Danish Society for Food Science and Technology. Member of the Sensory Committee at Nordic Association of Agricultural Scientists (NJF; Sektion VI: Food Science and Nutrition).

#### *Teaching*

Academic courses and lectures in dairy technology, basic and advanced sensory and texture at The Royal Veterinary and Agricultural University and Technical University of Denmark. International courses in QIM at Research Institutes. Training and supervision of BSc, MSc. and Ph.D. students.

#### **Selected publications:**

Martinsdóttir, E. Sveinsdóttir, K., Luten, J. Schelvis-Smit R., and Hyldig, G. 2001. Sensory evaluation of fish freshness. A reference manual for the fish industry. Available in 11 languages from [www.qim-eurofish.com](http://www.qim-eurofish.com)

Nielsen, J., Hyldig, G. and Larsen, E. (2001): 'Eating quality of fish - a review' *Journal of Aquatic Food Product Technology*, Vol.11 (3/4) 2002, pp 125-141.

Larsen, E., Hyldig, G., Dalgaard, P., Bech, A. C., and Østerberg, C. (2003): "Consumers and experts responses to fresh cod fillets." In Luten, J. B., Oehlenschläger, J., and Ólafsdóttir, G. (eds.) "Quality of fish from catch to consumer: labelling, monitoring and traceability." Pp. 345-360. Wageningen Academic Publ., Wageningen, The Netherlands.

Nielsen D, Hyldig G, Nielsen HH and Nielsen J. 2004. Sensory Properties of Marinated Herring (*Clupea harengus*) – Influence of Fishing Ground and Season. *Journal of Aquatic Food Product Technology*, Vol. 13 pp3-24.

Hyldig G and Green-Petersen DMB. 2005. Quality index Method – An objective Tool for Determination of Sensory Quality. *Journal of Aquatic Food Product Technology*, Vol. 13 (4), 71-80.

Green-Petersen, D.M.B., Nielsen, J. and Hyldig, G. (2006). Sensory Profiling of the Most Common Salmon Products on the Danish Market. *Journal of Sensory Studies*. Vol. 21, pp 415-427.

Vogel, B.F., Ng, Y.Y., Hyldig, G., Mohr, M. and Gram, L. (2006). Potassium lactate combined with sodium diacetate can inhibit growth of *Listeria monocytogenes* in vacuum-packed cold-smoked salmon and has no adverse sensory effects. *Journal of Food Protection*, **69**, 2134-2142

Sveinsdóttir, K., Martinsdóttir, E., Green-Petersen, D., Hyldig, G., Schelvis, R. And Delahunty, C. (2006). Sensory characteristics of different cod products and consumer preferences. *Food Quality and Preference*; *submitted*

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## **CURRICULUM VITAE**

### **Charlotte Munch Jacobsen**

Senior Research Scientist  
Department of Seafood Research  
Danish Institute for Fisheries Research (DFU)  
Building 221, DTU  
DK-2800 Kgs. Lyngby

**Date of birth:** October 21, 1965

#### **Educational degrees:**

1990 Technical University of Denmark, Department of Biotechnology  
M.Sc. Chemical Engineering  
July 1999 Technical University of Denmark, Department of Biotechnology and  
Danish Institute for Fisheries Research, Department of Seafood Research  
Ph.D.

#### **Employments:**

Mar 03- Senior Research Scientist, Department of Seafood Research, DIFRES  
July 99-Feb 03 Project Research Scientist, Department of Seafood Research, DIFRES  
Nov 96-June 99 Ph.D. student, Department of Seafood Research, DIFRES/Department of Biotechnology, DTU  
June 92-Oct 96 Research assistant, Department of Seafood Research, DIFRES  
Feb 91-April 92 Scientific Officer, Food Biotechnology Centre, SISIR, Singapore  
March-Dec 1990 Assistant Factory Manager, Padriew Egg Products Co., Thailand

#### **Research areas/competencies:**

- Application of fish oil and specific structured interesterified lipids in foods
- Lipid oxidation in 1) complex food emulsions and 2) fish including interactions with proteins
- Physical stability and rheological properties in emulsions

#### **Project management/coordination (recent projects)**

- Nutritious and tasty n-3 PUFA rich food products for a slim and healthy population (2006-2010)
- Fish oil enriched foods: Stability – nutrition – consumer acceptance (2005-2008)
- Structured lipids for fish feed (2004)
- LipidText a project under the SEAFOODplus EU FP6 programme (2004-2008)
- Protein and lipid oxidation in frozen fish (2002-2006)
- Protection towards oxidation in fish oil enriched foods (2001-2006)
- Sub-project manager STVF framework programme: Fats: Technology -Quality - Nutrition (LipoTech) (1999-2007).

#### **Other academic activities:**

- Referee: *J. Agric. Food Chem.*, *Food Chem.*, *Eur. Food Sci.Technol.*, *J. Sci. Food Agric.*, *Nahrung*, *JAOCS*, *CBP*.
- Officially appointed examiner at the Royal Veterinary and Agricultural University
- Vice president European Section of American Oil Chemists Society
- Secretary/treasurer for the Lipid Oxidation board under The American Oil Chemists Society

#### **Awards and Grants:**

- Ph.D. student conference grant (1998) and Marcuse Lecturer grant, (1999) both at Nordic Lipidforum
- Outstanding paper presentation award (The American Oil Chemist Society), 1999
- Danisco Award 2003 (250.000 DKK)

#### **Publications**

56 peer-viewed publications in international journals and books, 10 conference proceedings, national publications and reports

More than 80 oral and poster contributions to national and international conferences.

#### **Three recent publications**

Jensen, K.N., Jacobsen, C., Nielsen, H.H. (2006). Fatty acid composition of herring (*Clupea harengus*) – Influence of time and place of catch on n-3 PUFA content. *J Sci Food Agric (in press)*

Let, M.B., Jacobsen, C., Sørensen, A.D.S., Meyer, A.S. Homogenization conditions affects the oxidative stability of fish oil enriched milk emulsions: Lipid oxidation. *J. Agric. Food Chem (in press)*

Nielsen, N.S., Götttsche, J.R., Holm, J., Xu, X., Mu, H. and Jacobsen, C. (2005) Effect of structured lipids based on fish oil on the growth and fatty acid composition in Rainbow Trout (*Oncorhynchus mykiss*). *Aquaculture*. 250 (1-2), 411-423

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## CURRICULUM VITAE

**Name:** Flemming Jessen

**Date of birth:** 09.12.54

**Citizenship:** Danish

**Training:**

Ph.D. 1988. Membrane Physiology, University of Copenhagen, Denmark

MSc. 1984. Biology, University of Copenhagen, Denmark

**Positions held:**

1997- Associate professor at Technical University of Denmark  
1991 - Senior scientist at Danish Institute for Fisheries Research (DIFRES),  
Department of Seafood Research, Denmark  
1985-1991 Scientist at the August Krogh Institute, University of Copenhagen, Denmark

**Scientific focus and professional experiences**

*Scientific focus:*

The influence of composition and condition of the live fish on technological and sensory quality of the product. Proteome analysis of fish muscle in relation to quality (sensory properties) and authenticity. Cellular membrane proteins. Rigor mortis and thaw rigor. Protein changes in fish and fish products during iced and frozen storage. Post mortem biochemistry of fish muscle tissue. Special experience in two-dimensional gel electrophoresis, image analysis and multivariate data handling for proteome analysis.

*Recent research projects:*

Project co-ordinator in national (Direktoratet for FødevarerErhverv) financed scientific project: Prediction of technological and sensory quality of trout (2003-2007)

Participant in EU-financed (Sixth Framework Programme) integrated project: SEAFOODplus (2003-2008)

Associate partner in Norwegian (Research Council of Norway) project: Atlantic salmon, knowledge basis for increased pre-rigor processing (2003-2008)

Participant in national (Direktoratet for FødevarerErhverv) financed scientific project: Protein and lipid oxidation in frozen fish (2002-2005)

Project co-ordinator in national (Direktoratet for FødevarerErhverv) financed scientific project: Growth rate and quality of aquaculture fish (2001-2005)

Project participant in national (Danish Agricultural and Veterinary Research Council) financed scientific project: Calcium, pH and cellular water balance in determination of fish meat quality (2001-2004)

Participant in national (Danish Agricultural and Veterinary Research Council) financed network: FISHNET (2001-2004)

Project leader (DIFRES) in national (Direktoratet for FødevarerErhverv) financed scientific project: Proteome analysis of muscle tissues (1999-2003)

Project leader (Danish) in EU-financed scientific project: Advanced methods for identification and quality monitoring of (heat) processed fish (1996-2000)

Project co-ordinator in national (Direktoratet for FødevarerErhverv) scientific project: Thaw rigor (1995-2000)

Danish participant in EU concerted action: New Frozen Food Technology (1996-1999)

*Professional experiences:*

Editorial board member in Journal of the Science of Food and Agriculture. Referee for: J Sci Food Agric; J Food Sci; Food Res Int; Int J Food Res and Tech; Proteomics; Trends Food Sci & Tech. External Examiner at University of Copenhagen and University of Aarhus. Giving academic courses and lectures in fish muscle biochemistry at the Technical University of Denmark. Supervisor of bachelor, MSc. and Ph.D. students.

**Five selected publications:**

Kjærsgård, I.V.H. and Jessen, F. (2004) Two-dimensional gel electrophoresis detection of protein oxidation in fresh and tainted Rainbow Trout muscle *J. Agric. Food Chem.*, 52, 7101-7107

Godiksen, H. and Jessen, F. (2003) Sarcoplasmic reticulum Ca<sup>2+</sup>-ATPase and cytochrome oxidase as indicators of frozen storage in cod (*Gadus morhua*). *J. Food Sci.* 68(8), 2579-2585

Kjærsgård, I.V.H. and Jessen, F. (2003) Proteome Analysis Elucidating *Post mortem* Changes in Cod (*Gadus morhua*) Muscle Proteins. *J. Agric. Food Chem.* 51, 3985-3991

Godiksen, H. and Jessen, F. (2002). Temperature and Ca<sup>2+</sup> dependence of the sarcoplasmic reticulum Ca<sup>2+</sup>-ATPase in haddock, salmon, rainbow trout and zebra cichlid. *Comp. Biochem. Physiol. B*, 133, 35-44

Jessen, F., Lametsch, R., Bendixen, E., Kjærsgård, I.V.H. and Jørgensen, B.M. (2002). Extraction information from two-dimensional electrophoresis gels by partial least squares regression. *Proteomics* 2(1), 32-35

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## **CURRICULUM VITAE**

**Name: Villy J. Larsen**

**Date of birth:** 05.05 - 1965

**Citizenship:** Danish

### **Position:**

Account Manager

Danish Aquaculture Organisation

Vejlsøvej 51, DK-8600 Silkeborg

Ph. + 45 89 21 22 60 Fax. + 45 89 21 22 61

Email: [villy@danskakvakultur.dk](mailto:villy@danskakvakultur.dk)

### **Training:**

1993 *Cand. Oecon.* Master thesis dealing with marketing issues (University of Aarhus, Dk)

1987 *Fisheries Technician*, educated from University of Aalborg, Esbjerg

### **Positions held:**

2004 - Account Manager – Danish Aquaculture Organisation

1994 - 2004 Consultant – Association of Danish Trout farmers

1993 - 1994 Project manager (Marketing & Promotion) – Celsius International A/S

### **Scientific focus and professional experiences**

Villy J. Larsen (VJL) has been employed at Danish Aquaculture Association (until 2004 named Association of Danish Trout farmers) for more than ten year, with various responsibilities related to aquaculture. This includes counselling, economical and technical guidance to fish farmers, working out individual proposals of industrial and environmental issues, teaching, project management and involvement in several boards. VJL has made several presentation regarding issues of organic fish farming, to authorities, NGO, retailer and consumers, fish farmers and others.

VJL was the first representative from the industry to participate in meetings regarding development of organic fish farming in 1997 (Ministry of Food Agriculture and Fisheries), and has since been the involved and representative in all works regarding organic fish farming.

VJL has launched and been project coordinator and responsible manager of the aquaculture oriented projects

1/ "Introduction of organic fish farming and quality standards at Danish pioneer fish farms" and

2/ "Promotion of results from introduction of organic fish farming and quality standards at Danish pioneer fish farms".

Both project, funded by DFFE and FIUF were initiated in 2001 and finished in 2006.

The projects have been essential for Danish organic fish farming, and are the main reason that certified fish were available in fall 2005.

### **Projects management of aquaculture projects (*Recent Major Project*)**

Responsible project management and coordinator of project **1/** "Introduction of organic fish farming ... (2001-2006), **2/** "Promotion of results from introduction of organic fish farming... (2001-2006),

**3/** Aquaculture account statistics (2005 – 2007), **4/** Direct sale of fish from fish farms to consumer – phase 1 (2001-

2003), **5/** Direct sale of fish from fish farms to consumer – phase 2 (2004-2006), **6/** Farmed fish – quality and safety in production (2002-2004)

### **Five selected publications:**

DFU-rapport 146 (in press-2005). Introduktion af økologi og kvalitetsmærkning på danske pionerdambrug.

Pedersen, L.-F., **Larsen, V.J.** & Henriksen, N.H., 116 sider [*In Danish*]

Pedersen, L.-F. & **Larsen, V.J.** 2003. Økologisk ørred opdræt i Sverige. Dambrugeren, nr. 3 side 11-12.

Pedersen, L.-F. & **Larsen, V.J.** 2003. Status for økologisk akvakultur. Ferskvandsfiskeribladet, Vol. 8, p. 186-189

Pedersen, L.-F. & **Larsen, V.J.** 2002. Erfaringer med økologisk opdræt i England.

Ferskvandsfiskeribladet, nr. 11, side 248-250.

**Larsen V.J.** (2003). Direkte salg af opdrætsprodukter fra dambrugere til forbrugere, Fase-1.

Projektrapport – Dansk Dambrugereforening, 33 sider

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# **Enclosure 1**

## **Cooperation agreements**

BioMar A/S

Danish Technological Institute

Skravad Mølle Dambrug

Todbøl Dambrug

Åbro Dambrug

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# COOPERATION AGREEMENT

Between on the one side

BioMar A/S

and on the other side

Danish Institute for Fisheries Research (HØK)

Danish Institute for Fisheries Research (FF)

Danish Aquaculture Organization

Danish Technological Institute

Hereinafter called the "the partners",

has by 27th November 2006 entered into the following cooperation agreement concerning the project: **Organic Aquaculture – the linkage between sustainable production and superior products** under the research programme: **Research in Organic Food and Farming DARCOF III 2005 – 2010**.

## 1. Project title

**"Organic Aquaculture – the linkage between sustainable production and superior products"**

hereinafter called "the project".

## 2. Aim

The partners agree to cooperate in the project as it is described in the application called "Organic Aquaculture – the linkage between sustainable production and superior products" to the Danish Research Centre for Organic Farming.

The aim of the project is to contribute to the consolidation of organic fish farming as an economically sound and sustainable production form of high quality products. Investigations will compare and develop organic fish feeds, investigate management methods (case studies) with consideration of health and fish welfare, and investigations resulting fish quality. The results are expected to contribute significantly to the development of organic fish farming in Denmark, and to ensure a sustainable alternative to conventional aquaculture.

The contents of the project, budgets and time schedules are described in the application in question.

## 3. Economy

The main responsible in relation to the Ministry of Food, Agriculture and Fisheries is research director Helge A. Thomsen, The Danish Institute for Fisheries Research (DIFRES).

The costs connected to the project are covered by each of the partners in accordance with approved budgets.

## 4. Feed production

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The experimental feeds are manufactured at the fish feed plant at Danish Technological Institute (TI), Kolding, which is approved for production of organic feed. However, BioMar A/S is in charge of formulation of the recipes for organic fish feed used in Danish organic fish farms and delivery of pre-treated raw materials to TI.

BioMar A/S herewith confirm to continue to follow and support the development and production of the experimental feeds for the project as outlined in the proposal.

In case of emergency BioMar A/S will assist the project management to look into alternative facilities for production of the experimental diets. In that case the costs will be covered by the budget allocated to Danish Technological Institute.

## 5. Organisation

To secure a close affiliation to the organic fish farmers and an advisory group is established with relevant persons from the aquaculture sector.

The advisory group will be called annually for meetings to discuss the obtained results and future plans and activities.

## 6. Reporting and dissemination

The results of the project will be reported annually to FØJO/DFFE. Results from the project are planned to be published nationally and internationally, including contributions at seminars, conferences etc. after mutual agreement between the partners involved in the project.

By the end of the project a final report is written.

## 7. Confidentiality

The partners display ordinary discretion concerning confidential informations, which is received from another partner of the project in connection with this agreement.

---

Signature and date

-----, ../.. 2006  
Research director Ole Christensen, BioMar A/S

-----, ../.. 2006  
Research director Helge A. Thomsen, DIFRES-HØK

-----, ../.. 2006  
Research director Torger Børresen, DIFRES-FF

-----, ../.. 2006  
Director Brian Thomsen, Danish Aquaculture

-----, ../.. 2006  
Director Lars Germann, Danish Technological Inst.

---

# COOPERATION AGREEMENT

Between on the one side

Danish Technological Institute (TI)

and on the other side

Danish Institute for Fisheries Research (HØK)  
Danish Institute for Fisheries Research (FF)  
Danish Aquaculture Organization  
BioMar A/S

Hereinafter called the "the partners",

has by 27th November 2006 entered into the following cooperation agreement concerning the project:  
**Organic Aquaculture – the linkage between sustainable production and superior products**  
under the research programme: **Research in Organic Food and Farming DARCOF III 2005 – 2010**.

## 1. Project title

**"Organic Aquaculture – the linkage between sustainable production and superior products"**

hereinafter called "the project".

## 2. Aim

The partners agree to cooperate in the project as it is described in the application called "Organic Aquaculture – the linkage between sustainable production and superior products" to the Danish Research Centre for Organic Farming.

The aim of the project is to contribute to the consolidation of organic fish farming as an economically sound and sustainable production form of high quality products. Investigations will compare and develop organic fish feeds, investigate management methods (case studies) with consideration of health and fish welfare, and investigations resulting fish quality. The results are expected to contribute significantly to the development of organic fish farming in Denmark, and to ensure a sustainable alternative to conventional aquaculture.

The contents of the project, budgets and time schedules are described in the application in question.

## 3. Economy

The main responsible in relation to the Ministry of Food, Agriculture and Fisheries is research director Helge A. Thomsen, The Danish Institute for Fisheries Research (DIFRES).

The costs connected to the project are covered by each of the partners in accordance with approved budgets.

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#### 4. Feed production

The Danish Technological Institute (TI) hereby confirm, that the experimental feeds can be manufactured at the fish feed plant at Danish Technological Institute (TI), Kolding, which is approved for production of organic feed. However, BioMar A/S is in charge of formulation of the recipes for organic fish feed used in Danish organic fish farms and delivery of pre-treated raw materials to TI.

By separate agreement BioMar A/S has confirmed to continue to follow and support the development and production of the experimental feeds for the project as outlined in the proposal.

In case of emergency BioMar A/S has by separate agreement confirmed to assist the project management to look into alternative facilities for production of the experimental diets. In that case the costs will be covered by the budget allocated to Danish Technological Institute.

As outlined in the project proposal and specifically in WP2 a main issue of the project is to look into new protein sources for organic fish feed in cooperation with the animal feed sector (incl. fish) and technological institutes and/or investigate the possibilities of producing a vegetable fraction high in protein and low in fibre and carbohydrate from existing or new crops. The experimental work will be carried out in appropriate facilities aiming the specific enrichment procedure i.e. at Danish Technological Institute (TI) or other facilities with relevant equipment and experience. However, wherever the work is carried out (as decided by the project management) the total costs of the protein enrichment activities are included in the budget of TI. In case the specific experimental work is done outside TI the costs involved will be allocated from the current budget given in this proposal. However, it is expected that the amount that should be ear-marked for activities outside TI will be maximum DKK 300.000.

#### 5. Organisation

To secure a close affiliation to the organic fish farmers and an advisory group is established with relevant persons from the aquaculture sector.

The advisory group will be called annually for meetings to discuss the obtained results and future plans and activities.

#### 6. Reporting and dissemination

The results of the project will be reported annually to FØJO/DFFE. Results from the project are planned to be published nationally and internationally, including contributions at seminars, conferences etc. after mutual agreement between the partners involved in the project.

By the end of the project a final report is written.

#### 7. Confidentiality

The partners display ordinary discretion concerning confidential information, which is received from another partner of the project in connection with this agreement.

---

Signature and date

-----, ../. 2006  
Director Lars Germann, Danish Technological Inst.

-----, ../. 2006  
Research director Helge A. Thomsen, DIFRES-HØK

-----, ../. 2006  
Research director Torger Børresen, DIFRES-FF

-----, ../. 2006  
Director Brian Thomsen, Danish Aquaculture

-----, ../. 2006  
Research director Ole Christensen, BioMar A/S

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# COOPERATION AGREEMENT

Between on the one side

Skravad Mølle Dambrug  
v/ Niels Ole Andersen  
Skivevej 21  
9632 Møldrup  
Tlf. 8669 1066  
Fax 8669 2466  
mail: [Skravadfiskepark@mail.dk](mailto:Skravadfiskepark@mail.dk)  
www: <http://www.skravadfiskepark.dk>

and on the other side

Danish Institute for Fisheries Research (HØK)  
Danish Institute for Fisheries Research (FF)  
Danish Aquaculture Organization  
Danish Technological Institute

Hereinafter called the "the partners",

has by 27th November 2006 entered into the following cooperation agreement concerning the project:  
**Organic Aquaculture – the linkage between sustainable production and superior products**  
under the research programme: **Research in Organic Food and Farming DARCOF III 2005 – 2010.**

## 1. Project title

**"Organic Aquaculture – the linkage between sustainable production and superior products"**

hereinafter called "the project".

## 2. Aim

The partners agree to cooperate in the project as it is described in the application called "Organic Aquaculture – the linkage between sustainable production and superior products" to the Danish Research Centre for Organic Farming.

The aim of the project is to contribute to the consolidation of organic fish farming as an economically sound and sustainable production form of high quality products. Investigations will compare and develop organic fish feeds, investigate management methods (case studies) with consideration of health and fish welfare, and investigations resulting fish quality. The results are expected to contribute significantly to the development of organic fish farming in Denmark, and to ensure a sustainable alternative to conventional aquaculture.

The contents of the project, budgets and time schedules are described in the application in question.

## 3. Economy

The main responsible in relation to the Ministry of Food, Agriculture and Fisheries is research director Helge A. Thomsen, The Danish Institute for Fisheries Research (DIFRES).

The costs connected to the project are covered by each of the partners in accordance with approved budgets.

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#### 4. Field experiments

To investigate fish performance under the designated feed and management regimes, Skravad Mølle Dambrug, which is run as an organic fish farm, hereby confirm that I (Niels Ole Andersen) want to support the research plans outlined in the project application and if needed to provide test units for the project according to agreement with the project management. I also confirm that I am willing to take active part in data collection during case studies under supervision of members of the project group.

#### 5. Organisation

To secure a close affiliation to the organic fish farmers and an advisory group is established with relevant persons from the aquaculture sector.

The advisory group will be called annually for meetings to discuss the obtained results and future plans and activities.

#### 6. Reporting and dissemination

The results of the project will be reported annually to FØJO/DFFE. Results from the project are planned to be published nationally and internationally, including contributions at seminars, conferences etc. after mutual agreement between the partners involved in the project.

By the end of the project a final report is written.

#### 7. Confidentiality

The partners display ordinary discretion concerning confidential information, which is received from another partner of the project in connection with this agreement.

---

Signature and date

-----, ../.. 2006  
Niels Ole Andersen, Skravad Mølle Dambrug

-----, ../.. 2006  
Research director Helge A. Thomsen, DIFRES-HØK

-----, ../.. 2006  
Research director Torger Børresen, DIFRES-FF

-----, ../.. 2006  
Director Brian Thomsen, Danish Aquaculture

-----, ../.. 2006  
Director Lars Germann, Danish Technological Inst.

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# COOPERATION AGREEMENT

Between on the one side

Todbøl Dambrug  
v/ Klaus Futtrup  
Mosevej 89  
7752 Snedsted  
Ph. 9793 4880/22687722  
E-mail: [amkjeldgaard@ofir.dk](mailto:amkjeldgaard@ofir.dk)

and on the other side

Danish Institute for Fisheries Research (HØK)  
Danish Institute for Fisheries Research (FF)  
Danish Aquaculture Organization  
Danish Technological Institute

Hereinafter called the "the partners",

has by 27th November 2006 entered into the following cooperation agreement concerning the project:  
**Organic Aquaculture – the linkage between sustainable production and superior products**  
under the research programme: **Research in Organic Food and Farming DARCOF III 2005 – 2010.**

## 1. Project title

**“Organic Aquaculture – the linkage between sustainable production and superior products”**

hereinafter called "the project".

## 2. Aim

The partners agree to cooperate in the project as it is described in the application called “Organic Aquaculture – the linkage between sustainable production and superior products” to the Danish Research Centre for Organic Farming.

The aim of the project is to contribute to the consolidation of organic fish farming as an economically sound and sustainable production form of high quality products. Investigations will compare and develop organic fish feeds, investigate management methods (case studies) with consideration of health and fish welfare, and investigations resulting fish quality. The results are expected to contribute significantly to the development of organic fish farming in Denmark, and to ensure a sustainable alternative to conventional aquaculture.

The contents of the project, budgets and time schedules are described in the application in question.

## 3. Economy

The main responsible in relation to the Ministry of Food, Agriculture and Fisheries is research director Helge A. Thomsen, The Danish Institute for Fisheries Research (DIFRES).

---

The costs connected to the project are covered by each of the partners in accordance with approved budgets.

#### 4. Field experiments

To investigate fish performance under the designated feed and management regimes Todbøl Dambrug, which is run as an organic fish farm, hereby confirm that I (Klaus Futtrup) want to support the research plans outlined in the project application and if needed to provide test units for the project according to agreement with the project management. I also confirm that I am willing to take active part in data collection during case studies under supervision of members of the project group.

#### 5. Organisation

To secure a close affiliation to the organic fish farmers and an advisory group is established with relevant persons from the aquaculture sector.

The advisory group will be called annually for meetings to discuss the obtained results and future plans and activities.

#### 6. Reporting and dissemination

The results of the project will be reported annually to FØJO/DFFE. Results from the project are planned to be published nationally and internationally, including contributions at seminars, conferences etc. after mutual agreement between the partners involved in the project.

By the end of the project a final report is written.

#### 7. Confidentiality

The partners display ordinary discretion concerning confidential information, which is received from another partner of the project in connection with this agreement.

---

Signature and date

----- , ../. 2006  
Klaus Futtrup, Todbøl Dambrug

----- , ../. 2006  
Research director Helge A. Thomsen, DIFRES-HØK

----- , ../. 2006  
Research director Torger Børresen, DIFRES-FF

----- , ../. 2006  
Director Brian Thomsen, Danish Aquaculture

----- , ../. 2006  
Director Lars Germann, Danish Technological Inst.

---

# COOPERATION AGREEMENT

Between on the one side

Åbro Dambrug  
v/ Chr. R. Jørgensen  
Skarrild  
Skjernvej 19  
6933 Kibæk  
Tlf. 9719 6767 / 40409787  
Fax 9719 6787  
mail: [Kaerhede@mail.tele.dk](mailto:Kaerhede@mail.tele.dk)

and on the other side

Danish Institute for Fisheries Research (HØK)  
Danish Institute for Fisheries Research (FF)  
Danish Aquaculture Organization  
Danish Technological Institute

Hereinafter called the "the partners",

has by 27th November 2006 entered into the following cooperation agreement concerning the project:  
**Organic Aquaculture – the linkage between sustainable production and superior products**  
under the research programme: **Research in Organic Food and Farming DARCOF III 2005 – 2010.**

## 1. Project title

**“Organic Aquaculture – the linkage between sustainable production and superior products”**

hereinafter called "the project".

## 2. Aim

The partners agree to cooperate in the project as it is described in the application called “Organic Aquaculture – the linkage between sustainable production and superior products” to the Danish Research Centre for Organic Farming.

The aim of the project is to contribute to the consolidation of organic fish farming as an economically sound and sustainable production form of high quality products. Investigations will compare and develop organic fish feeds, investigate management methods (case studies) with consideration of health and fish welfare, and investigations resulting fish quality. The results are expected to contribute significantly to the development of organic fish farming in Denmark, and to ensure a sustainable alternative to conventional aquaculture.

The contents of the project, budgets and time schedules are described in the application in question.

## 3. Economy

The main responsible in relation to the Ministry of Food, Agriculture and Fisheries is research director Helge A. Thomsen, The Danish Institute for Fisheries Research (DIFRES).

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The costs connected to the project are covered by each of the partners in accordance with approved budgets.

#### 4. Field experiments

To investigate fish performance under the designated feed and management regimes Åbro Dambrug, which is run as an organic fish farm, hereby confirm that I (Chr. R. Jørgensen) want to support the research plans outlined in the project application and if needed to provide test units for the project according to agreement with the project management. I also confirm that I am willing to take active part in data collection during case studies under supervision of members of the project group.

#### 5. Organisation

To secure a close affiliation to the organic fish farmers and an advisory group is established with relevant persons from the aquaculture sector.

The advisory group will be called annually for meetings to discuss the obtained results and future plans and activities.

#### 6. Reporting and dissemination

The results of the project will be reported annually to FØJO/DFFE. Results from the project are planned to be published nationally and internationally, including contributions at seminars, conferences etc. after mutual agreement between the partners involved in the project.

By the end of the project a final report is written.

#### 7. Confidentiality

The partners display ordinary discretion concerning confidential information, which is received from another partner of the project in connection with this agreement.

---

Signature and date

----- , ../. 2006  
Chr. R. Jørgensen, Åbro Dambrug

----- , ../. 2006  
Research director Helge A. Thomsen, DIFRES-HØK

----- , ../. 2006  
Research director Torger Børresen, DIFRES-FF

----- , ../. 2006  
Director Brian Thomsen, Danish Aquaculture

----- , ../. 2006  
Director Lars Germann, Danish Technological Inst.