EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT

Directorate B. Multilateral relations, quality policy
B.4. Organics

Expert Group for Technical Advice on Organic Production

EGTOP

Final Report on Aquaculture (part C)

The EGTOP adopted this technical advice by written procedure
in September 2016

About the setting up of an independent expert panel for technical advice

With the Communication from the Commission to the Council and to the European Parliament on a European action plan for organic food and farming adopted in June 2004, the Commission intended to assess the situation and to lay down the basis for policy development, thereby providing an overall strategic vision for the contribution of organic farming to the common agricultural policy. In particular, the European action plan for organic food and farming recommends, in action 11, establishing an independent expert panel for technical advice. The Commission may need technical advice to decide on the authorisation of the use of products, substances and techniques in organic farming and processing, to develop or improve organic production rules and, more in general, for any other matter relating to the area of organic production. By Commission Decision 2009/427/EC of 3 June 2009, the Commission set up the Expert Group for Technical Advice on Organic Production.

EGTOP

The Group shall provide technical advice on any matter relating to the area of organic production and in particular it must assist the Commission in evaluating products, substances and techniques which can be used in organic production, improving existing rules and developing new production rules and in bringing about an exchange of experience and good practices in the field of organic production.

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The report of the Expert Group presents the views of the independent experts who are members of the Group. They do not necessarily reflect the views of the European Commission. The reports are published by the European Commission in their original language only.

http://ec.europa.eu/agriculture/organic/eu-policy/expert-advice/documents/final-reports/index_en.htm

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The topic of the dietary needs of shrimps, as well as the question about the use of zooplankton in organic aquaculture have both been addressed in the previous Final Reports on Aquaculture (part A and B) delivered on December 2013 and July 2014, respectively.
It is the opinion of the Group that most of the technical and scientific information contained in those reports are still valid in order to outline the technical advice on the matters included in the term of reference of the current mandate.

Early life stages of shrimp larvae
The Group does not see the possibility of establishing scientifically sound limits for the amount of fish meal and oil in diets of early life stages of shrimp. Neither the Group considers appropriate the application of the limitations laid down in Art. 25l 3(b) of Reg. 889/2008 to the early life stages of shrimp. Because those limitations were clearly related to a different life stage (i.e. shrimp already weaned) and to a different rearing environment (i.e. ponds), where the main source of feed is provided by the carrying capacity of the local environment.
As far as the applicability of such limitations to the other species referred in Art. 25l 3(a) of Reg. 889/2008, the Group confirms that those limitations only applies to the grow-out stage.

Specific rules for production of zooplankton
The Group does not consider the practice of zooplankton bioencapsulation different from the practice of zooplankton enrichment. Therefore, in the opinion of the Group, the considerations already expressed in the Final Report on Aquaculture (part B) on zooplankton are still valid. As a result, the Group sees no other possibility than to allow the use of non-organic zooplankton (enriched or bioencapsulated) until better alternatives have been developed.

2. BACKGROUND

Germany (and a number of independent producers) asked for clarifications, or if necessary a revision of the Article 25l of Commission Regulation (EC) No 889/2008[1] regarding organic shrimp hatchery diet for Tiger shrimp (*Penaeus monodon*). They argue that the limit of fishmeal (25%)/-oil (10%) inclusion in organic shrimp feed is not consistent with the need of larvae between zoea 3 and post larval 2 development stages. According to some organic certifiers and operators, this limitation would lead to malnutrition in the sensitive larvae and to drastically increased mortality.
Some certifiers currently interpret Article 25l to only apply to the grow-out phase, resulting in requirements on shrimp feed that are effectively less strict than the EU ones on this matter: in relation to the early development stages, they require only that fishmeal and fish oil used originate from the same area where the farms are located.
P. monodon producers also argue that there is currently no adequate organic shrimp feed available on the market for the above mentioned development stages which would also respect Article 25l.
In parallel, questions were received about bioencapsulation in zooplankton used as shrimp feed. Since conventional zooplankton can be used as feed in organic aquaculture, clarification is sought on whether all bioencapsulated products (emulsifiers, anti-oxidant, trace elements, etc) fall into the conventional category and could therefore be fed to organic shrimp farms without triggering problems for organic farmers.
Therefore, the Group is requested to prepare a report with technical advice on the matters included in the terms of reference.

3. TERMS OF REFERENCE

In the light of the most recent technical and scientific information available to the experts, the Group is requested to answer the questions below.
1. Application of Article 25l to early life stages of shrimp larvae: Does this article allow the dietary needs of shrimps in their early life stages to be met (zoea 3 - post larval 2), in accordance with the requirements of Art. 15 (1) (d) of Regulation 834/2007. If this is not the case, would limiting its application to the grow-out phase only be consistent with organic production principles? The group is invited to give specific advice related to *P. monodon* and an indication of applicability to other species referred in the Article 25l.
2. Zooplankton bioencapsulation: Is this practice compatible with the principles of organic production? Should specific rules be formulated and/or specific products be prohibited, and if so, which parameters should be taken into account to this purpose?
For the preparation of its report the group is invited to examine the technical dossier provided to the Commission and to suggest any necessary amendments to the current Regulation.

Deadline:

The deadline for adoption of the final report is 30th September 2016.

[1] Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control, 5OJ L 250, 18.9.2008, p. 1–84

4. CONSIDERATIONS AND CONCLUSIONS

4.1 Introductory remarks

The topic of the dietary needs of shrimps, as well as the question about the use of zooplankton in organic aquaculture have both been addressed in the previous Final Reports on Aquaculture (part A and B) delivered on December 2013 and July 2014, respectively.
It is the opinion of the Group that most of the technical and scientific information contained in those reports are still valid in order to outline the technical advice on the matters included in the term of reference of the current mandate. Therefore, for the purpose of facilitating the reading of this document, some relevant parts of those reports have been included here.
Note: in larviculture, the term 'food' is often used for live prey and the term 'feed' is used for formulated rations. In this report, however, the term 'feed' is used throughout.

4.2 Early life stages of shrimp larvae

4.2.1. Introduction, scope of this chapter

High quality fish meal with an optimal amino acid profile has a high nutrient digestibility and hence high utilization by the fish that results in minimum discharge of nutrients to the environment. For larvae and juveniles it is critical to secure optimum feed quality for survival and growth. Hence, fish meal and fish oil are strategic ingredients to be used at critical stages of the life-cycle, when optimum performance is required. However, according to the EU Reg. 889/2008, it should be ensured that the marine ingredients are obtained from sustainable fisheries. Furthermore, the limited availability and increasing prices of fish meal and fish oil will counteract and could limit the inclusion rates of these resources and increase the pressure for alternative sources to balance the specific amino acid requirements of farmed fish species.
Here are reported the conclusions of the Final Report on Aquaculture (part A) about the dietary requirements of shrimps:
"*The Group recognizes the clear differences between shrimp species, their feeding habits and their nutrient requirements. Furthermore, all the above considerations show the need for animal protein and lipids in the diet of shrimps, although in different proportions according to their life stages. Therefore the Group recognises the need for the use of fish meal and fish oil in the diet of shrimps. […] the Group supports a limited use of fishmeal and fish oil derived from sustainable fisheries, as a supplement to the feed naturally available in the rearing environment. In the case of shrimps only, such feed rations should not be above 10% for fish oil, as in the current regulation, but could be up to 25% for fish meal.*"
It is important to highlight that: i) in the above conclusions it was emphasized the difference in nutritional needs according to the life stage; ii) the conclusions on the limited use of fish meal and fish oils were related to the grow-out stage of the reared shrimps, and iii) the current mandate specifically asks whether the limitations of Art. 25l 3 (b) of Reg. 889/2008 are also applicable to the early life stages of shrimp, without prejudice to their nutritional needs.

4.2.2. Reflections of the Group / Balancing of arguments in the light of organic farming principles

In the hatchery stage newborn larvae ("Nauplius" in case of shrimp, "Zoea" in case of prawn and crab), produced from domesticated or wild breeders, are reared over a period of 2-3 weeks on a mixture of algae, rotifers and/or *Artemia*, as well as formulated diets. Larvae evolve through different molts and metamorphoses (nauplius-zoea-mysis-postlarva in case of Penaeid shrimp, zoea-postlarva in case of prawn, zoea-megalopa-crab in case of crab) into juveniles. At the end of the hatchery phase (shrimp postlarva stage 4 to 6, just metamorphosed prawn postlarvae, first crab stages) these juveniles are still too sensitive for successful transfer to the grow-out ponds.

They are reared for another 2 to 4 weeks in nursery tanks where they are fed with a combination of *Artemia* (in decreasing quantities) and formulated feeds.
Although the nutritional requirements for the grow-out stages of shrimp and prawn species are well documented (NRC, 2011), very limited information is available for the hatchery and juvenile stages. Researchers in the 1970s defined the nutritional requirements of penaeids by conducting experiments in laboratory conditions (Kanazawa et al., 1970; Kanazawa, 1989; Kurmaly et al. 1989a, b). In 1977 Jones et al and in 1998 Shiau reviewed this framework of knowledge. NRC (2011) presented an overview of recent progress and summarized the information that has been published to date. However, still crustacean nutritional requirements for protein and lipids, and even more larvae nutrition, are areas where more research is needed. Key subjects are associated with the use of live feed in larval culture and the development of a formulated diet for hatchery production. As a result the formulated diets used so far are empirically made up with high quality fish meal (up to or even more than 50 %) and marine lipids.
Indeed, today it is not possible to identify optimal concentrations for the ingredients of formulated larval crustacean diets. The nutritional quality and physical properties of *Artemia* provide greater survival and growth to the *Artemia*-fed larvae (Sorgeloos et al. 1983). In addition, although the amount of live feed (especially *Artemia*) has been greatly reduced and replaced by formulated diets to make the production more cost-effective, present knowledge on the nutritional requirements of the early larval stages is still very limited, and complete replacement of live feed in commercial hatcheries is not feasible. Furthermore, growth rate and overall physiological condition (e.g. stress and disease resistance) of the juveniles are compromised when too much live feed is replaced by the current artificial diets (in terms of high quality fish meal and squid protein, lipid and vitamin composition).
Nutritional studies of crustaceans have investigated the optimal dietary protein and lipid levels for different species and different life stages. Table 1 below provides a list of the optimum dietary protein and lipid levels for *P. monodon* shrimps (different larval stages are shown when available information is provided). Generally, recommended dietary protein levels in shrimp larval feed vary from 46 to 56% depending on the type of the diet, with best growth results given when live diets are used.
A summary of the information related to protein, lipid, phospholipid, cholesterol and other nutrients for crustaceans is already provided in the Final Report on Aquaculture (Part A) in December 2013, pages 13-14.

Table 1: Summary of protein and lipid requirements for penaeid shrimp (NRC, 2011).

Nutrient/animal species	**Requirement level**	**Reference**
Protein *P. monodon larvae*	48-52%	Kurmaly et al 1989b
Protein *P. monodon larvae*	51-56%	Kurmaly et al. 1989a
Protein (*P. vannamei larvae,* stage M1 to PL1)	46%	D'Abramo et al (2006)
Lipids *P. monodon larvae*	5.5-16.6% total lipids	Kanazawa, 1990
Lipids (*P. monodon larvae*, stages Z1-Z3. Best growth when fed live diets	4.3%-23.5% total lipids 3.4-26.1% HUFA	Kurmaly et al. 1989a,b

Lipids (*P. monodon larvae*, stages M1-PL1. Best growth when fed live diets	16% total lipids 10.2% HUFA	Kurmaly et al. 1989b
Lipids (*P. monodon larvae*, stages M1-M3 fed encapsulated diets	18.2% total lipids 12.4% HUFA	Kurmaly et al. 1989a

Applicability of the current limitations of Art. 25l 3 to early life stages

The limitations of Art. 25l 3(b) are clearly related to a different life stage (i.e. shrimp already weaned) and to a different rearing environment (i.e. ponds), where the main source of feed is provided by the carrying capacity of the local environment. Application of these limitations to early life stages of shrimp would result in malnutrition and high mortality. In the Group's opinion it is, therefore, inappropriate to apply these limitations to the early life stages of shrimp. As far as the applicability of such limitations to the other species referred in Art. 25l 3(a) of Reg. 889/2008, the Group confirms that those limitations should only apply to the grow-out stage.

Alternative limitations for the early life stages

In light of the foregoing (i.e. chapter 4.2), the Group does not see the possibility of establishing scientifically sound limits for the amount of fish meal and oil in diets for the early life stages of shrimp.

4.2.3. Conclusions

The Group does not consider the limitations of Art. 25l 3(b) of Reg. 889/2008 applicable to the early life stages of shrimp. The Group recommends that early life stages are explicitly excluded from the provisions in Art. 25l 3 of Reg. 889/2008.

4.3 Specific rules for production of zooplankton

4.3.1. Introduction, scope of this chapter

Larval rearing is one of the most critical stages for the successful propagation of any species and represents one of the major bottlenecks of the whole aquaculture process (Sorgeloos, 2013). Most fish larvae, particularly the marine ones, and crustacean larvae are very small at first feeding and thus are sensitive to rearing environment and to feed quality. Furthermore, these small larvae require live plankton for their first feeding, and thus hatcheries include facilities for plankton production (both phytoplankton and zooplankton). Two species of zooplankton are mass cultured due to their appropriate size, feed value and easiness of rearing. These are (i) the rotifer *Brachionus sp.* and (ii) the nauplius of the branchiopod crustacean, brine shrimp *Artemia sp.* Rotifers are the initial prey for the majority of marine fish larvae and for some crustacean larvae, and are later replaced by *Artemia sp.* during the larval rearing process.

Rotifers are an excellent first feed because of their small size and slow swimming speed, their habit of staying suspended in the water column and their ability to be cultured at high densities due to a high reproductive rate (Dhert et al., 2001). For the feeding of rotifers several products are used (sometimes in combination), such as baker's yeast, different algal species and formulated feeds.

Artemia sp. is collected as dehydrated embryos or cysts from salt lakes and salt works. It is used either as instar I nauplii (400-600 micro-meters in size), hatched from cysts, or as instar II-III nauplii (800-1000 micro-meters), reared with specially enriched feed.

Artemia, as well as Rotifers, need to be enriched in highly unsaturated fatty acids (EPA and DHA) and vitamins (C and A) and this can be done with single cell products (microalgae, fungi, or algal pastes) or oil emulsions.

Here are reported the conclusions of the Final Report on Aquaculture (part B) about zooplankton:
" *... the Group sees the technical possibility of an organic production of zooplankton, which would differ from conventional zooplankton in several aspects. Rules for organic production would need to be based on: Use of organic yeast and other microorganisms (e.g. thraustrochytrids), only natural antioxidants and emulsifiers. [...] There are no organic enrichment diets available at the moment, and the Group is not able to evaluate whether their production would be commercially viable. The economic feasibility should be explored and the sector encouraged to consider organic production of zooplankton. Meanwhile, the Group sees no other possibility than to allow the use of non-organic zooplankton until better alternatives have been developed.*"
The current mandate specifically asks whether zooplankton bioencapsulation is compatible with the principles of the organic production.

4.3.2. Reflections of the Group / Balancing of arguments in the light of organic farming principles

Bioencapsulation or enrichment is the process involved in improving the nutritional status of live food organisms either by feeding, or incorporating within them, various kinds of nutrients (Dhert et al., 2001; Srivastava, 2010, Agh and Sorgeloos, 2005). Examples of practical and experimental enrichment diets are unicellular algae, yeast, fungi, emulsions, liposomes and microencapsulated diets. In general, marine larvae require the polyunsaturated fatty acids eicosapentaenoic acid (EPA: 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3) for their survival and normal development. Apart from EPA and DHA, arachidonic acid (ARA; 20:4n-6) has also been recognized as essential for marine fish and crustaceans (Sargent et al, 1999; Rees et al, 1994). The rotifer *Brachionus* sp. and the brine shrimp *Artemia* sp. are the two organisms most extensively used as larval feed.
The lipid sources in enrichment diets vary in lipid class composition, n-3 HUFA content and DHA/EPA ratio. However, EPA is often present in low amounts in *Artemia* nauplii and DHA is practically absent (Léger et al, 1986). For this reason, the nauplii need to be enriched before they can be used for feeding marine larvae. The enrichment is commonly achieved by placing the live prey (zooplankton) in a medium, generally an emulsion, containing EPA and DHA (Narciso et al, 1999; Van Stappen, 1996). The live prey are passive filter feeders and thus incorporate the emulsions in their digestive tract acting as live vehicles. This enrichment process has also been termed "bioencapsulation" and is successful enough to allow the use of *Artemia* nauplii as larval feed for marine organisms, at least during certain phases of their rearing. The degree of success in modifying the fatty acid profile of the live prey has shown to be influenced by the type of the enrichment diet, the enrichment conditions and the live feed strain itself.
In light of the foregoing, the Group does not consider the practice of zooplankton bioencapsulation different from the practice of zooplankton enrichment. Therefore, in the opinion of the Group, the considerations already expressed in the Final Report on Aquaculture (part B) on zooplankton are still valid.

4.3.3. Conclusions

At the moment and until better alternatives haves been developed, the Group sees no other possibility than to allow the use of non-organic zooplankton (enriched or bioencapsulated) as shrimp feed.

5. LIST OF ABBREVIATIONS / GLOSSARY

Annex VII	Annex VII to Regulation 889/2008
Grow-out	rearing of aquaculture animals from the juvenile stage to harvest size.
The Group	The Expert Group for Technical Advice on Organic Production (EGTOP)
EPA	Eicosapentaenoic acid
DHA	Docosahexaenoic acid

6. REFERENCES

Expert Group for Technical Advice on Organic Production (EGTOP). (2013). Final Report on Aquaculture (part A). http://ec.europa.eu/agriculture/organic/eu-policy/expert-advice/documents/final-reports/final_report_egtop_on_aquaculture_part-a_en.pdf

Expert Group for Technical Advice on Organic Production (EGTOP). (2014). Final Report on Aquaculture (part B). http://ec.europa.eu/agriculture/organic/eu-policy/expert-advice/documents/final-reports/final_report_egtop_on_aquaculture_part-b_en.pdf

Agh, N., Sorgeloos, P. (2005). Handbook of protocols and guidelines for culture and enrichment of live food for use in larviculture. Artemia&Aquatic Animals Reserch Center, Urmia University, Iran, 51 pges

Dhert, P.H., Rombaut, G., Suantika, G., Sorgeloos, P. (2001). Advancement of rotifer culture and manipulation techniques in Europe. Aquaculture, 200: 129-146.

D'Abramo, L.R., Perez, E.I., Sangha, R. and Puello-Cruz, A. 2006. Successful culture of larvae of *L. vannamei* fed a microbound formulated diet exclusively from either PZ2 or M1 to PL1. Aquaculture 261:1356-1362

Jones, D.A., Yule, A.B. and Holland, D.L. 1997. Larval nutrition. Chapter in Crustacean Nutrition (D'Abramo, L.R., Conklin, D.E. and Akiyama, E.M. eds). Advances in World Aquaculture ,vol. 6. WAS Baton Rouge, Louisiana, pp. 353-390

Kanazawa, A., Shimaya,M., Kawaski, M., Kashiwada, K. 1970. Nutritional requirements of prawns: I Feeding on artificial diet. Bull. Jpn. Soc. Sci. Fish. 36:949-954.

Kanazawa, A. (1989). Protein requirements of Penaeid shrimp. Advances in tropical aquaculture, Aquacop Ifremer Actes de Colloque, 9: 261-270.

Kurmaly, K., Yule A. B. and Jones, D. A. (1989a). An energy budget for the larvae of *Penaeus monodon* (Fabricius). Aquaculture, 81: 13-25.

Kurmaly, K., Jones, D. A., Yule, A. B. and East, J. (1989b). Comparative analysis of the growth

and survival of *Penaeus monodon* (Fabricius) larvae, from protozoea I to postlarva 1, on live feeds, artificial diets and on combinations of both. Aquaculture, 81:27-45.

Léger, P., Bengtson, D.A., Simpson, K.L., Sorgeloos, P. (1986). The use and nutritional value of *Artemia* as a food source. Oceanogr. Mar. Biol. Ann. Rev., 24: 521-623

Narciso, L., Pousao-Ferreira, P., Passos, A., Luis, O. (1999) HUFA content and DHA/EPA improvements of *Artemia* sp. with commercial oils during diferent enrichment periods. Aquac. Res., 30: 21-24

NRC (National Research Council) (2011). Nutrient Requirements of Fish and Shrimp. The National Academy Press, Washington, DC. Pp 363.

Rees, J.F., Curé, K., Piyatiratitivorakul, S., Sorgeloos, P., Menasveta, P. (1994). Highly unsaturated fatty acid requirements of *Penaeus monodon* postlarvae: an experimental approach based on *Artemia* enrichment. Aquaculture, 122: 193-207

Sargent, J.Bell, G., McEvoy, L., Tocher, D., Estévez, A. (1999) Recent developments in the essential fatty acid nutrition of fish. Aquaculture, 177: 191-199

Shiau, S-Y. 1998. Nutrient requirements of penaeid shrimps. Aquaculture, 164:77-93.

Sorgeloos, P. 2013. Aquaculture: the blue biotechnology of the future World Aquaculture, 44 (3): 16-25

Srivastava, A. (2010). Live Food: Mass production, biochemical profiling and enrichment: A study on mass production, biochemical composition and nutritional enrichment of some live fish food organisms. Lambet Academic Publishing, 188 pages

Van Stappen, G. (1996). Introduction, Niology and Ecology of *Artemia*. In: Manual on the production and use of live food for Aquaculture, Lavens, P. And Sorgeloos, P. (Eds). FAO Fisheries Technical paper 361, pp 79-163