



Baltic MUPPETS



DELIVERABLE 1.3

ASSESSMENT OF MARKET READINESS



Co-funded by
the European Union

Disclaimer: Baltic MUPPETS is co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority, European Innovation Council and SMEs Executive Agency (EISMEA). Neither the European Union nor the granting authority can be held responsible for them.

Grant agreement number	101083785
Project title	Baltic MUPPETS Baltic Mussel Products for PET-foods
Deliverable title	Assessment of the Market Readiness
Deliverable number	1.3
Deliverable version	2
Contractual date of delivery	30/09/2025
Actual date of delivery	02/03/2026
Document status	Final
Online access	Yes
Diffusion	Public
Nature of deliverable	RE- Document, Report
Work Package	1
Contributing partners	CRM
Author	Peter Krost, Susanne Woldmann (CRM)
Editor	Joanna Makocka (F6S), Susanna Minnhagen (ECO), Maya Miltell (SUBNET), Toninio Waelkens (SUBNET)
Keywords	Mussel Aquaculture, Market, Baltic Sea



CONTENT

1. Introduction	5
2. Whole mussels	7
3. Deshelling	10
4. Environmental Service.....	18
5. Conclusions.....	19
7. References.....	19

LIST OF FIGURES

Figure 1: Figure 1 shows the complexity and the relation between the single products or product ideas generated within Baltic MUPPETS.	6
---	---

LIST OF FIGURES

Table 1: Prices of Ecopelag's products compared to substitutes (price per kilogram).	11
---	----



1. INTRODUCTION

Baltic MUPPETS is a three-year project supported by the Interregional Innovation Investment (I3) instrument. The project aims to create a new value chain for small Baltic Sea blue mussels by developing nutritious and high-quality pet food products. It focuses on investing in innovative techniques for underwater cultivation, harvesting and processing of the Baltic Sea's native blue mussel. This initiative is expected to support local economic development and increase quality employment opportunities. In addition, mussel farming is expected to provide several ecosystem services such as nutrient removal, water quality improvement and biodiversity enhancement. Baltic MUPPETS is a follow-up of the [BalticBlueGrowth \(BBG\) project](#), and support for farmers can also be found in the BBG reports.

This document is part of the project's Work Package 1: *Preparing the market and sustainable businesses for scale-up*. It presents the assessment of market readiness and links to other work packages—particularly the exploitation activities in WP6—in order to showcase the overall market potential and readiness. Assessing the market readiness of a product involves looking at two key dimensions:

How ready is the product for the market?

This refers to the Technology Readiness Level (TRL) and indicates how far the product has progressed, from initial concept to market-ready solution.

How ready is the market for the product?

This perspective examines the maturity and openness of the target market. Are there established application areas and demand? Examples include pet food for dogs, cats, or ornamental fish, backyard poultry as hobby livestock, or the use of natural fertilisers. Depending on the market segment and customer base, readiness levels can vary significantly.

A successful market entry requires that both the product and the market reach sufficient levels of readiness. Those two dimensions will be examined in this document.

Figure 1 shows the complexity and the relation between the single products or product ideas generated within Baltic MUPPETS.

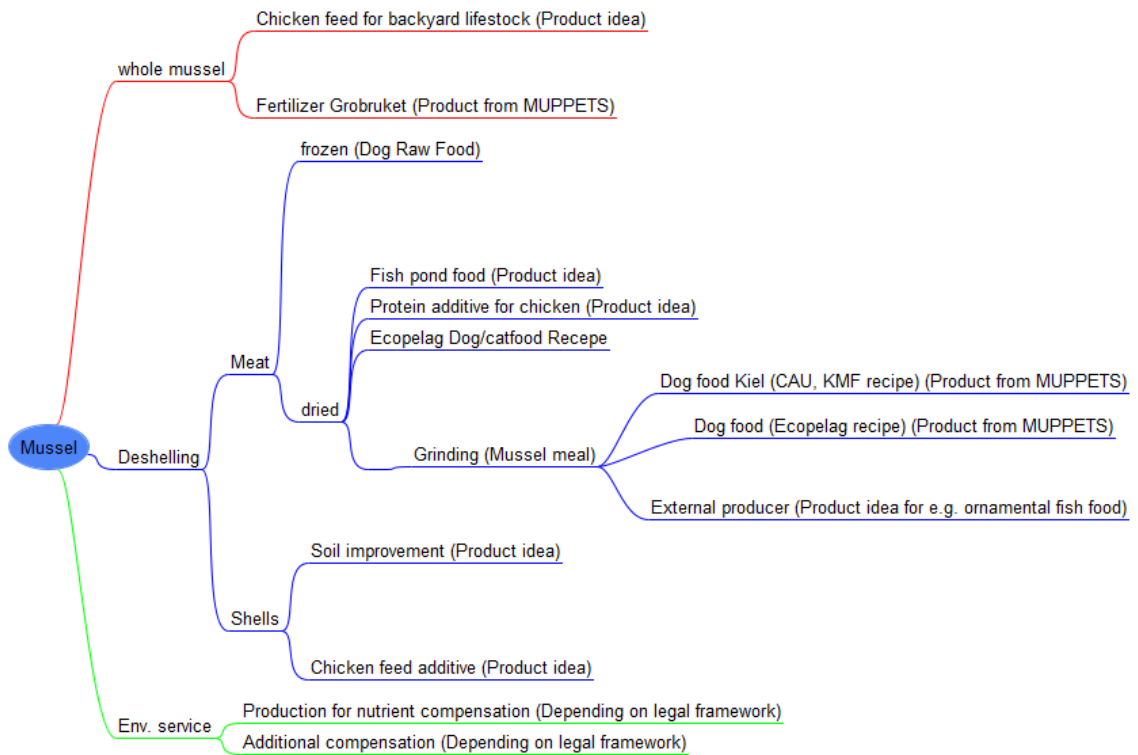


Figure 1: Figure 1 shows the complexity and the relation between the single products or product ideas generated within Baltic MUPPETS.

2. WHOLE MUSSELS

2.1 Chicken feed for backyard livestock

2.1.1 Market volume

According to current estimates, there are approximately 400,000 hobby poultry keepers in Germany. This projection is based on the assumption that around 0.5 % of the population in each federal state keeps chickens privately (<https://www.br.de>; <https://www.sueddeutsche.de>)

Typically, hobby keepers own between three and ten chickens, with an average of five birds. Based on an average of five chickens per household, this results in an estimated **2 million** privately kept chickens across Germany. These chickens are usually kept in backyards or on small plots, for self-sufficiency, sustainability, or simply out of affection for the animals. The steadily increasing number of small-scale flocks shows that chickens have found their place in the everyday lives of many families, not only in rural areas, but increasingly in urban settings as well.

To assess the overall market potential, we conservatively take the German numbers 2 times. According to this assumption we count with 800,000 hobby chicken keepers and around 4 million privately kept chickens across Europe. This assumption is supported by comparable trends in countries such as Austria, the Netherlands, and France, where urban backyard poultry keeping is also on the rise.

In average a hen needs 110 grams of feed per day (<https://www.ufa.ch>). Calculated on 4 million backyard chickens there is a need for around 160,600 tonne of chicken feed per year. In average chicken feed costs about €0.8 per kilogram in 25-kilogram bags (www.raisdorfermuehle.de). Calculated on the yearly demand of 160,600 tonne chicken feed this results in a market volume of approximately €128.5 million.

2.1.2 Composition of mussels

Cooked, dried and ground whole mussels provide 100% of the required calcium, about 42% of the required protein, and 17% of the required fat. The rest has to be added from other sources, we estimate a price of €1.00 additional costs per kilo gram product for the supplementary ingredients (corn, maize, gluten, plant-based proteins, fat, vitamins, spore elements and appetizers).

2.1.3 Cost comparison between chicken feed and whole mussel

The production cost for a complete chicken feed made from whole mussels amounts to €1.43 per kilogram when based on an annual mussel production volume of 2,700 tonnes. This cost calculation includes all steps of the value chain, from mussel farming and harvesting to processing and final packaging of the feed product.

At a larger production scale of 10,000 tonnes of mussels per year, the unit cost for producing the same complete mussel-based chicken feed drops to approximately €1.22 per kilogram. Conventional chicken feed for hobby poultry keepers is typically available on the market for around €1.50 per kilogram.

2.1.4 Conclusion

Concerning the achievable retail price for complete chicken feed in the hobby farming sector, the production costs for mussel-based chicken feed are relatively high. Given that conventional feed is typically sold at around €1.50 per kilogram, the calculated production costs of €1.43 to €1.22 per kilogram, depending on production volume, leave very little room for profit margins.

This narrow margin presents a challenge, particularly in a price-sensitive market where consumers are accustomed to low-cost feed options. While the product offers ecological and nutritional benefits, its competitiveness will depend heavily on efficient production, optimised logistics, and potentially the willingness of a niche market to pay a moderate premium for a sustainable, marine-based alternative.

2.2 Mussel-enhanced fertiliser

2.2.1 Market volume

To date, no fertilisers are available that specifically incorporate components from blue mussels. However, there are numerous products on the market that contain crustacean materials or seashells (mostly oyster shells). The primary active ingredients in these fertilisers are nitrogen, phosphorus, calcium, and magnesium, which collectively support plant growth, root development, and cellular structure.

As the mussel-based fertiliser is placed in the upper price segment, good marketing is required. Consumers will be private gardeners with a sense for sustainability and preservation of the Baltic Sea

2.2.2 Typical composition of fertiliser

A typical fertiliser used in private households, especially for home gardening, is a balanced NPK fertiliser that contains the three primary macronutrients: nitrogen (N), phosphorus (P),

and potassium (K). Common formulations include 10-10-10 or 5-5-5, meaning that the product contains 10% or 5% of each of these nutrients by weight. These all-purpose fertilisers are suitable for a wide range of plants and provide a balanced supply of nutrients necessary for healthy growth.

In addition to these general-purpose formulas, more specialised NPK ratios are also available depending on the specific needs of the plants. For example, a 3-1-2 ratio is often recommended for promoting balanced leaf, root, and flower development, while a 1-2-1 formulation is typically used for vegetables and flowering plants that require stronger root and bloom support.

Each macronutrient serves a distinct function: nitrogen promotes leafy growth, phosphorus supports root development and flowering, and potassium enhances overall plant resilience, improves fruit quality, and increases drought tolerance. The precise NPK values are always clearly stated on fertiliser packaging and help consumers choose the appropriate product based on their gardening needs.

2.2.3 Composition of mussels

Blue mussels contain large quantities of calcium carbonate (about 1/3 of fresh weight), and the flesh consists mainly of protein and, to a minor extent, of fat. Nitrogen content is around 1% of the fresh weight, phosphorus ca. 0.1%. In addition, there are numerous micronutrients such as potassium, zinc and magnesium.

To fulfil the requirements of plants, an additive (ammonia-sulphate and potassium- sulphate) is supplemented in a ratio of 40/60 (mussel weight / additive weight).

2.2.4 Conclusion

Mussels are a good base for fertiliser, which however needs to be enriched with macro and micronutrients. The costs as well as prices are high, target consumers are environmentally responsible private gardeners.

3. DESHELLING

3.1 Mussel meal for pet food

3.1.1 Pet food market volume

In 2023, the German pet industry demonstrated strong growth despite economic challenges, reaching a total market volume of approximately €7.1 billion. This included:

- €4.495 billion from prepared pet food
- €1.121 billion from pet supplies and accessories
- €1.316 billion from online retail
- €161 million from wild bird feed

(Source: [ZZF Market Data](#))

The pet food market is segmented into five key categories: cat food, dog food, ornamental bird food, ornamental fish food, and food for small mammals. Cat food holds the largest share, followed by dog food, which also shows dynamic growth.

From 2019 to 2023, the German pet food market saw an average annual growth of 8%, reflecting strong consumer demand and increasing investment in pet nutrition.

Focusing on dog food, sales grew by an average of 7% per year, supported by trends like premiumization and pet humanisation. The segment is divided into:

- Wet food: +9% average annual growth
- Dry food: +5% annual growth
- Snacks: +7% annual growth, and the highest revenue category within dog food

As a rough estimate, we assume that the potential market in the Baltic and North Sea region is about twice as high as the market size in Germany.

3.1.2 Example: dog food products from Ecopelag

The first dog snack was introduced to the market in July 2024. In spring 2025, three additional snack products were launched.

In 2024, a total of 2,150 bags of dog snacks were sold. In 2025, sales so far include 1,980 bags of snack products through retail channels.

3.1.3 Costs comparison between Ecopelag's products and comparable products

Table 1 contains prices per kilogram on Ecopelag's products in SEK (excl. VAT), and a comparison to similar products on the Swedish market.

Table 1: Prices of Ecopelag's products compared to substitutes (price per kilogram).

PRODUCT	PRICE PER KG EXCL. VAT (SEK)	SIMILAR PRODUCT	PRICE PER KG EXCL. VAT (SEK)	RETAILER
Sjötugg Hundsnacks freeze-dried mussels	1475.00	Trixie Premio freeze-dried shrimps	1120.00	Apotea.se
Sjötugg Hundsnacks roasted mussels	862.50	TassaFritt Träningsgodis Dried mussels	740.63	Vet Zoo
Sjötugg Tillskott freeze-dried mussel powder	1490.00	Hundapoteket green lipped mussel freeze-dried powder	2092.50	Hundliv shop
Sjötugg Tillskott roasted mussel powder	990.00	PAWS & PATCH Drjed green lipped mussel powder	1580.00	Zooplus.se

3.1.4 Conclusion

In principle, the market is ready for a dried dog food product. However, this segment faces intense competition, high processing costs, and the limitation that only a small percentage of harvested mussels can be utilised as dog snacks.

By contrast, wet feed could represent a more viable option, as it would require significantly lower investment in equipment, avoid the energy-intensive drying process, and allow for more efficient use of raw materials.

3.2 Mussel meal for other producers, such as ornamental fish food (Tetra)

There is a clear interest in using mussel meal as a feed ingredient, provided that consistent quality and a reliable supply are ensured. An annual purchase volume of up to 200 tonnes is considered realistic.

A price surcharge over fishmeal is only justifiable if supported by clear sustainability or ecosystem benefits. These aspects are increasingly relevant as the industry moves away from fishmeal and soy. Fish health is also becoming a strong selling point, potentially allowing for health claims based on fatty acid content, especially in combination with algae.

An organic label is seen positively but is not enough to justify significantly higher prices. Mussel meal should be priced competitively with fishmeal, a doubled price is unlikely to be accepted.

3.2.1 Costs comparison between mussel meal and standard market prices

The current world market price for conventional fishmeal is approximately €1.35 to €1.60 per kilogram (source: FRED Economic Data, fred.stlouisfed.org). For organic fishmeal, a premium of around 50% on the conventional price can be assumed, resulting in an estimated price range of €2.03 to €2.40 per kilogram.

However, producing mussel meal economically requires a substantial number of fresh mussels. Only about 40% of the weight of cooked Baltic mussels consists of usable mussel meat. During the drying process, this meat loses an additional 80% of its weight, meaning that approximately 15.6 kilograms of fresh mussels are needed to produce one kilogram of mussel meal. Based on a simulated annual production of 10,000 tonnes of fresh mussels, this results in a theoretical yield of approximately 641 tonnes of dried mussel meal. Considering the processing steps—cooking, deshelling, drying, and grinding—the calculated production cost amounts to approximately €2.70 per kilogram of final product.

3.2.2 Conclusion

In general, the market is ready for mussel meal as a substitute for fishmeal in ornamental fish feed. There is a clear and growing interest in replacing conventional fishmeal, which often originates from unsustainable fisheries, with more environmentally friendly alternatives. Demand for sustainably produced protein sources that are both ecologically responsible and functionally effective is increasing, not only in aquaculture but also in the pet food industry.

From a technological standpoint, mussel meal is also ready for market introduction. The product quality is high, and its nutritional properties are comparable to those of fishmeal. Processing technologies, from cooking and deshelling to drying and milling, are well established and scalable.

The current challenge lies in the economic conditions. Despite its technical feasibility, production costs for mussel meal, even in the organic segment, remain significantly higher

than for conventional or certified organic fishmeal. The primary cost driver is the high raw material requirement: approximately 15.6 kilograms of fresh mussels are needed to produce 1 kilogram of mussel meal. In addition, the production involves energy-intensive processing steps and notable logistical costs.

Without targeted support mechanisms, environmental incentives, or price premiums for sustainable products, it remains economically difficult to establish mussel meal on a meaningful scale in the market. However, the fundamental conditions for market entry are in place—both on the demand side and in terms of product readiness.

3.3 Mussel meat: frozen raw dog food (“BARF”)

3.3.1 Market volume

In Germany, the market for raw pet food (BARF = Biologically Appropriate Raw Food) has developed significantly in recent years and has become a well-established segment within the pet food industry. The overall pet food market in Germany is estimated at approximately €2.3 billion for the year 2024 ([grandviewresearch.com](https://www.grandviewresearch.com)). Within this market, around 10% is attributed to the BARF segment ([maximizemarketresearch.com](https://www.maximizemarketresearch.com), [kompetenznetz-mittelstand.de](https://www.kompetenznetz-mittelstand.de)), corresponding to an estimated sales volume of around €230 million in Germany alone.

BARF products are particularly relevant in the dog food category, which makes up most of the market. In Europe, 58% of pet food revenue is generated by dog products, while 35% comes from cat products ([petfoodindustry.com](https://www.petfoodindustry.com)). Raw pet food is increasingly perceived as a nutritionally beneficial and natural feeding method—a trend reflected in the growing availability of fresh and frozen product ranges.

On a global level, the market for raw pet food was valued at USD 3.68 billion in 2024 and is projected to grow to USD 4.23 billion by 2025 ([thebusinessresearchcompany.com](https://www.thebusinessresearchcompany.com)). Europe accounts for approximately 28% of this global market, resulting in a market volume of around USD 1.03 billion across the continent (de.wikipedia.org). This positions Europe, and Germany in particular, as a key region for BARF products with continued growth potential.

3.3.2 Cost comparison between frozen meat and standard market prices

Current retail prices for frozen pet food range from €1.25 to €2.50 per 500 g, depending on the variety. Beef blood represents the entry-level option at €1.25, while common varieties such as chicken, horse, beef, rumen, or rabbit fall within the upper part of this range. An organic variant (e.g., turkey ragout) is priced significantly higher at €5.80 per 500 g, currently representing the top end of the price scale.

Assuming an annual production volume of 2700 tonnes of fresh mussels, the production cost for 1 kilogram of frozen mussel meat is estimated at €1.11. This figure includes all major processing steps, such as cooking, deshelling, packaging, and freezing, as well as the operating costs of the farm and harvesting.

3.3.3 Conclusion

In principle, the market is ready for frozen mussel meat as a raw pet food ingredient. In the raw pet food segment (BARF), there is stable and growing demand; however, sustainability currently plays a subordinate role for end consumers in this area. Interest in functional, novel ingredients is increasing, but price remains the key factor that determines marketability.

Mussel meat as a novel raw material is generally considered interesting and acceptable, particularly due to its natural origin, good digestibility, and potential health benefits (e.g., for skin, coat, or joints). To succeed in the highly price-sensitive BARF segment, the product must fall within the established market price range of comparable ingredients.

This condition is met at a projected production volume of 3,000 metric tons of fresh mussels per year. The product is clearly positioned within the usual price level for BARF ingredients. Mussel meat can therefore compete very well on price, especially when offered in bulk through specialist retailers or online distribution channels.

From a technical perspective, the product is fully market-ready: all necessary processing steps—cooking, deshelling, freezing, and packaging—are well established and can be integrated into scalable production chains. The product form (frozen, vacuum-packed) is familiar, and its use is straightforward for pet owners. As such, frozen mussel meat meets all the requirements—on both the supply and demand side—for a successful market launch in the pet food sector.

3.4 Mussel meat: Dried product from Ecopelag (dog snack)

3.4.1 Market volume

The European market for dog snacks and treats is a significant and fast-growing segment within the pet food industry. In 2024, the market for natural dog treats in Europe reached a value of approximately USD 1.462 billion, with a projected compound annual growth rate (CAGR) of 11.8% through 2030 (Grand View Research – Europe Outlook). This strong growth is driven by increasing consumer demand for healthier, more natural alternatives to conventional pet snacks.

Dog treats account for the majority share within the European pet treats category, representing about 61% of the total pet treats market, while cat treats make up the remaining 39% (Global Pet Industry). The segment is particularly dynamic in Western and Northern Europe, where pet owners show a high willingness to spend on premium and functional products.

These developments reflect broader trends in pet ownership and care, where dogs are increasingly seen as family members. This shift is mirrored in consumer purchasing behaviour, with a growing preference for nutritionally balanced, functional, and sustainable treat options. The European market for dog snacks is therefore not only large in volume but also evolving in terms of product quality, differentiation, and branding.

3.4.2. Cost comparison between dried meat and standard market prices

European retail prices for dog treats range broadly, from around €7–12 per kilogram for standard and mid-tier products up to €65–100 per kilogram for premium or speciality chews. This widespread reflects differences in ingredients, production method, and market positioning.

With a production volume of 2,700 kilograms of mussels, the production cost per kilogram for manufacturing dried mussel meat as a dog treat amounts to approximately €5.53. This cost includes all processing steps required to produce a shelf-stable, ready-to-market product.

3.4.3 Conclusion

The market is ready for a mussel-based dog treat, as current pricing structures allow for a competitive position within the premium segment. With production costs at approximately €5.53 per kilogram, the product can be offered at an average retail price of around €9.00 per kilogram, which is in line with established mid- to high-range dog treats. This pricing leaves room for a reasonable margin while maintaining market acceptance.

Given the increasing demand for natural, functional, and protein-rich pet snacks, mussel meat offers a compelling nutritional profile—particularly due to its omega-3 content and digestibility. These attributes make it well-suited for consumers seeking added health benefits in pet products. In this context, the mussel-based treat is not only economically feasible but also well aligned with current trends in the dog snacks market.

The product is also technically ready for market entry, as all necessary technologies for producing dried mussel meat are already established. The full processing chain—from harvesting and cooking to deshelling, drying, and packaging—relies on proven and scalable methods. This ensures consistent product quality and efficient production workflows, enabling reliable supply and commercial viability. Combined with the positive market conditions and pricing feasibility, the product is well-positioned for a successful launch in the pet snacks segment.

3.5 Mussel meat: Pond fish feed

3.5.1 Market volume

According to the report by the European Market Observatory for Fisheries and Aquaculture Products (MONTHLY HIGHLIGHTS | No. 3/2025 – First Sales in Europe), the first sales value of “freshwater fish” in 2024 amounted to €21.51 million, with landings totalling 7,482 tonnes.

This volume of freshwater fish, which is produced almost exclusively in pond aquaculture systems, represents a significant share of the fish feed market. The estimated annual feed requirement for this production is approximately 13,000 tonnes. In addition, feed is required for juvenile fish (fingerlings), ornamental and hobby fish and private fishpond operators. As a

result, the total market volume for freshwater fish feed in Europe is estimated at around 200,000 tonnes per year.

3.5.2 Costs comparison between dried meat and standard market prices

Retail prices for freshwater fish feed in Europe average around €10 per kilogram, depending on the composition, brand, and packaging size. This price range reflects both standard pond fish diets and more specialised feeds used for species like carp and trout.

In comparison, the production cost of a mussel-based fish feed—using dried mussel meat as the primary protein source—can be estimated at approximately €4 per kilogram, assuming an annual processing volume of 2,750 tonnes of fresh mussels. This calculation includes all necessary processing steps such as cooking, deshelling, drying, grinding, and formulation.

3.5.3 Conclusion

The market is ready for this product. With growing interest in sustainable and natural alternatives to conventional fish feed, a mussel-based feed product can meet both ecological and nutritional demands—particularly in the context of freshwater pond aquaculture, where regional sourcing and circular approaches are gaining relevance.

The economic potential is equally promising: European retail prices for freshwater fish feed currently average around €10 per kilogram, depending on quality and formulation. In contrast, the estimated production cost for a feed based on dried mussel meat is approximately €4 per kilogram, assuming an annual production volume of 2,750 tonnes of fresh mussels. This cost includes all essential process steps like harvesting, cooking, deshelling, drying, grinding, and packaging. The resulting margin between production and market price indicates a viable business case, especially when targeting high-value segments such as feed for carp, trout, or ornamental pond fish.

The product is also technologically ready for market introduction. All required processing technologies—such as mechanical deshelling, controlled drying, and hygienic packaging—are well established and available on a scalable, industrial level. There is no need for fundamental innovation or new infrastructure; rather, the process can be implemented using existing equipment and know-how from both aquaculture and food processing sectors.

In summary, both the market conditions and the technical feasibility align to support the successful launch of mussel-based freshwater fish feed. The concept offers not only a competitive cost structure but also clear communication potential in terms of regional value creation, sustainability, and product differentiation.

3.6 Mussel meat: Protein additive for chicken (backyard stock)

Private chicken farming in the backyard is getting increasingly popular in Europe; according to German law, for instance, between 3 and 20 chickens (and one rooster) can be kept in a private backyard. Chickens need feed, and especially a source of chalk in order to produce the shells of the eggs. In Baltic 3 types of food and food additives for chicken were identified:

Ground and dried mussel meat as a replacement for mealworms or black soldier fly larvae.

Cooked and dried, and ground whole mussels. These provide 100% of the required calcium, about 42% of the required protein, and 17% of the required fat. The rest has to be added from other sources; we estimate a price of €1.00 additional costs per kilogram product for the supplementary ingredients (corn, maize, gluten, plant-based proteins, fat, vitamins, spore elements and appetisers).

Ground shells as chalk (calcium carbonate) addition to other chicken feed.

The cost/revenue table shown in the business plan reveals that a production above 10,000 t of fresh mussels can be profitable, particularly in the case of dried meat as a substitute for other animal protein sources. A particular advantage is given in the fact that dried mussel meat can be combined with the sale of the remaining shells, which would result in a profit of more than €3.00 per kilogram of fresh mussel produced.

3.6.1 Market volume

We assume a market volume of 500 tonnes for the dried mussel meat as well as for the recipe that includes entire dried and ground mussels (see business planning). For the total European market, the potential is estimated to be about twice as large (1,000 tonnes per year). The marketable amount of shells is huge, provided that the price is competitive.

3.6.2 Cost comparison between frozen meat and standard market prices

In our calculations, we assumed prices for ground and dried mussel meat to be similar to those of dried mealworms or black soldier fly larvae.

3.6.2 Conclusion

Chicken feed for hobby chicken husbandry seems to be a potentially profitable sector. However, profitability is given only for large volumes of production, which requires a sound marketing.

3.7 Shells

3.7.1 Chicken feed additive

Private chicken farming in the backyard is getting increasingly popular in Europe; according to German law, for instance, between 3 and 20 chickens (and one rooster) can be kept in a private backyard. Chickens need feed, and especially a source of chalk in order to produce the shells of the eggs. In Baltic MUPPETS, we identified 3 types of food resp. food additives for chicken:

1. Ground and dried mussel meat as a replacement for mealworms or black soldier fly larvae.

2. Cooked and dried, and ground whole mussels. These provide 100% of the required calcium, about 42% of the required protein, and 17% of the required fat. The rest has to be added from other sources; we estimate a price of 1.00 € additional costs per kilogram product for the supplementary ingredients (corn, maize, gluten, plant-based proteins, fat, vitamins, spore elements and appetisers).
3. Ground shells as chalk (calcium carbonate) addition to other chicken feed.

The cost/revenue table shown in the business plan reveals that a production above 1000 tonnes of fresh mussels can be profitable, particularly in the case of dried meat as a substitute for other animal protein sources. A particular advantage is given in the fact that dried mussel meat can be combined with the sale of the remaining shells, which would result in a profit of nearly €3.00 per kilogram of fresh mussel produced.

4. ENVIRONMENTAL SERVICE

Mussel farming can contribute significantly to the good environmental state of the Baltic Sea (Stybel et al. 2009, Lindahl & Kollberg 2009). One of the main issues in the Baltic Sea is eutrophication, a euphemism of the situation that the Baltic Sea is critically enriched with nutrients (nitrogen, phosphorus), which results in an excess growth of ephemeral algae (phytoplankton as well as seasonal filamentous macro algae), causing severe oxygen depletion in deeper parts of the sea bottom. In good approximation, 1% of the biomass of a fresh blue mussel is nitrogen; thus, farming and harvest of 10,000 tonnes of mussels would therefore extract 100 tonnes of nitrogen or 443 tonnes of nitrate from the water body.

For the time being, there is no compensation for this environmental service in force anywhere in the Baltic Sea and we have to conclude that the market readiness of this approach is not given. Nevertheless, some local initiatives exist (e.g., see Ecopelag), which could be used as a blueprint for other regions as well.

It is a well-known fact among divers and snorkelers that the water transparency is significantly higher above and in the vicinity of mussel beds. A more quantitative study by Schröder et al. (2014) at and around the Kiel Marine Farm has also shown that the water transparency is increased downstream of the farm.

Mewes (2007) estimated costs to reduce the input or content of a water body to be around €20.00 per kilogram of nitrogen. An extended report (UBA 2017) comes to similar orders of magnitude, of course, with considerable variations in costs according to the employed methods (denitrification, improved fertilisation of fields, wetlands etc.) and location. Taking these €20.00 per kilogram of nitrogen as a base would result in an extra benefit of €0.20 per kilogram of mussels harvested and would make mussel farming considerably more profitable.

Unfortunately, a compensation scheme for nutrient retention by extractive aquaculture is not in sight; more lobbying is required, and there is hope that in future this ecosystem service of mussel farming will be adequately acknowledged someday.

5. CONCLUSIONS

Mussels are a suitable and attractive ingredient for pet food, offering a marine-based protein source that can support product differentiation and circular bioeconomy objectives. The market is also showing readiness for a mussel-based pet food product, with growing consumer interest in sustainable, natural, and novel protein sources for companion animals.

However, the current analysis indicates that dried mussel products are not the preferred route for scale-up. Drying demands substantial capital investment (e.g., dryers and extrusion lines) and is energy-intensive, which raises unit costs and undermines price competitiveness relative to market benchmarks.

A wet-food pathway is therefore the more viable option. Wet formulations avoid most of the drying-related capex and energy burden, require fewer processing steps, and allow efficient use of raw material while aligning with established premium price tiers in the market. Within this pathway, minimally processed BARF-style products (biologically appropriate raw food) present the simplest and potentially most cost-effective approach, as they can be produced with the fewest unit operations and limited specialised equipment.

Pursuing BARF-style or other wet formats will nonetheless require rigorous food-safety controls (e.g., validated sourcing, hazard analyses, appropriate heat treatment or strictly managed cold chains, and clear labelling) as well as shelf-life and palatability validation. Subject to these standard assurances, prioritising wet and especially minimally processed formulations provides the most credible route to commercialisation, whereas dried products should be de-emphasised or retained only for niche, higher-margin applications.

REFERENCES

Lindahl, O., Kollberg, S., 2009: Can the EU agri-environmental aid program be extended into the coastal zone to combat eutrophication? *Hydrobiologia* 629 (1), 59 – 64.

Mewes, M. 2007: Kosten-Wirksamkeitsanalyse von Gewässerschutzmaßnahmen zur diffusen Nährstoffreduktion – deutsches Ostseeinzugsgebiet (Cost-effectiveness-analysis of water protection measures according to diffuse nutrient reduction – German Baltic Sea catchment area). *Rostocker Meeresbiolog. Beitr.* Heft 17 67 - 76 Rostock 2007

Schröder, T., et al., The impact of a mussel farm on water transparency in the Kiel Fjord, *Ocean & Coastal Management* (2014), <http://dx.doi.org/10.1016/j.ocecoaman.2014.04.034>

Stybel, N., Fenske, C., Schernewski, G., 2009: Mussel cultivation to improve water quality in the Szczecin Lagoon. *J. Coast. Res. (SI 56 (ICS 2009))*, 1459 – 1463.

UBA, Umweltbundesamt 2017: Quantifizierung der landwirtschaftlich verursachten Kosten zur Sicherung der Trinkwasserbereitstellung. UBA Texte 43/2017; 252 pp.