

# Understanding the value of freshwater aquaculture and fish processing by-products through agroinnovative approach & technological solutions

## INTRODUCTION

The H2020 SEA2LAND project (2021-2024) aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. This project will meet this challenge by **improving and adapting technologies for nutrient recovery to produce bio-based fertilisers (BBFs) and Tailor Made fertilisers (TMFs) from fishery and aquaculture by-products generated in Europe.** Therefore, SEA2LAND will contribute to independence and secure the supply of nutrients to European agricultural systems and will promote the production of large-scale fertilizers (from non-imported raw materials), based on the circular economy model to transform by-products into nutrients for crops. Particularly, CAVIAR PIRINEA together with some research partners are making available extended catalogue of animal by product, which are routinely sold to waste managing companies with no valorisation income derived. The technological approaches developed herein by BETA Technological Centre (BETA TC) are revealing that within a private aquaculture production scenario of 3.100Tn fish/year (i.e., rainbow trout (*O. mykiss*) and sturgeon (*Arcipenser sp.*)) and 1.902Tn of fresh processed products/year (i.e., fish, roe and caviar) => 69m<sup>3</sup> fish sludge, 96Tn fish viscera and 200Tn of non-conforming fish/year could respectively be valued through some of the current research techniques in progress. Likewise, the project could show that **every increased productivity as derived from intensification in aquaculture and/or fish processing practices will not only lead to a subsequent huge, but also economically recoverable production of agro innovative byproducts.** The solutions developed are expected to reduce the soil nutrient imbalance in Europe.

## MATERIAL & METHODS

An innovative technological approach is being evaluated within some of the work packages for the valorization of aquaculture by-products (fish sludge and dead fishes). The **SLUDGE** is separated into solid and liquid fractions. Solid fraction valorization is conducted by applying biodrying processes, aiming to reduce the water content and obtain a nutrient-rich biodried product to be used as an organic amendment. The combustion of this product to recover phosphorus from the ashes to produce **phosphoric acid** is also expected. The feasibility of recovering the volatilized ammonia during the biodrying to produce **ammonium salt** is also under current evaluation within the project. The liquid fraction from sludge is being valorized by using several concentration processes. The method consists of an ultrafiltration (UF) system to separate solid particles present in the liquid fraction. The permeate produced by UF passes through the reverse osmosis (RO) system to concentrate the nutrients. The RO concentrate generated is subsequently processed in a Freeze Concentration (FC) unit, where the water is crystallized, and the **nutrients** are recovered in a nutrient-rich concentrate product. Moreover, a high-quality RO permeate with potential to be reused in the aquaculture industry facilities is also produced. Likewise, dead trout **FISH FROM FARMING MORTALITY** is used as co-substrate of the solid fraction in the bio-drying process.

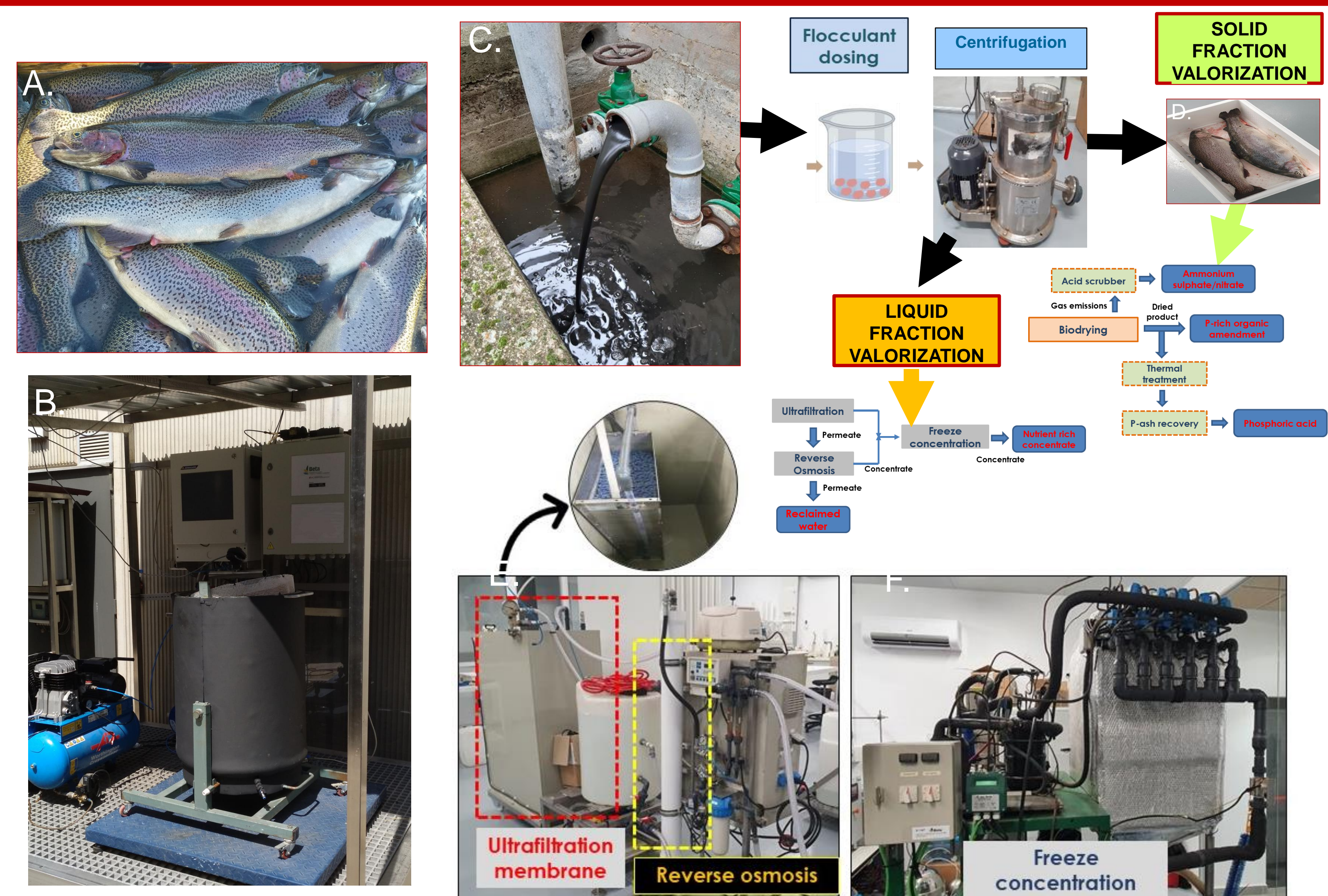


Figure 1: A. Individuals of Rainbow Trout from Caviar Pirinea. B. Biodrying pilot unit for the valorization of fish sludge and dead fish set in BETA.

Figure 2: Technologies applied for the liquid fraction valorization. C. Fish Sludge from the processing plant. D. Dead fish as co-substrate. E. Mechanical process and osmosis. F. Freeze concentrator.

## RESULTS AND DISCUSSION

- ✓ The by-products (sludge + dead fish) that are being used from freshwater aquaculture systems can be successfully valorized by a portfolio of technologies to recover nutrients on a dry basis, as follows for example:
  - Solid fraction of freshwater sludge: 7.0% TKN, 0.4% TP, and 0.1% K.
  - Liquid fraction of freshwater sludge: 0.33 g N/L, 0.02 g TP/L, and 0.02 g K/L.
- ✓ Dead fish is being valorized as a co-substrate during the treatment of the solid fraction from freshwater aquaculture sludge. **The specific use of trout as a co-substrate is being very interesting because it presents high organic matter content and valuable and recoverable nutrients** as N (4.4% TKN) and P (0.4% TP) on a dry basis.
- ✓ 26 private and public stakeholders involved in 9 work-packages and with expertise in the fields of agriculture, aquaculture, fisheries and fish processing from all over Europe represent the technical basis structure generating, through the end of 2024, comprehensive data sets relating to (i.) **agriculture and fertilization**; (ii.) **side-streams characterization and technology development**; (iii.) **food waste and circular economy**; (iv.) **environmental performances and constraints**; (v.) **sustainability assessment and business models**.
- ✓ The physicochemical characterizations herein are making evident the **feasibility of recovering nutrients from dead fish at sludge produced in aquaculture companies** and it could represent a promising option for the production of bio-based fertilizers (BBF) from aquaculture by-products (further details on freshwater vs. marine, in progress).
- ✓ The potential application of **these BBF could reduce the costs associated with sludge management**, bringing both cost reduction a new market opportunities, for the aquaculture sector.
- ✓ CAVIAR PIRINEA and BETA Technological Centre will continue working on **nutrients recovering and pilot valorisation activities**, for both aquaculture (i.e., dead fish) and trout processing (i.e., sludge) activities.
- ✓ NEXT STEPS: Batch tests on BBFs production and agronomic assessment on Pot Tests will be developed.
- ✓ POTENTIAL RISKS: Low concentration of nutrients and/or variability in composition of raw materials which cannot be used for BBF.

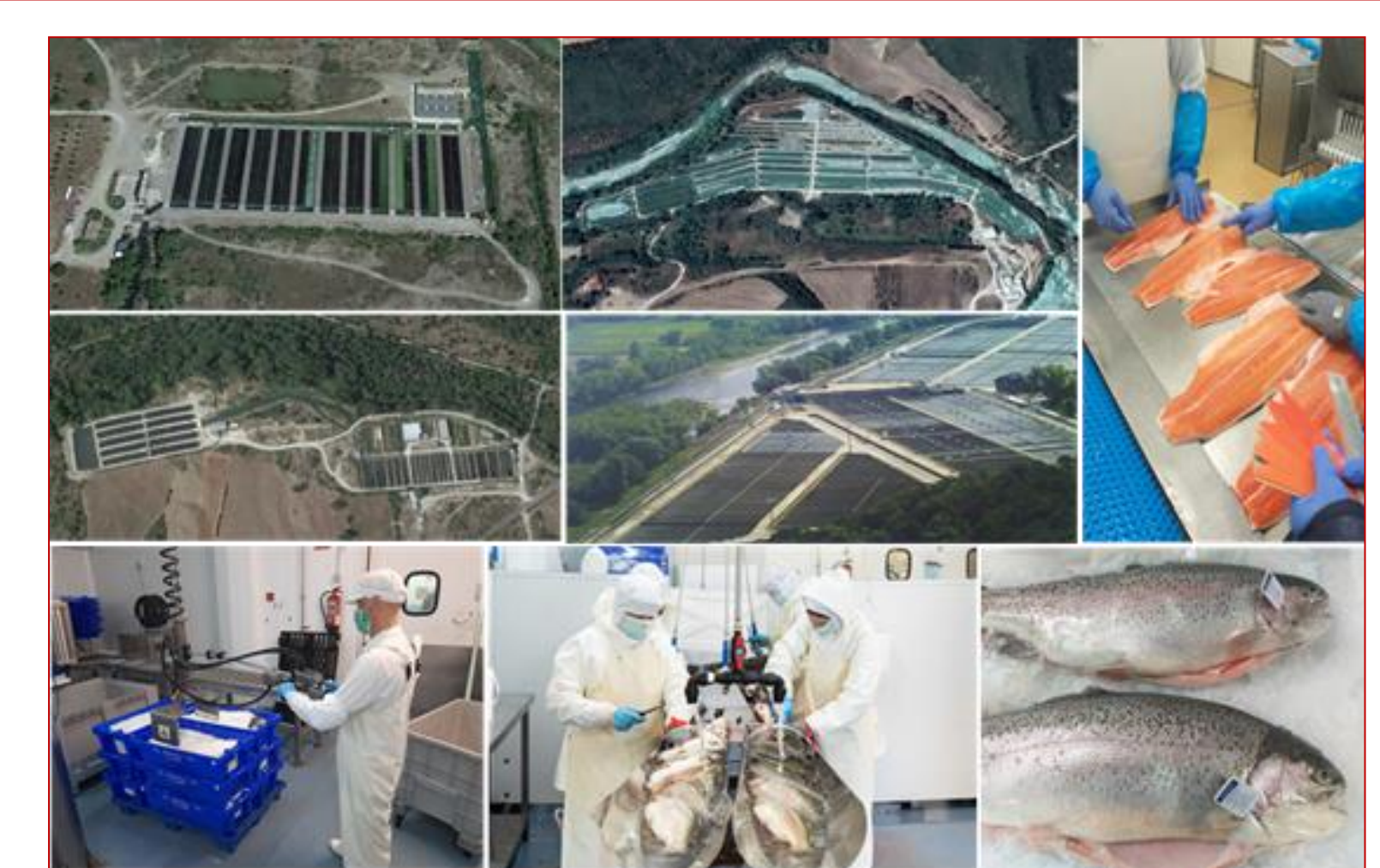


Figure 3: Some of the facilities and activity of Caviar Pirinea Slu.

	Fish sludge	Solid fraction	Liquid fraction
TS (%)	2.2 - 3.3	11.8 - 13.2	0.05 - 0.08
VS (%)	1.9 - 2.8	10.5 - 11.6	0.012 - 0.018
TKN (g/L or g/kg)	1.2 - 1.9	8.3 - 9.9	0.31 - 0.35
TP (mg/L or mg/kg)	36 - 119	47 - 637	0.07 - 35.1
K (mg/L or mg/kg)	34 - 42	114 - 135	20 - 23

Figure 4: Physicochemical characterization of the industrial WWTP sludge provided by CAVIAR during the different sampling campaigns.

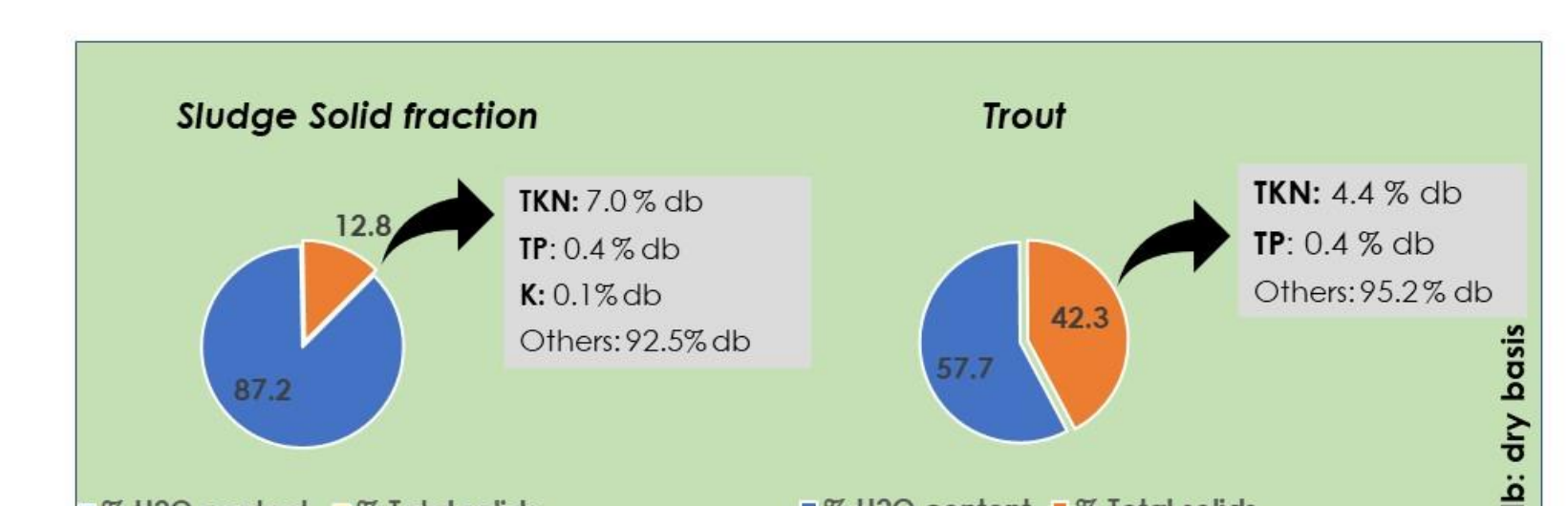


Figure 5: Freshwater Aquaculture by-product characteristics.