MICROBIAL PROTEIN IN STARTER FISH FEEDS

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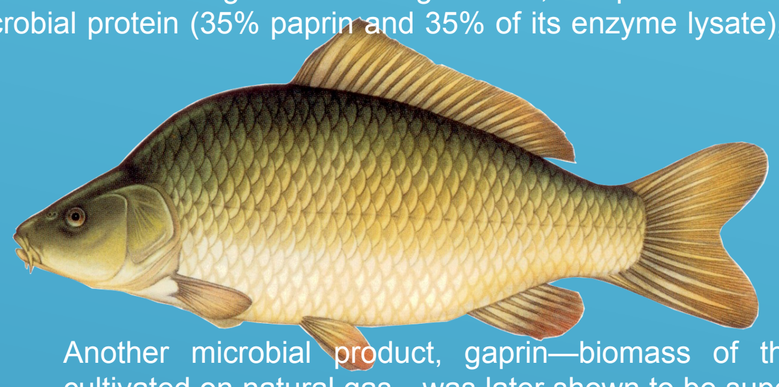
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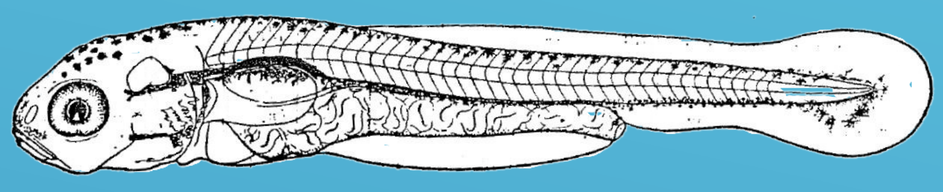
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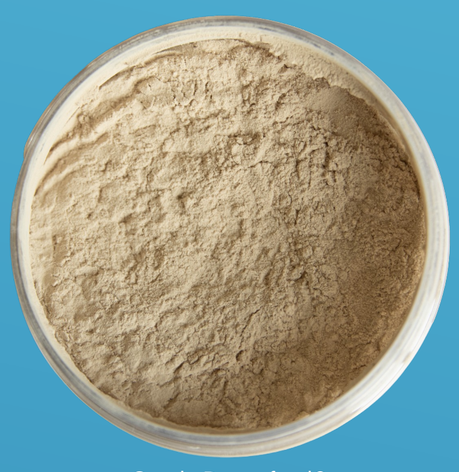
The Soviet Union was the first country to experience a protein shortage for livestock feed. To solve this problem, it was proposed to produce g.*Candida* yeast using petroleum byproducts—n-alkanes. The product, called paprin, was mass-produced in the USSR in the 1970s and 1980s. At peak, its production reached 1 million tons per year, and it was successfully used as a protein supplement in feed for cattle, pigs, poultry, and fish (primarily carp). However, this product also proved to have another very useful feature.

The larvae of most fish species begin exogenous feeding while their digestive systems are still developing, which requires a high level of readily available nutrients—especially protein—in starter feeds. Under natural conditions, this need is met by the unique structure of small zooplankton proteins, which are rich in low-molecular-weight peptides and free amino acids. However, including large amounts of conventional high-protein ingredients (such as fishmeal) in starter feeds often leads to mass mortality in larvae.

In the 1970s and 1980s, after extensive testing of various ingredients, this problem was solved only through the use of microbial protein, specifically paprin. The starter feed EQUISO, containing 70% microbial protein (35% paprin and 35% of its enzyme lysate), was successfully used throughout warm-water aquaculture for feeding common carp (*Cyprinus carpio*) larvae.







Gaprin Dreamfeed®
by Giprobiosintez LLC, Russia

Another microbial product, gaprin—biomass of the methane-oxidizing bacterium *Methylococcus capsulatus*, cultivated on natural gas—was later shown to be superior to paprin for carp at all developmental stages, from larvae to broodstock. Unfortunately, production of microbial protein products ceased at the end of the last century. In recent years, however, rising demand for feed protein has renewed interest in these materials.

Unlike fishmeal, bacterial biomass—similar to small zooplankton—contains small peptides and free amino acids essential during the initial feeding period of larvae. It also contains larger peptides and low-molecular-weight proteins required for the subsequent development of digestive function. In nature, juveniles obtain these proteins as their diet gradually shifts. The amino acid composition of bacterial biomass is quantitatively similar to that of zooplankton and fishmeal across all limiting amino acids, including lysine, methionine, tryptophan, phenylalanine, and isoleucine. Gaprin, produced from rapidly growing microorganisms, also contains large amounts of nucleic acids of various sizes, similar to zooplankton and fish larvae themselves.



СОЮЗ СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК
ГОСУДАРСТВЕННЫЙ КОМИТЕТ ПО ИЗОБРЕТЕНИЯМ И ОТКРЫТИЯМ
ПРИ ГОСУДАРСТВЕННОМ КОМИТЕТЕ СССР ПО НАУКЕ И ТЕХНИКЕ
(ГОСКОМИЗОБРЕТЕНИЙ)

АВТОРСКОЕ СВИДЕТЕЛЬСТВО
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На основании полномочий, предоставленных Правительством СССР, Госкомизобретений выдал настоящее авторское свидетельство на изобретение "Гаприновый корм для мальков"

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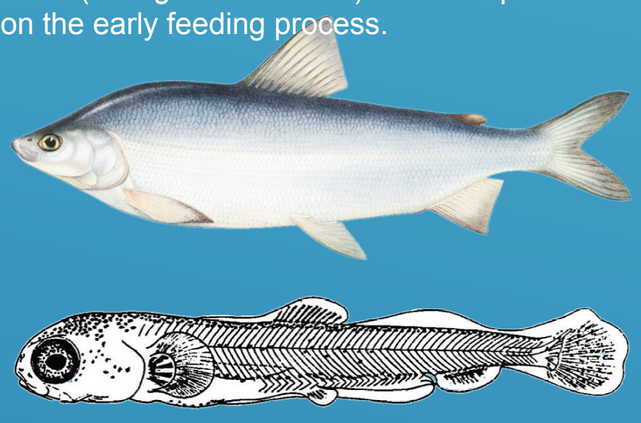
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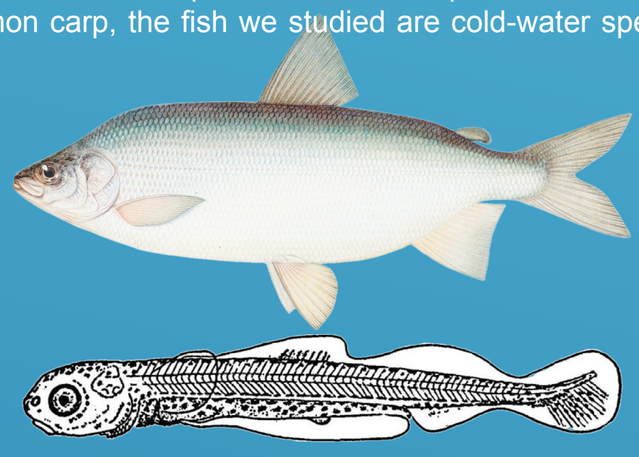
Председатель Комитета

Начальник отдела

The revival of interest in gaprin as a source of protein in fish feed and the start of its production allowed us to conduct experiments on two species of whitefish (Salmonidae, Coregoninae): muksun (*Coregonus muksun*) and European whitefish (*Coregonus lavaretus*). Unlike common carp, the fish we studied are cold-water species, which has a significant impact on the early feeding process.



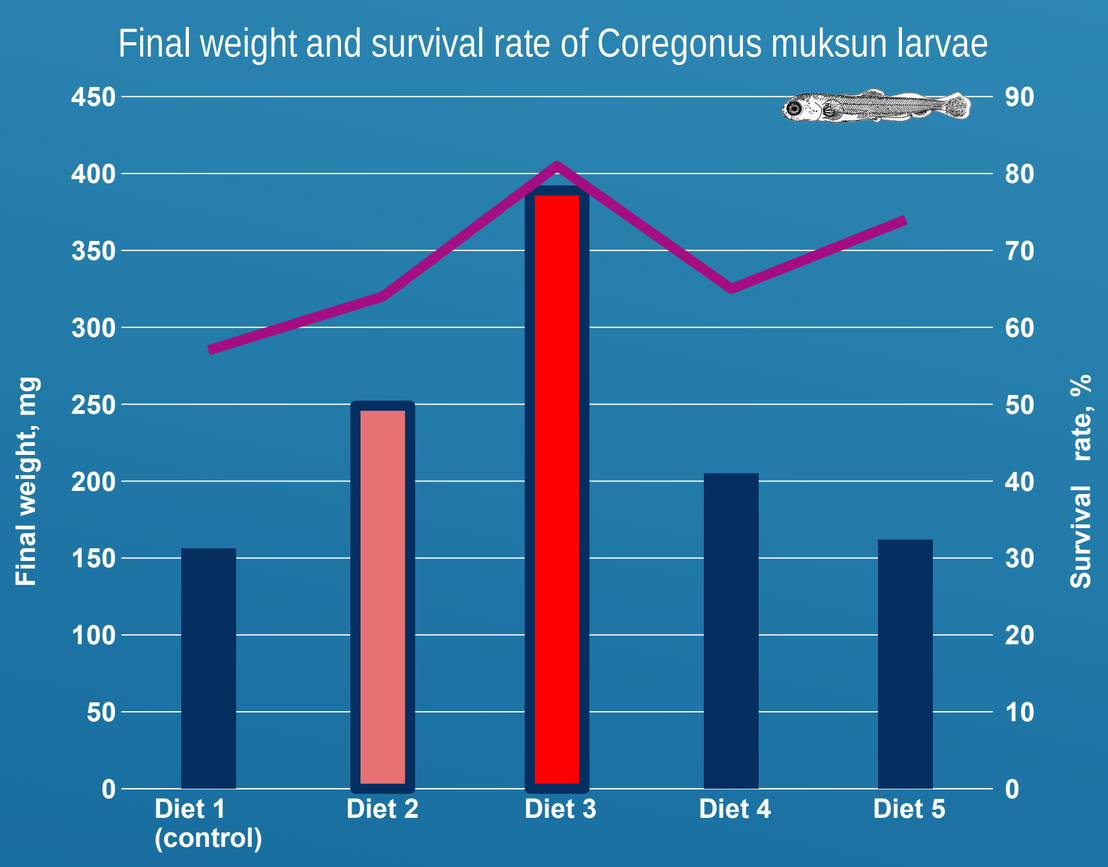
Muksun (*Coregonus muksun* (Pallas, 1814)) is an Arctic whitefish native to the rivers and large lakes of Siberia. It spends most of its life in estuaries with salinities of 6-8 ‰, ascending to the rivers to spawn. Mature fish average 33 cm in length and weigh 1-2 kg, with maximum sizes reaching 75 cm and 7-8 kg. It feeds on zooplankton and zoobenthos. In the wild, it matures at 6-7 to 11-14 years of age, depending on the water body. A valuable commercial species and a promising aquaculture target. In the wild, it suffers from water pollution and poaching. Artificial reproduction is necessary.

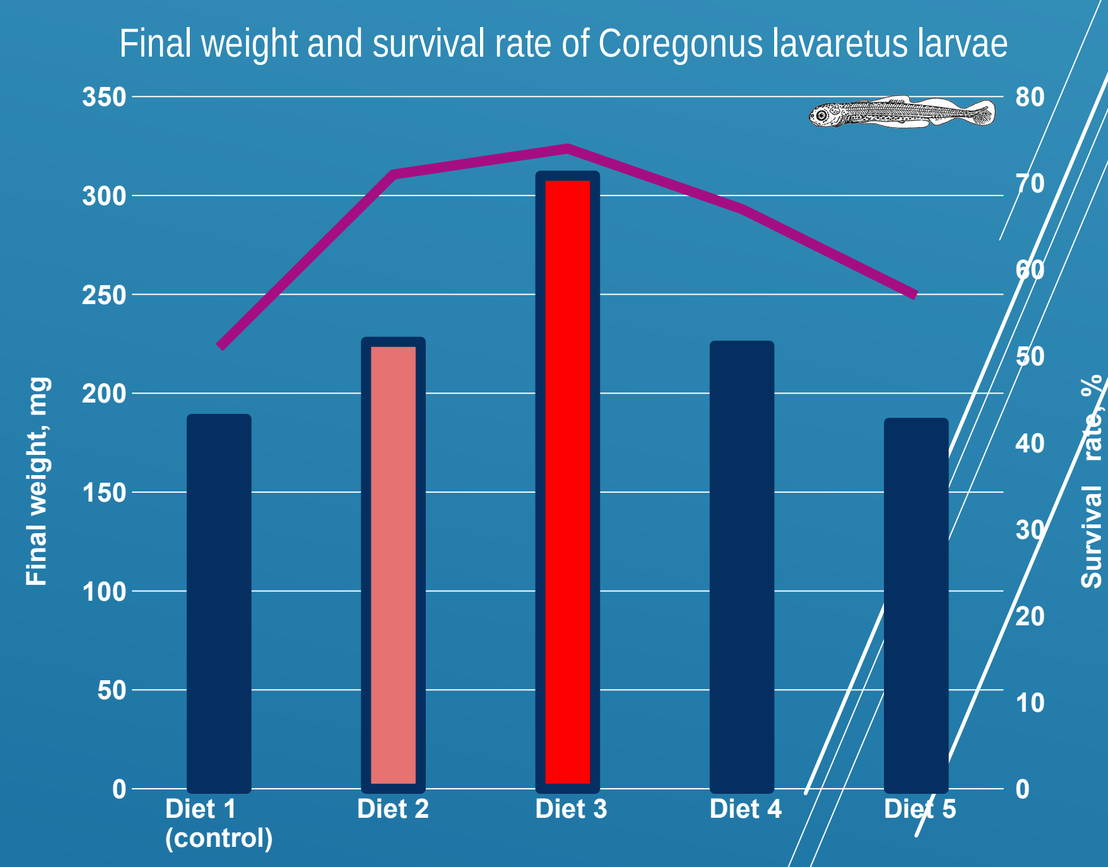


The common whitefish (Coregonus lavaretus Linnaeus, 1758) is a polymorphic species widespread across northern Eurasia and America, from the Baltic Sea to Chukotka, Alaska, and Canada. It occurs in numerous ecological forms, both freshwater and semi-anadromous, feeding on zooplankton and benthos. Body length varies from 10-15 cm in small forms to 30-60 cm in larger forms, and weight can reach 1-2 kg, with the maximum recorded weight being 12 kg. It reaches sexual maturity at 4-6 years of age, and spawns in most forms in autumn and winter. A valuable commercial species and an object of aquaculture. In the wild, it suffers from eutrophication of water bodies and poaching. Artificial reproduction is necessary.

Five experimental starter diets were formulated for testing. The control diet (No.1) contained fish meal, meat meal, dried egg white, wheat flour, fish oil, dry soy phosphatides, and physiologically active additives. In the experimental diets, part of the fishmeal was replaced with gaprin (No.2), gaprin with liquid soy phosphatides (No. 3), fish fermentolysate (No. 4), or chicken meat hydrolysate (No. 5).

Experiments were conducted in 40-liter tanks with larvae of two whitefish species at the Forvat fish farm. Each tank contained 600 larvae. Feeding began on the first day of exogenous feeding. The experiment lasted 43 days at an average water temperature of 13.3°C (rising from 8°C to 16°C over the course of the trial). Muksun and whitefish larvae fed these diets significantly outperformed those fed the control and other experimental feeds in both growth (see figure) and survival.





Diets containing gaprin - particularly formulations with liquid phosphatides - significantly improved growth and survival relative to the control. Survival of muksun larvae increased from 57% (control) to 64–81% with gaprin-based diets, while whitefish survival increased from 51.7–74%. Feeds containing fish fermentolysate and chicken hydrolysate also improved survival but to a lesser extent.

These results demonstrate that gaprin is an effective primary protein source for starter feeds and can also serve as a valuable substitute for fishmeal in later developmental stages. The findings support renewed application of microbial proteins in aquaculture nutrition.