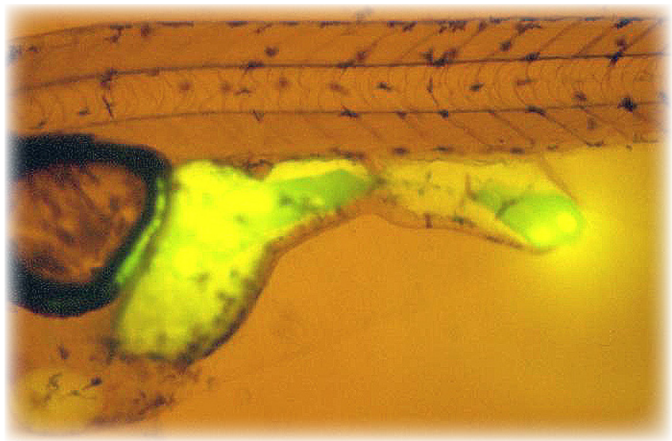
Tiny capsules may lead to big advances for aquaculture



Chris Langdon

Glowlight tetra (*Hemigrammus erythrozonus*) larvae fed on complex zein particles with embedded lipid spray beads containing riboflavin.

Oregon Sea Grant researcher Chris Langdon wants to help feed the world by using tiny beads.

Langdon, based at Oregon State University's Hatfield Marine Science Center, is building a better fish food for use in aquaculture, enclosing nutrients and medicines in microscopic beads made of fats in order to deliver them to animals ultimately destined for the dinner plate.

Why not feed farmed fish their usual wild diet? While this approach makes the most sense nutritionally, it poses a number of problems. "Live feed is often very expensive and of uneven quality," Langdon explained. In addition, he said, "live prey and microalgae culture require high labor costs, and algal cultures can crash, fueling bacterial blooms which can be trouble for the cultured species."

Langdon knew that artificial foods could solve these problems, but first a battery of challenges had to be addressed. For example, nutrients that dissolve easily in water tend to leach from food pellets quickly, ending up in the water rather than in the fish. Also, as any parent of a toddler can attest, just because certain foods are nutritious doesn't mean the picky eater will consume them. Artificial foods must be palatable and of an edible consistency so that the cultured fish and shellfish will eat them.

In the 1970s, protein-walled capsules were developed for administering therapeutic enzymes to diabetics. The enzymes were contained in these microscopic capsules. Langdon and some of his colleagues wondered: Could this approach work for delivering nutrients and medicines to fish, shellfish, and other cultured organisms?

With funding from Oregon Sea Grant, Langdon started by using protein-walled capsules to supplement diets of aquacultured oysters. He found that the oysters did absorb protein this way, with an efficiency of 40 percent.

Langdon also tried working with microbeads, capsules with walls made of fats. He found that while microbeads could contain nutrients well under most conditions, the payload—the amount of material that could be contained by the beads—was limited. That problem was solved by using a new technique that Langdon and colleagues have been perfecting: The use of lipid spray beads. Instead of being formed as a wall surrounding a core material, lipid spray beads consist of the material to be delivered, bound with a matrix of lipid (fat). The beads are made by spraying a mixture of the lipid and core materials into a chamber containing liquid nitrogen, which hardens the beads.

Lipid spray beads have been successful in encapsulating nutrients for feeding larval fish, shellfish, and live food for aquacultured species such as brine shrimp. By trying different combinations of lipid and payload, Langdon has been able to determine which lipid matrix material works best with each substance to be delivered.

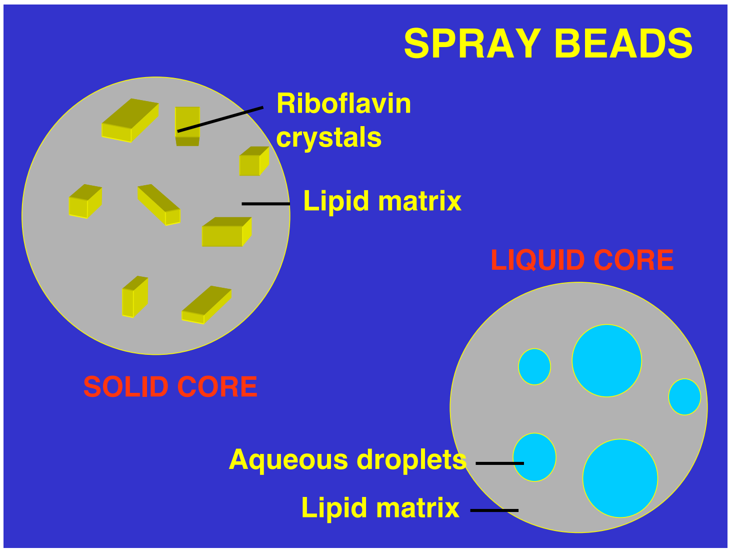
Langdon's colleagues in the aquaculture world are taking note of his achievements. "Chris's work addresses one of the holy grails of aquaculture," said Michael Rust of the National Marine Fisheries

Service in Seattle. "He has created particles that behave more like zooplankton than typical fish food, in that they can deliver nutrients without allowing their payload to leak out."

With further Sea Grant funding, Langdon has also shown that lipid spray beads can successfully deliver medicines to larval fish, particularly the antibiotic oxytetracycline. "You can't inject a fish larva with antibiotics," Langdon pointed out. Another hurdle was that oxytetracycline, although approved for use for aquaculture, could not be used in marine settings because it is inactivated in seawater. Langdon and one of his students successfully developed a lipid spray bead that contained the antibiotic and delivered it to fish larvae while protecting it from seawater.

While Langdon has surmounted problems of nutrient delivery and bead digestibility, getting the microcapsules to disperse in water is still a challenge for his laboratory. The particles tend to clump when added to water because, as most school children know, oil and water do not mix. One solution he is exploring is to create more complex particles that coat the lipid beads with zein, a protein derived from corn.

As total human population increases worldwide, so too will the demand for foods from the sea. "But there aren't enough wild stocks of fish and shellfish to meet the needs of the growing human population," Langdon said. "As a result, global aquaculture is growing at a phenomenal rate of about 10 percent a year." Langdon's work will help support aquaculture growth in the U.S., especially for high-quality food species, such as cod, that can be grown in pens offshore. Langdon believes that within 10 to 20 years, pen aquaculture will arrive on the West Coast. His research could lay the groundwork for that potential revolution.



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