





Smart Aqua4 FuturE

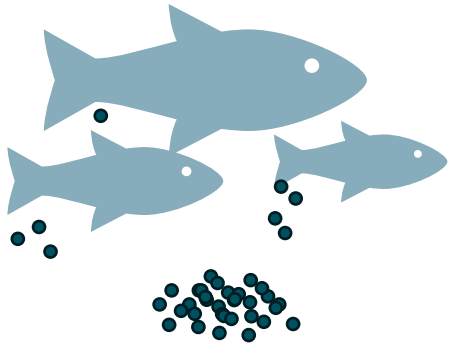
Centro Tecnológico de Investigación del Champiñón de La Rioja

From waste to worth: How mushrooms can help build a more circular aquaculture

27 October 2026

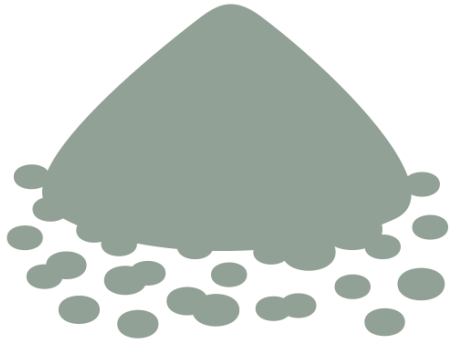
Marisa Tello

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Fish Farm (Generation of organic waste)

Substrate kitchen (Mixing waste with agro-ingredients)





Mushroom stems (Functional fish feed ingredient)

Mushroom cultivation (High-value food production)



The Substrate Kitchen

Three years of trials to find the perfect biological recipes.



Step 1: Chopping & Mixing

Balancing the carbon-to-nitrogen ratio.



Step 2: Pasteurization & Bagging

Eliminating competition.



Step 3: Incubation

Mycelial colonization in climate-controlled rooms.



Step 4: Fruiting

Triggering reproduction via temperature drops.

Mushroom cultivation trials

- ✓ Carp pond sediments
- ✓ Salmon RAS sludge
- ✓ Mealworm insect frass
- ✓ Aquatic plants (Watercress and Duckweed)





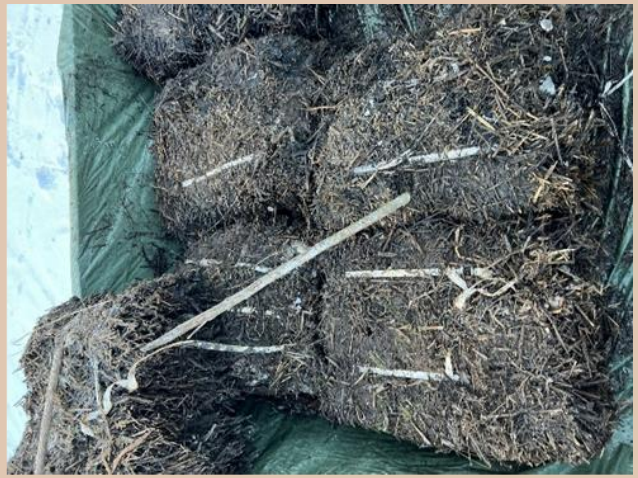


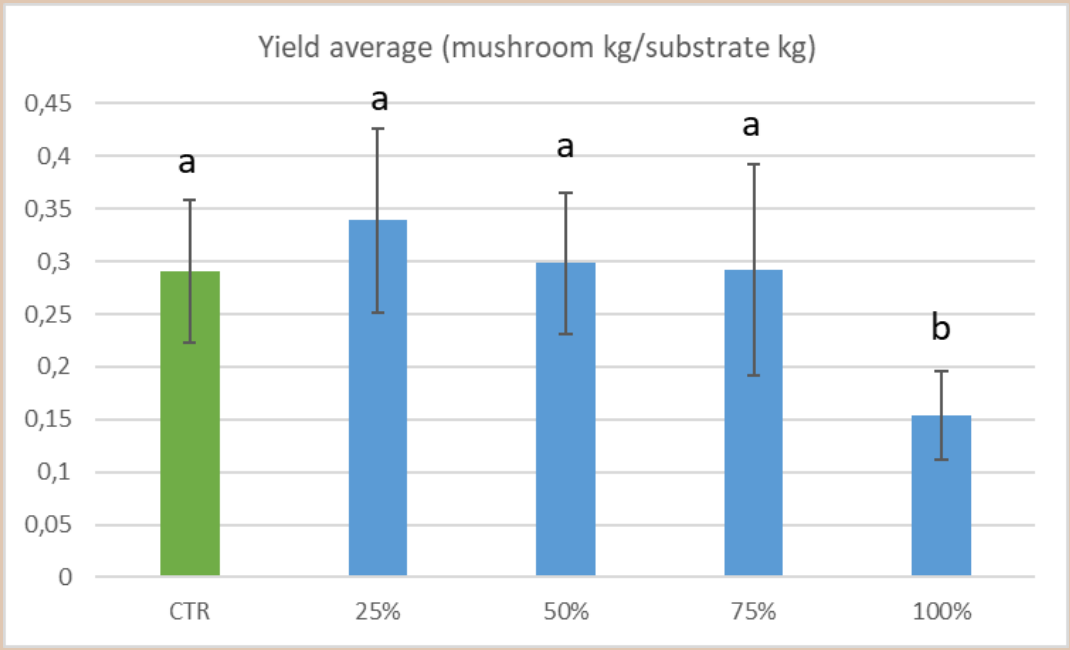
Carp pond sediments → Oyster mushroom

- ✓ CTR: control only with mushroom substrate.
- ✓ 25% straw+ sediment
- ✓ 50% half straw+sediment
- ✓ 75% straw+sediment
- ✓ 100% straw+sediment









Scaling-up → Fish feed trials

2,000kg carp pond waste material






1,800kg

Oyster mushrooms successfully produced

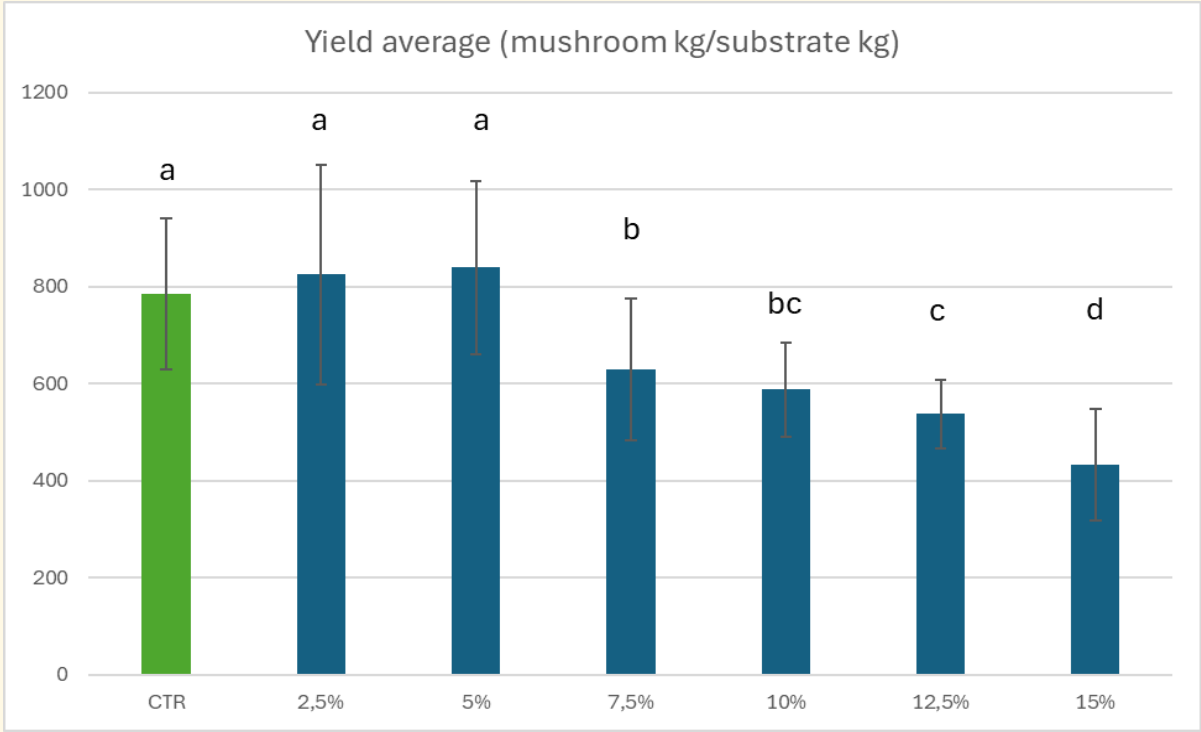


Functional fish feed ingredient

Salmon RAS Sludge → Oyster mushroom



- Salmon sludge dried with WAISTER system from Norway
- Mushroom substrates currently used by the industry as control (CTR)
- Mushroom substrates design (7 inclusion levels):
  - CTR: control only with mushroom substrate
  - 2.5% salmon sludge
  - 5% salmon sludge
  - 7.5% salmon sludge
  - 10% salmon sludge
  - 12.5% salmon sludge
  - 15% salmon sludge



Salmon RAS Sludge → King oyster mushroom

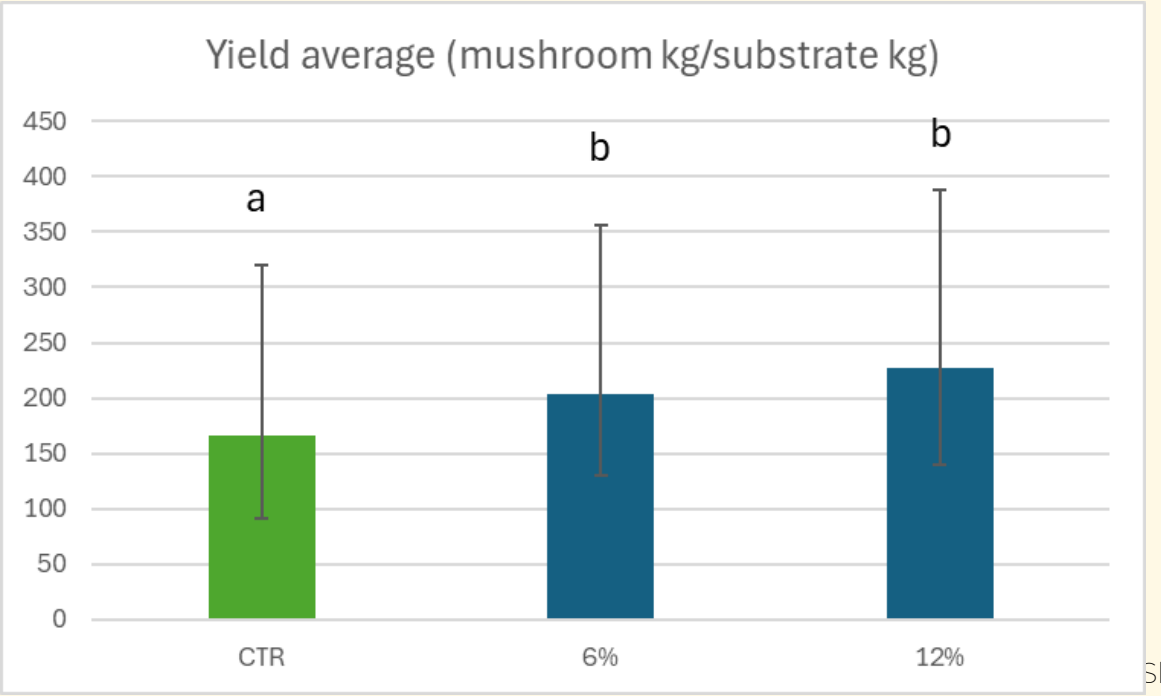


- Salmon sludge dried with WAISTER system from Norway
- Mushroom substrates elaborated at CTICH (sterilized) as control (CTR)
- Mushroom substrates design (3 inclusion levels):

✓ CTR: control only with mushroom substrate.

✓ 6% salmon sludge

✓ 12% salmon sludge



Salmon RAS Sludge → Piopino mushroom

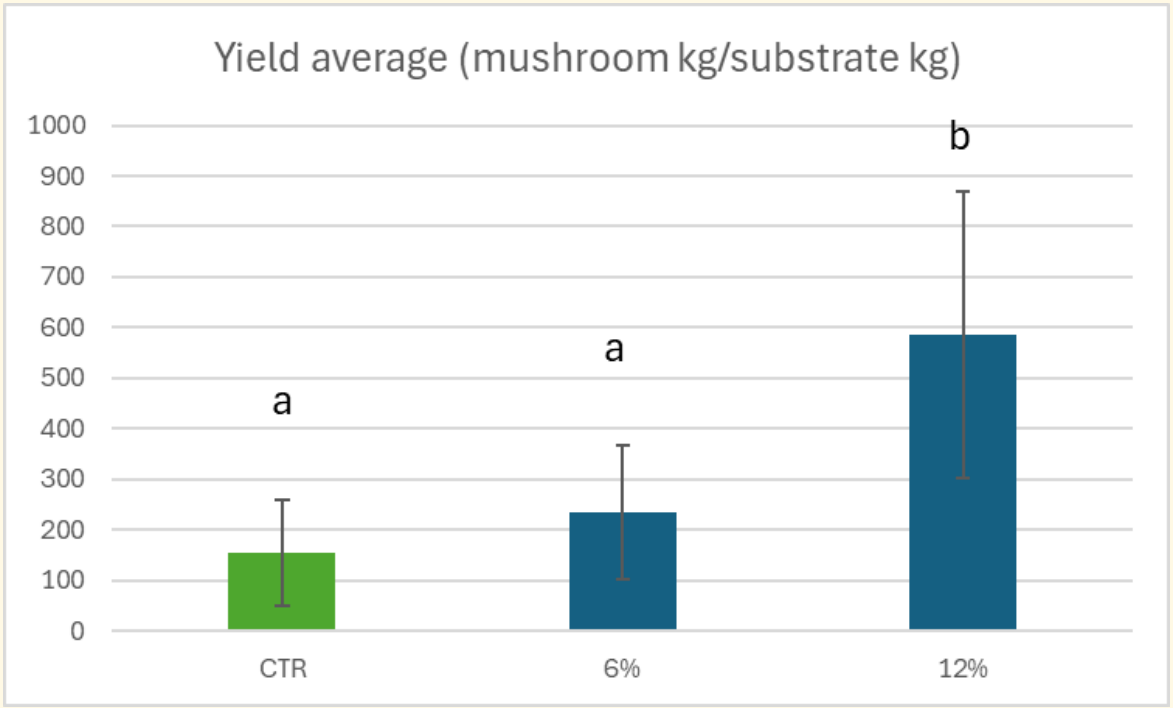


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✓ 6% salmon sludge

✓ 12% salmon sludge



Salmon RAS Sludge → Nameko mushroom

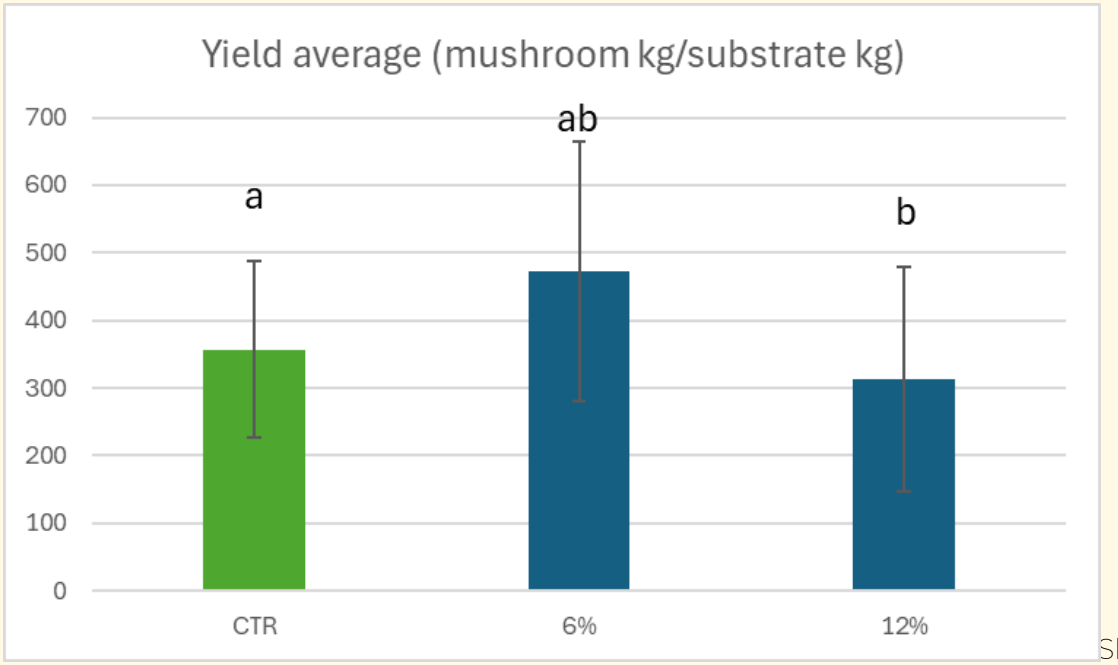
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✓ 6% salmon sludge

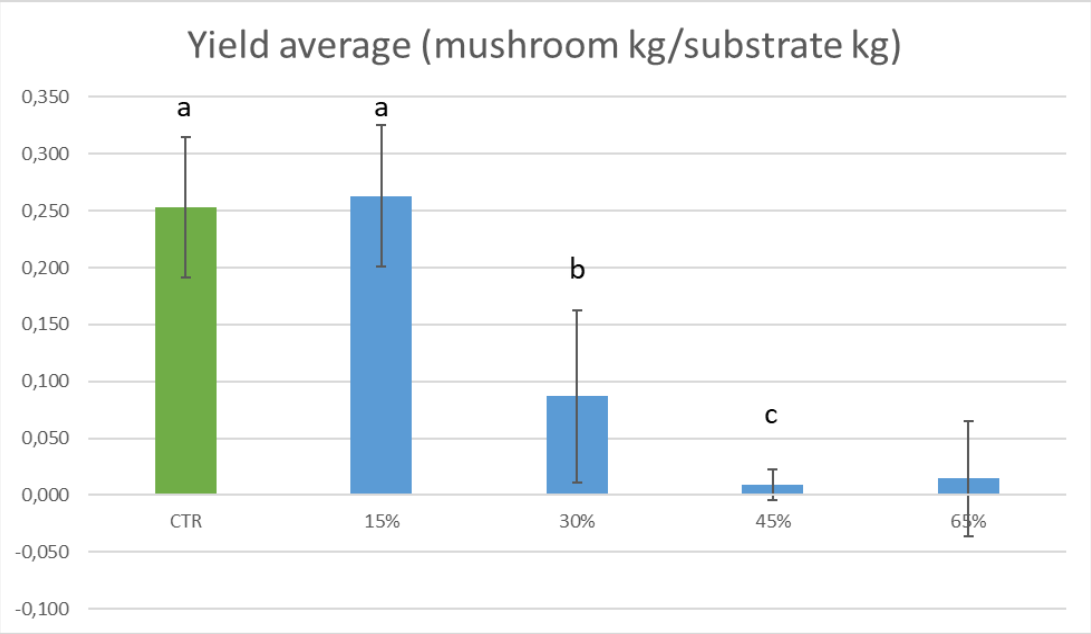
✓ 12% salmon sludge



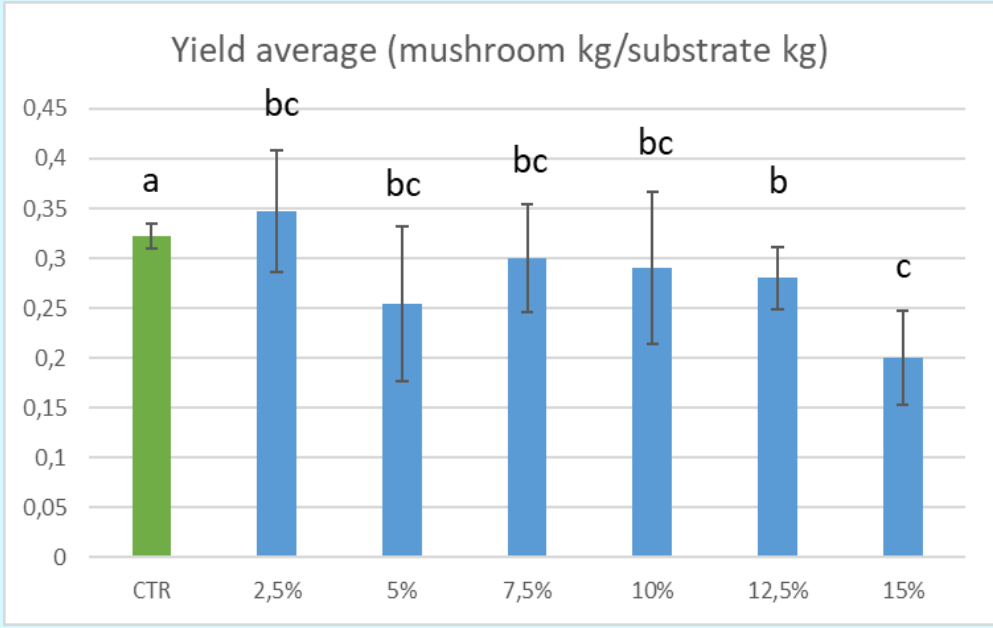


Mealworm insect frass trials → Oyster mushroom

- CTR: control only with mushroom substrate
- 15% insect frass
- 30% insect frass
- 45% insect frass
- 65% insect frass



- CTR: control only with mushroom substrate
- 2.5% insect frass
- 5% insect frass
- 7.5% insect frass
- 10% insect frass
- 12.5% insect frass
- 15% insect frass



✓ Aquatic plants (duckweed and watercress) trial → Oyster mushroom

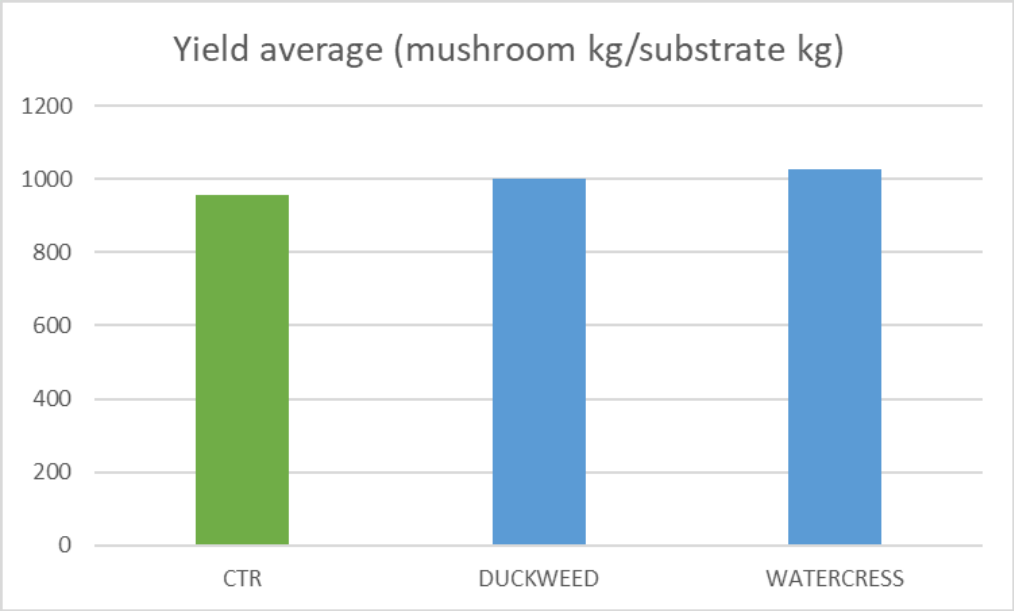
- D&W were used as ingredient for Oyster mushroom cultivation
- Mushroom substrates elaborated at CTICH (sterilized) as control (CTR)
- Mushroom substrates design:

✓ CTR: control only with mushroom substrate.

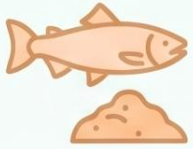
✓ DUCKWEED: mushroom substrate + 11.4% D

✓ WATERCRESS: mushroom substrate + 17.1% W



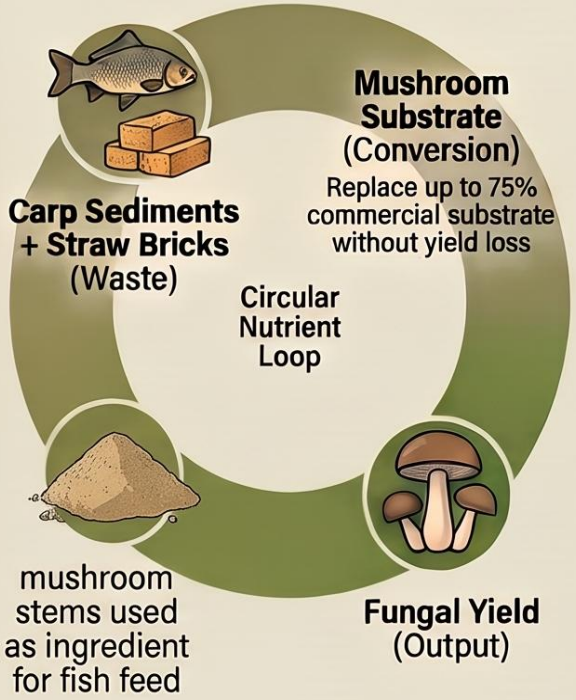


The Waste to Worth Cookbook

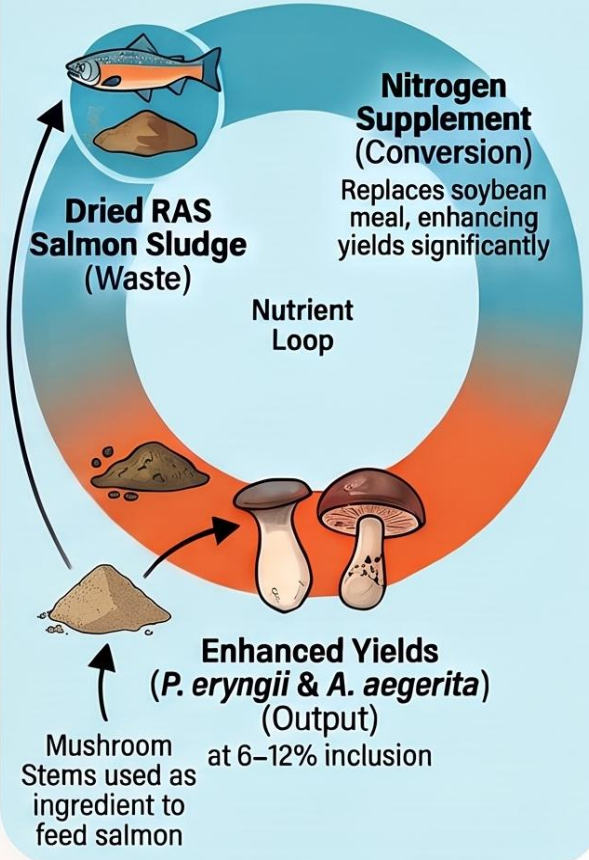
	Waste Stream	Primary Benefit	Optimal Inclusion	Best Application
	Carp Sediment	Bulk volume replacement	Up to 75%	Oyster mushrooms (High scalability)
	Salmon Sludge	Soy replacement (Protein)	6% - 12%	Premium fungi (King Oyster, Nameko)
	Insect Frass	Nitrogen & Nutrient density	≤10%	General use (requires coarse mix)
	Aquatic Plants	Renewable biomass base	~11% - 17%	Flexible baseline addition

Circular Bioeconomy: Upscaling Organic Waste via Fungal Bioconversion

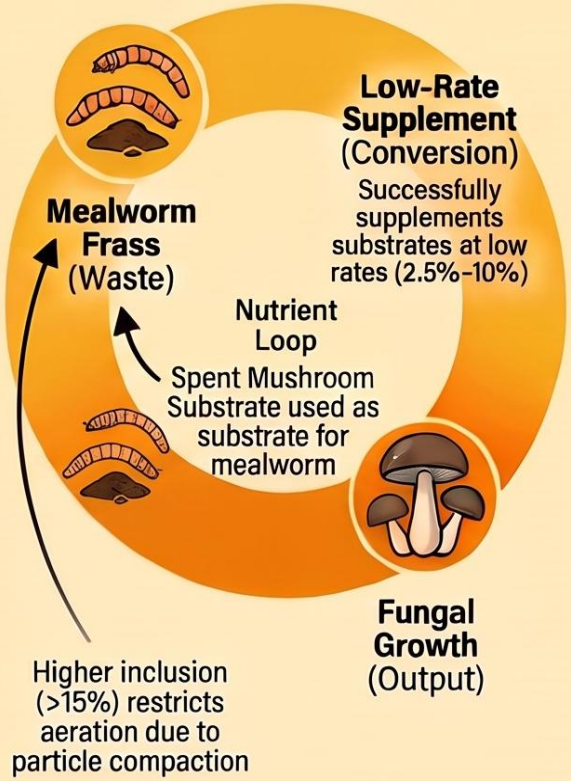
Carp Sediments to Mushroom Substrate



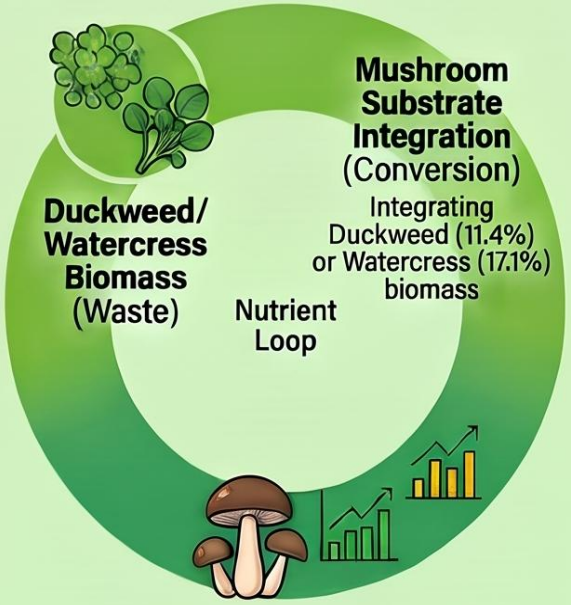
Salmon Sludge Replaces Soybean Supplements



Mealworm Frass Enhances Fungal Growth



Aquatic Plants Boost Mushroom Yields









Centro Tecnológico de Investigación del Champiñón de La Rioja

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Thank you for your attention

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In your opinion, which circular loop has the biggest potential?

