

Opportunities and challenges in the use of plant protein concentrates in feeds for carnivorous fish



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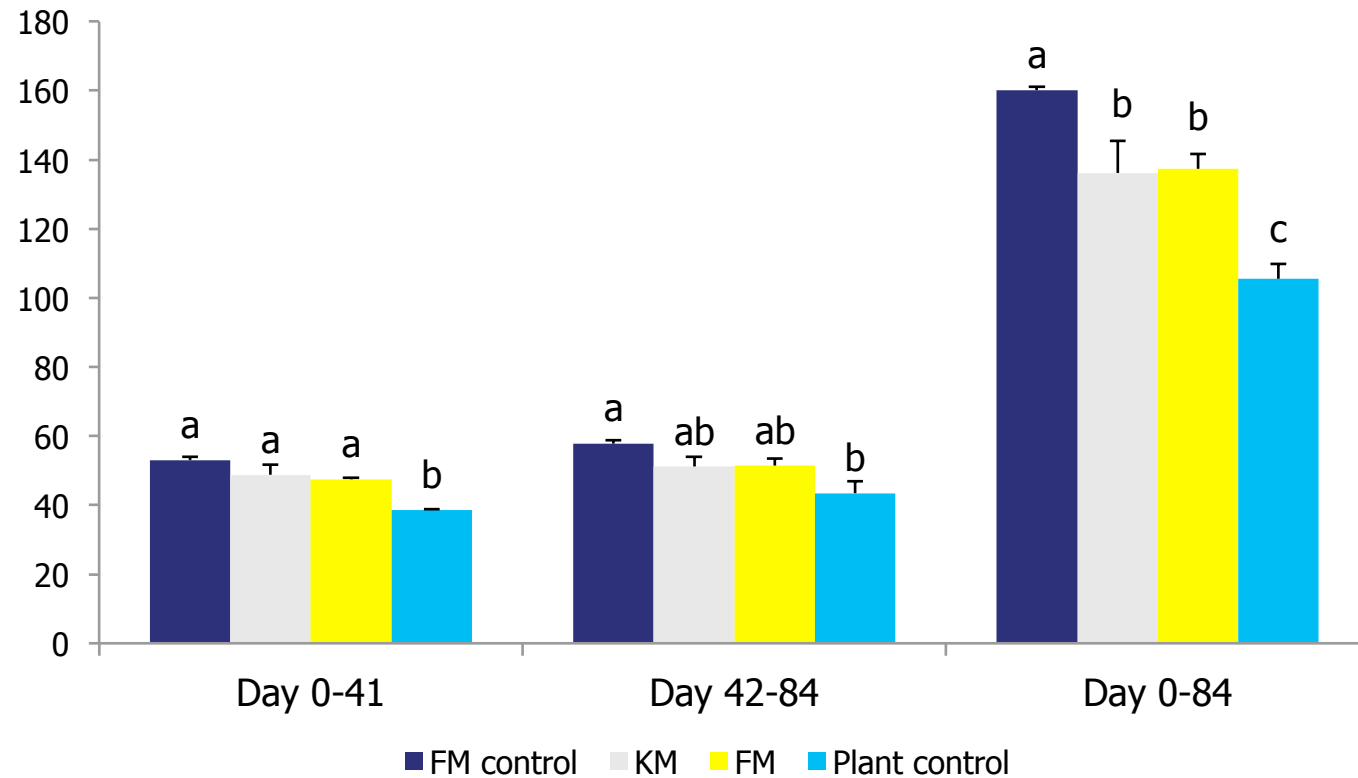
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Does salmon require dietary fish meal?

Diet	FM control	5% KM	5% FM	Plant control
Ingredient g kg⁻¹ DM				
Fish meal	562	0	50	0
Krill meal	0	55	0	0
Soy protein concentrate	0	195	193	211
Pea protein concentrate	0	195	193	211
Potato protein concentrate	0	195	193	211
Fish oil	113	117	121	119
Rapeseed oil	113	117	121	119
Wheat	167	85	85	85
Pea starch	42.0	13.8	20.0	18.3
Methionine	0	4.6	4.5	4.9
Lysine	0	2.2	2.2	2.4
Taurine+Premix+MCP	4.0	19.0	19.0	19.0

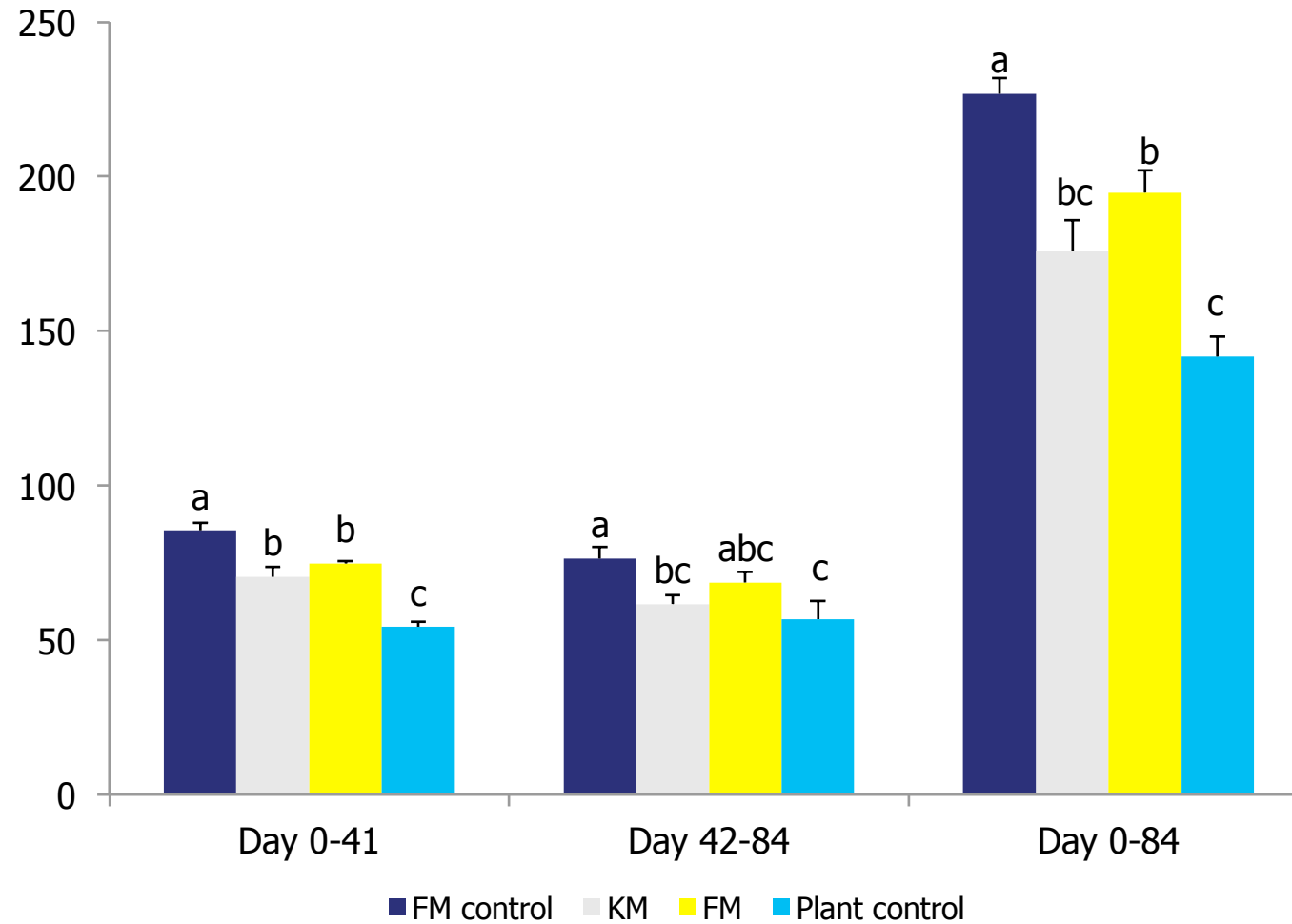
Feed intake in 0.2 kg Atlantic salmon fed a diet with LT fish meal as the only source of protein (FM control), only plant protein (Plant control), or 5% krillmeal (KM) or LT Fish meal (FM)

Feed intake % of initial body weight



Growth of the salmon

Body weight increase, %

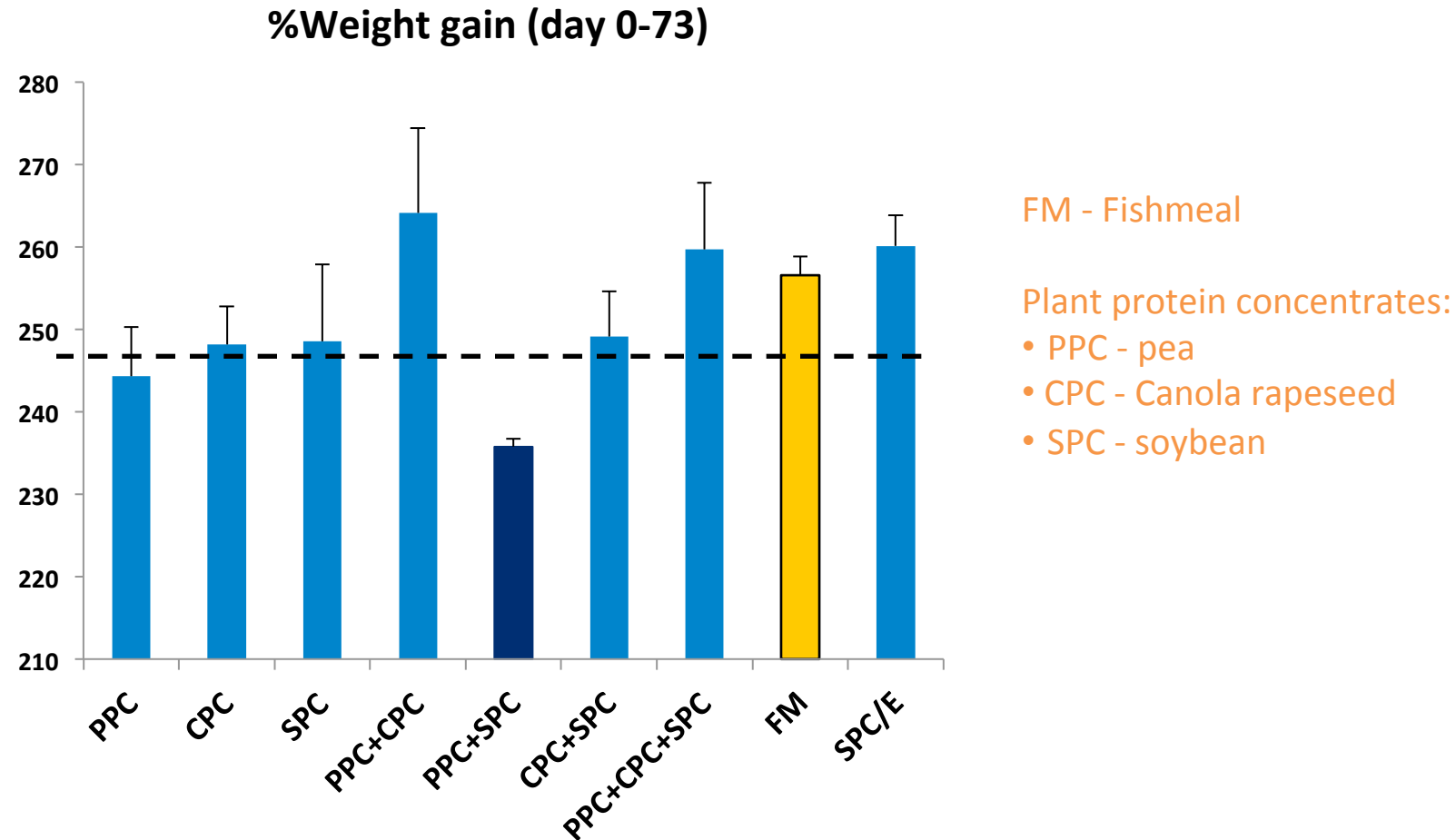


Composition of plant protein mixtures used in an experiment with rainbow trout

	P-MIX	C-MIX	S-MIX
Ingredients, g kg⁻¹			
Pea protein concentrate	491	-	-
Potato protein concentrate	491	490	-
Canola protein concentrate	-	490	-
Soy protein concentrate	-	-	932
Canola oil	-	-	38
<i>DL</i> -Methionine	13	10	14
<i>L</i> -Lysine	6	-	16
<i>L</i> -Arginine	-	11	-

Growth of 0.2-kg rainbow trout fed 95% of dietary protein from plant protein concentrates and 5% from krill meal

FCR 0.78-0.85; Protein retentions 50-53%

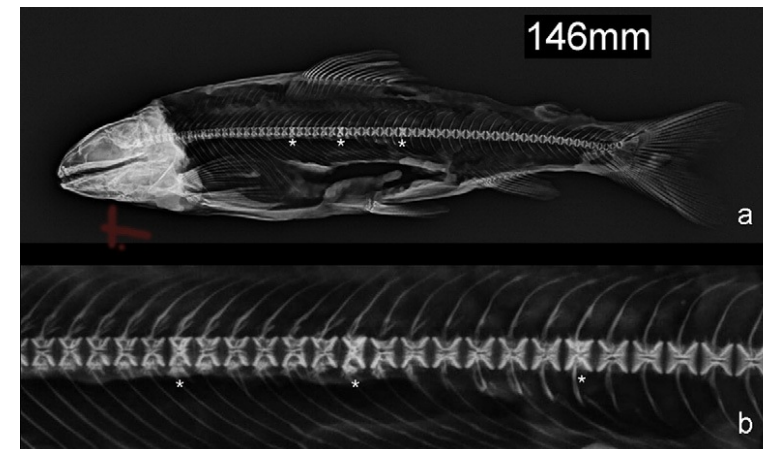
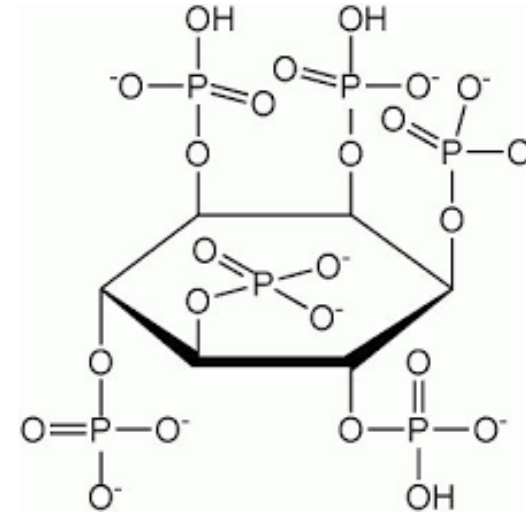


Soy protein in salmonid diets

- Soybean meal (SBM)
 - Solvent extracted
 - Causes enteritis
 - Protein digestibility similar to that of LT fish meal
- Soya protein concentrate (SPC)
 - Factors causing enteritis removed by the extraction
 - Phytic acid is a main challenge (up to 2% in SPC)
 - Common source of protein in salmon feeds

Phytic acid is a main limiting factor for the use of plant protein concentrates

- Poorly available source of phosphate
- Binds 2 and 3-valent cations such as Mg, Mn, Zn
- Results in poor mineralization, deformities and increased fecal phosphate pollution
- Plant protein concentrate production often causes elevated concentration of phytic acid
 - SPC, 2%;
 - Rapeseed protein concentrate, up to 3%



Need for phytase which is active at low temperature

Coldwater fish require **incubation with phytase** due to low temperature in the gut

Warmwater fish efficiently utilize dietary phytase. Thermo-stable enzyme or top coating is needed for extruded feeds

	FM	SPC	SPC-E
Total P, g/kg DM	13.0	8.1	8.4
MCP, g/kg feed	0	10	10
P digestibility, %	40	47	62
Digestible P, g/kg DM	5.2	3.8	5.2

Sustainability

- As defined by the "Farm Bill"
- [Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA), Public Law 101-624, Title XVI, Subtitle A, Section 1603 (Government Printing Office, Washington, DC, 1990) NAL Call # KF1692.A31 1990].

The term sustainable agriculture means:

“An integrated system of plant and animal production practices having a site-specific application that will, **over the long term:**

- satisfy human food and fiber needs;
- **enhance environmental quality and the natural resource base upon which the agricultural economy depends;**
- **make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;**
- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole.”

Sustainability: Fish meal bad – plants good?

Which is challenging, Fish meal or plants?

- Use freshwater: Plant
- Arable land and topsoil: Plant
- Phosphate loss to the marine environment: Plant
- Phosphate excretion to the freshwater environment: Both (Plants are more efficient than fish meal even without phytase treatment)
- CO₂ footprint: Both
- **Not sufficient amounts of fish meal available to satisfy the growing demand for high-quality protein in fish feeds, even with increased utilization of byproducts from marine catches.**