Alternative views on shrimp pond nutrition

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Dietary requirements shrimp

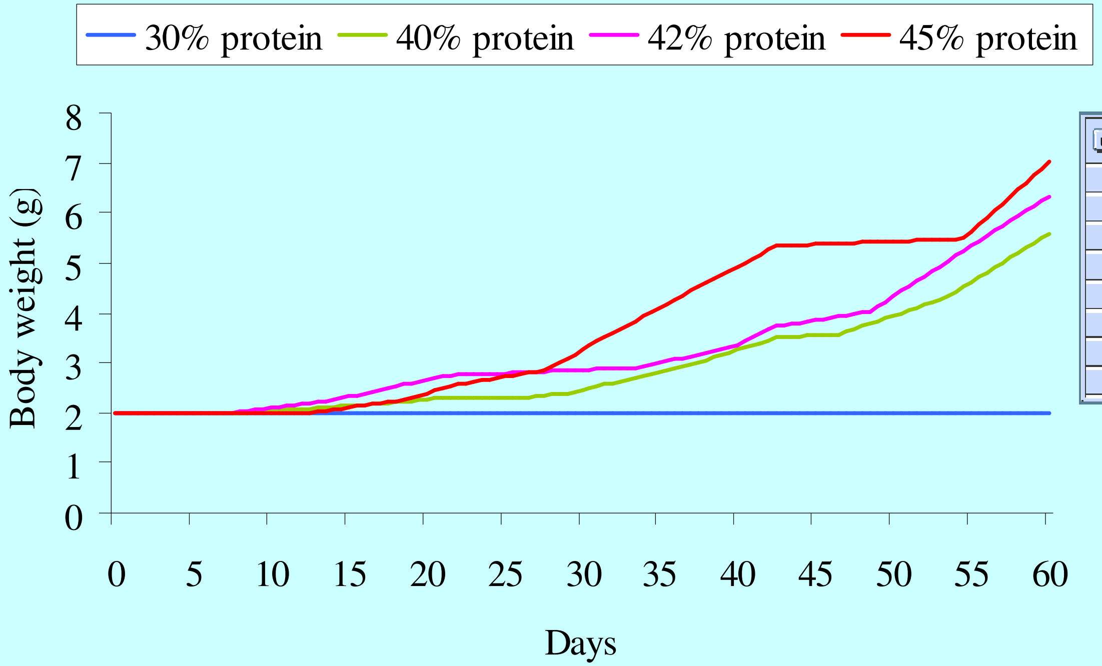
Requirement of dietary component	Percentage of diet	Reference
Dietary protein	45–50%	Lee (1971)
	40–44%	Alava and Lim (1983)
	40–50%	Bautista (1986)
	40–44%	Shiau et al. (1991)
	35–45%	Bages and Solane (1981)
	36–40%	Shiau and Chou (1991)
	40–50%	Chen (1993a)
Dietary lipid	6%	Wu (1986)
	4–11%	Sheen et al. (1994a)
HUFA	0.5–1%	Chen and Tsai (1986)
Linolenic acid and DHA	1.44%	Merican and Shim (1997)
Cholesterol	0.50%	Chen (1993b)
	0.2–0.8%	Sheen et al. (1994b)
Dietary carbohydrate	20%	Alava and Pascual (1987)
	20–30%	Shiau and Peng (1992)

35-45% dietary protein

20-30% dietary carbohydrate

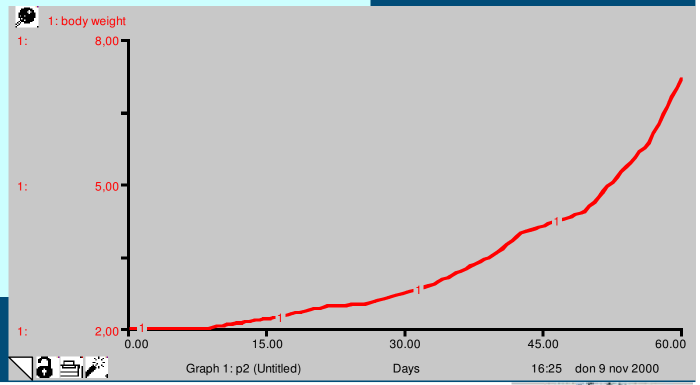
Model use

- Protein level in the diet



Feed and Feeding

feeding %	**3.5**
feed lip %	8
feed carbo %	15
feed dry matter	90
lipid digestibility	0.63
protein digestibility	0.92
carbo digestibility	0.4



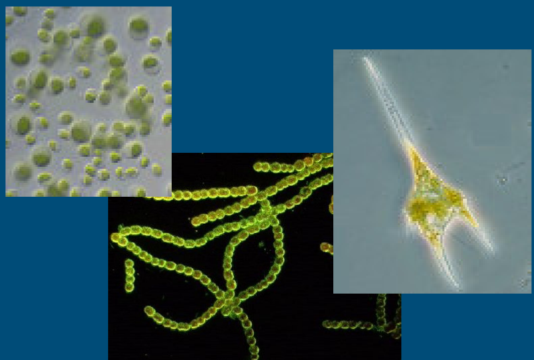
Bacterial flocks

- Active suspension ponds technology
- Bacterial flocks
- Source of:
  - Protein
  - PUFA’s
  - Minerals and vitamins

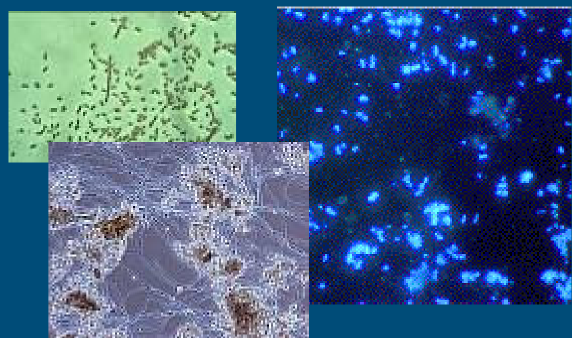
Bacterial flocks in extensive ponds?

- Density ± 100 times higher on surfaces
  - Bottom
  - Submerged surfaces
- Algal density and bacterial density in water column are linked – high primary productivity

Algae



bacteria



ASP technology might work partially

Foods Webs

Increase C:N ratio of feed inputs

reduce protein content in diet
add CH-source

High C:N ratio in feed

Experimental set-up

- 3 experiments
  - Indoor tank experiment (production, growth)
  - Outdoor tank experiment (water quality, N-budget)
  - Pond experiment (production, water quality)

Indoor tank

Outdoor tank

Outdoor pond

Experiments

- Stocking density: 6 shrimp m^{-2}
- Fertilized tanks with
  - 4 g urea
  - 1 g super phosphate, per m^2 per week
- 2 diets
  - 40 % protein, C:N ratio 8.1
  - 25 % protein, C:N ratio 12.9

Indoor experiment, continued

- Assumptions
  - Tapioca = 50% Carbon
  - 50% N in feed ➔ released as ammonia
  - 20 g tapioca per g TAN released

➔ 25% prot. diet: 0.39 kg tapioca/kg feed

40% prot. diet: 0.62 kg tapioca/kg feed

4 treatments:

- P25
- P25 + CH
- P40
- P40 + CH

Pond experiment

- 2 treatments
  - P25 + CH
  - P40
- 200 m^2 ponds
- Previously used for rice cultivation
- Pond bottoms cleaned, limed, disinfected
- Biweekly fertilization with urea and TSP
- 4 replicates
- Focus on
  - Production
  - Economics

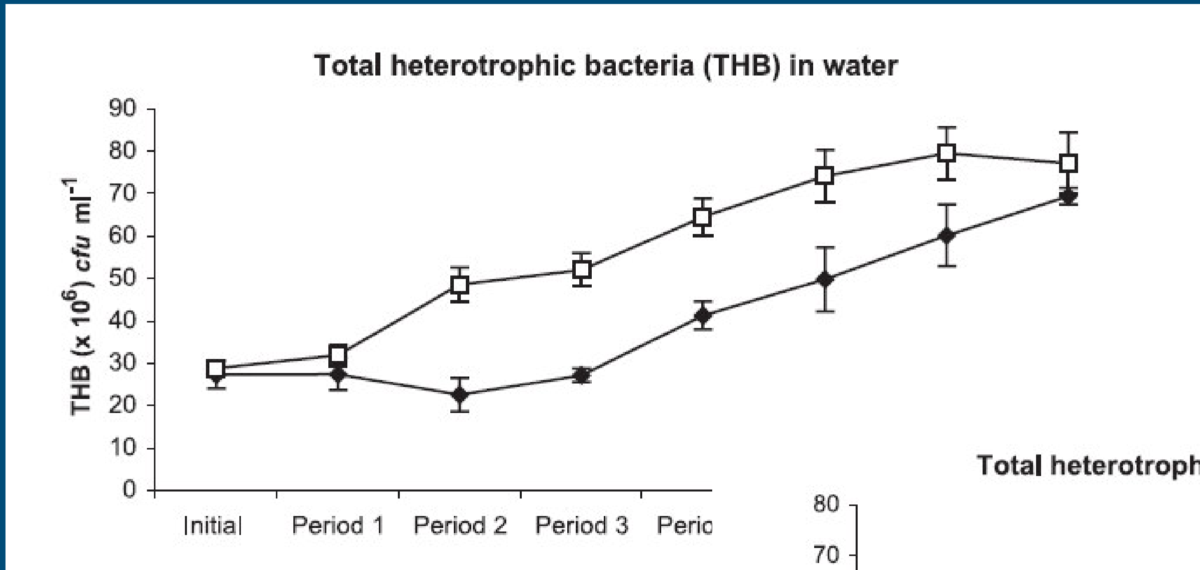
Water quality

Indoor tanks CH addition water column ➔ less TAN; more TH

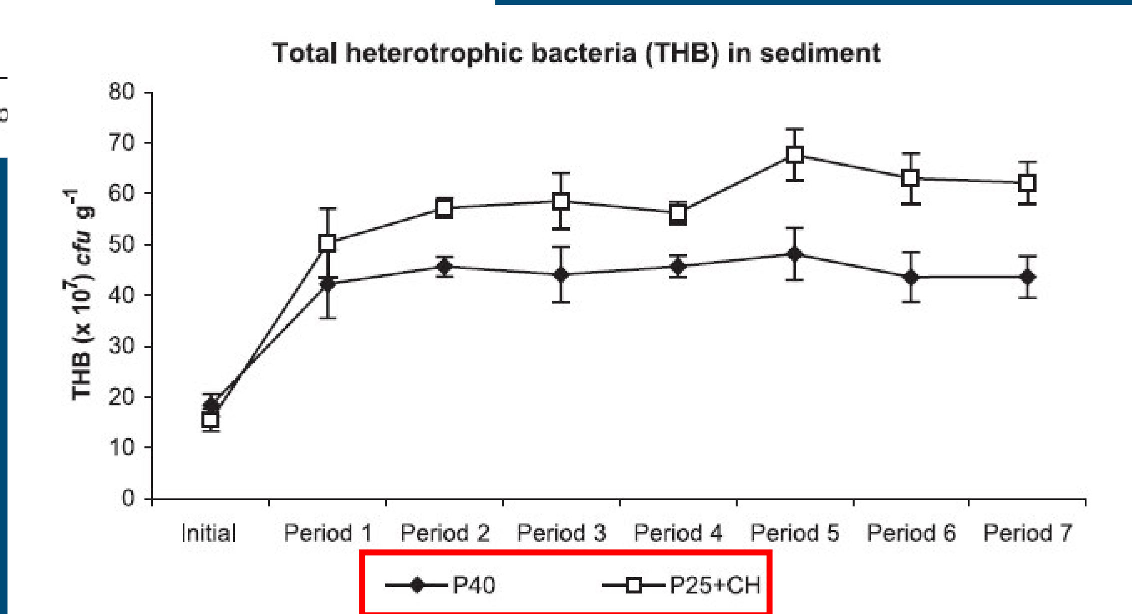
Water column	P25	P25+CH	P40	P40+CH
TAN (µg l^{-1})	4.7^{b}	3.1^{b}	9.0^{a}	3.7^{b}
Total N (µg l^{-1})	169^{b}	103^{c}	341^{a}	200^{b}
THB (x10^{4} *cfu* ml^{-1})	17.3^{ab}	23.9^{a}	12.1^{b}	26.9^{a}
Sediment				
TAN (µg g^{-1})	36.2^{a}	32.9^{ab}	36.2^{a}	31.1^{b}
Total KN (µg g^{-1})	189^{ab}	177^{b}	218^{a}	202^{ab}
THB (x10^{6} *cfu* ml^{-1})	33.8^{ab}	41.3^{ab}	24.8^{b}	62.1^{a}

Same in sediment

Total heterotrophic bacteria



PONDS



Increases during culture in water column

Plate counts

Difference in THB-count

Strong correlation to production

N-budget (%)

Inputs

Treatment	Nitrogen inputs (g N tank^{-1})					
	Water	Sediment	Fertilizers	Feed	Shrimp	Total
P25	0.31	33.20	36.70	29.80	0.01	100
P25+CH	0.30	32.50	36.90	30.30	0.01	100
P40	0.26	27.50	31.40	40.80	0.01	100

Outputs

Treatment	Nitrogen outputs (g N tank^{-1})					Unaccounted
	Water	Sediment	Exchange loss	shrimp	Total output	
P25	0.48	71.3	2.3	16.1	90.1	9.9
P25+CH	0.44	69.9	2.3	21.1	93.8	6.2
P40	0.49	67.7	2.7	16.7	87.6	12.4

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Production parameters

Indoor tanks	P25	P25+CH	P40	P40+CH
Net shrimp yield (g m^{-2})	6.4[c]	13.5[b]	13.7[b]	17[a]
FCR	6.4[a]	3.0[b]	3.0[b]	2.4[b]
N retention in shrimp (%)	16.3[c]	28.9[a]	17.1[c]	22.4[b]
Protein efficiency ratio	0.6[c]	1.3[a]	0.9[c]	1.1[b]
Ponds				
Net shrimp yield (g m^{-2})		25.7[a]	21.1[b]	
FCR		1.6[b]	2.2[a]	
N retention in shrimp (%)		45.3[a]	19.8[b]	
Protein efficiency ratio		2.5[a]	1.2[b]	

Same trend indoor and ponds

Similar results as for ASP

Economic analysis ponds

	P25+CH	P40
Total production cost (Rs.)	83,202	103,420
Gross return (Rs.)	193,275[a]	125,406[b]
Net profit (Rs.)	110,073[a]	21,986[b]
Benefit/cost ratio	1.3[a]	0.2[b]

US$ 1 = 44.65 Rupees (Rs.) (2003)

Discussion

- CH-addition ➔ increased shrimp yield
  - Higher THB-count in sediment
  - Substrate biofilms took role of bacterial flocks?
- CH-addition ➔ increase N-retention
  - Dietary protein requirements of shrimp are 35-50%
  - N-retention increase from 16 to 21%
  - Higher N-retentions have been recorded, but then feed contributed 76-92% of total N input (30-40% in this study)

Conclusion

CN-addition in combination with low-protein diet worked in extensive ponds

- Improved benefit/cost ratio from 0.2 (P40) to 1.3 (P25+CH)
- Well controlled experimental conditions
  - Pond bottom preparation (clean, rice root systems ➔ aerates bottom)
  - Careful distribution of tapioca-water over water surface
  - Biofilms on sediments took over role of bacterial flocks?

More research is needed

Suggestions for further research

Bring substrate for biofilm development into water column

Combine C/N technology with periphyton technology

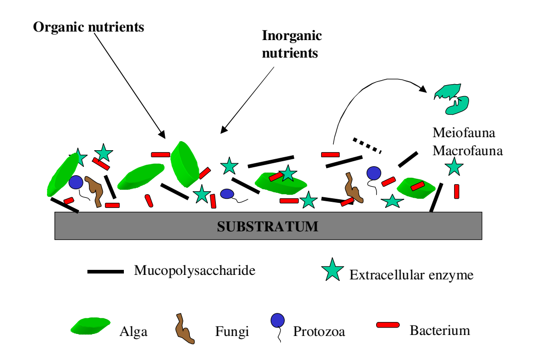

Fig. 9.1

Thank you for your attention