*Larvi 2009 —— Gent, Belgium*

# Studies on larval nutrition of large yellow croaker
# A review

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# Large yellow croaker

## (*Pseudosciaena crocea* )

One of most economically important marine fish in China

Over-fishing

It has been widely cultured since 1990s after the success in **artificial hatchery**

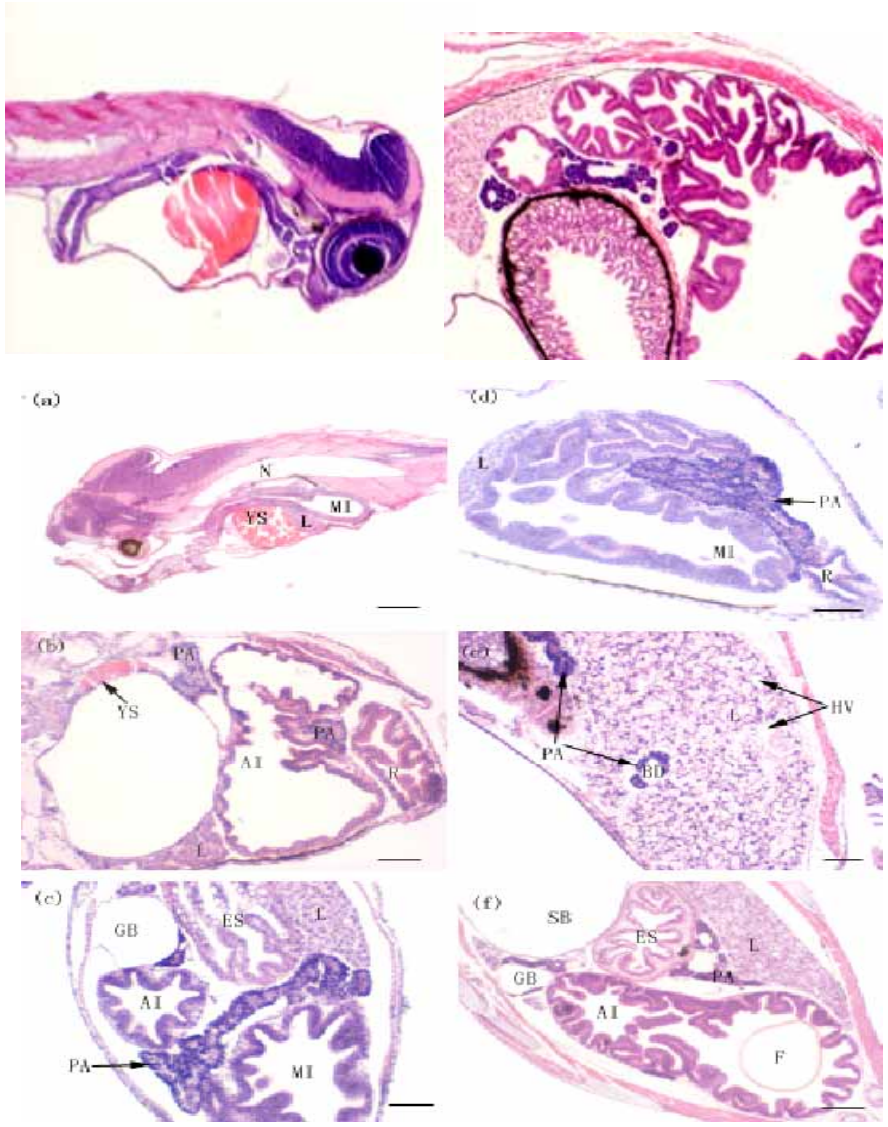
# Marine cage-culture

## 70,000 tons annually

**Nutrition & feeding becomes one of bottleneck in hatchery & culture**

**Our lab started to study larval nutrition of large yellow croaker from 1999**

# 1. A histological study on digestive system development




On the basis of observations on the development of digestive organs & histology:

Pro-larvae: 0 – 5 DAH

Post-larvae: 6 – 20 DAH

Juvenile : begin at 21 DAH

(Mai et al. 2005, J. Fish Biol)

# 2. Activities of selected digestive enzymes during larval development

**Enzymes in pancreas**

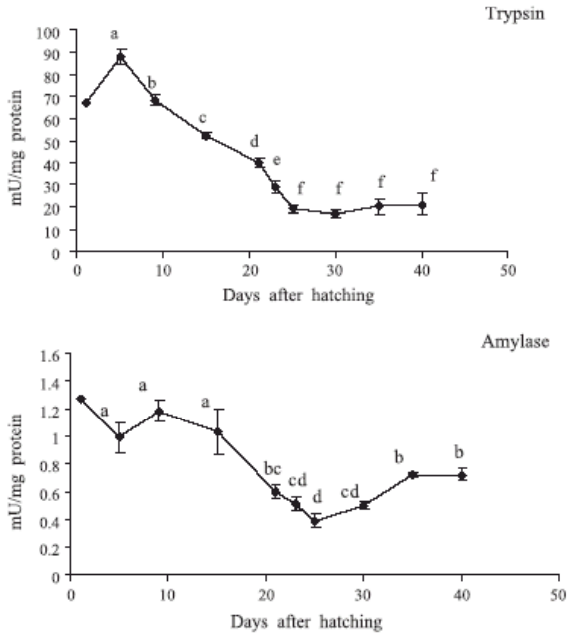



Fig. 3. Specific activity of two pancreatic enzymes, amylase and trypsin, assayed in pancreas of *P. crocea* during larval and juvenile development. Means±S.D. ($n$=4) with the same superscript letter are not significantly different ($P$>0.05).

**Enzymes in intestine**

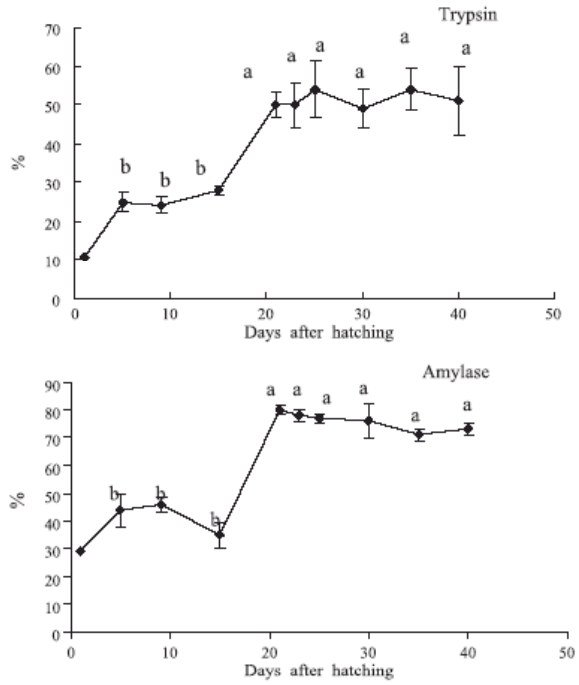
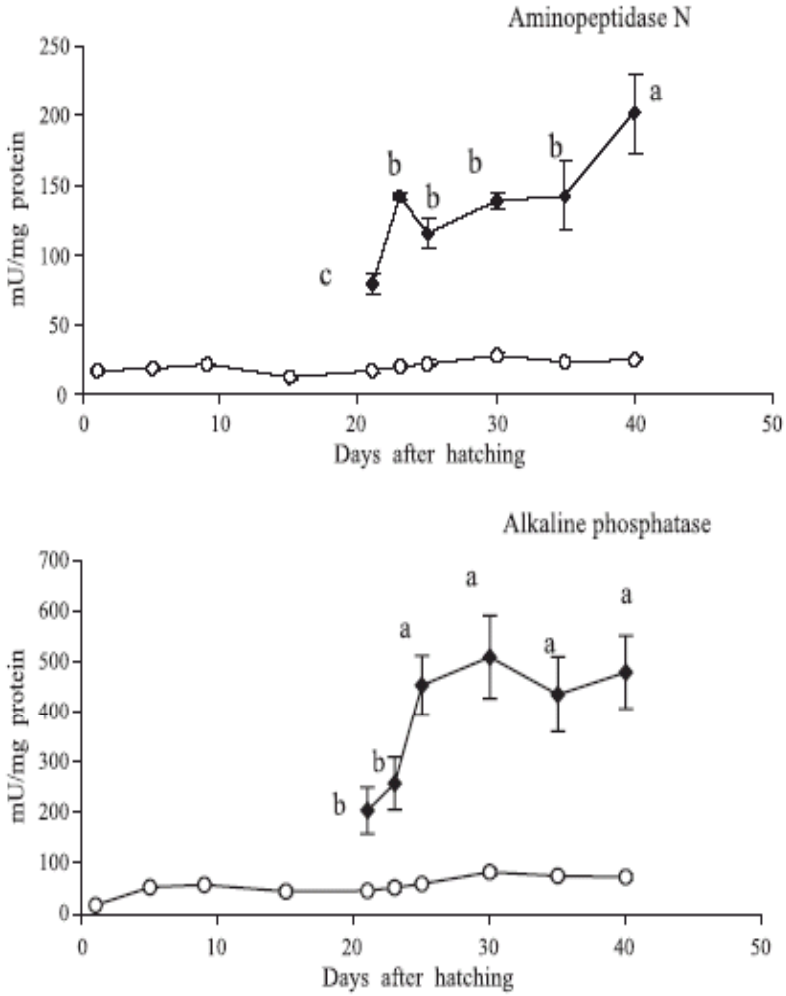



Fig. 4. Percentage of secreted trypsin and amylase (trypsin or amylase assayed in intestinal segment related to total trypsin or amylase) during larval and juvenile development of *P. crocea*. Means±S.D. ($n$=4) with the same superscript letter are not significantly different ($P$>0.05).

# 2. Activities of selected digestive enzymes during larval development

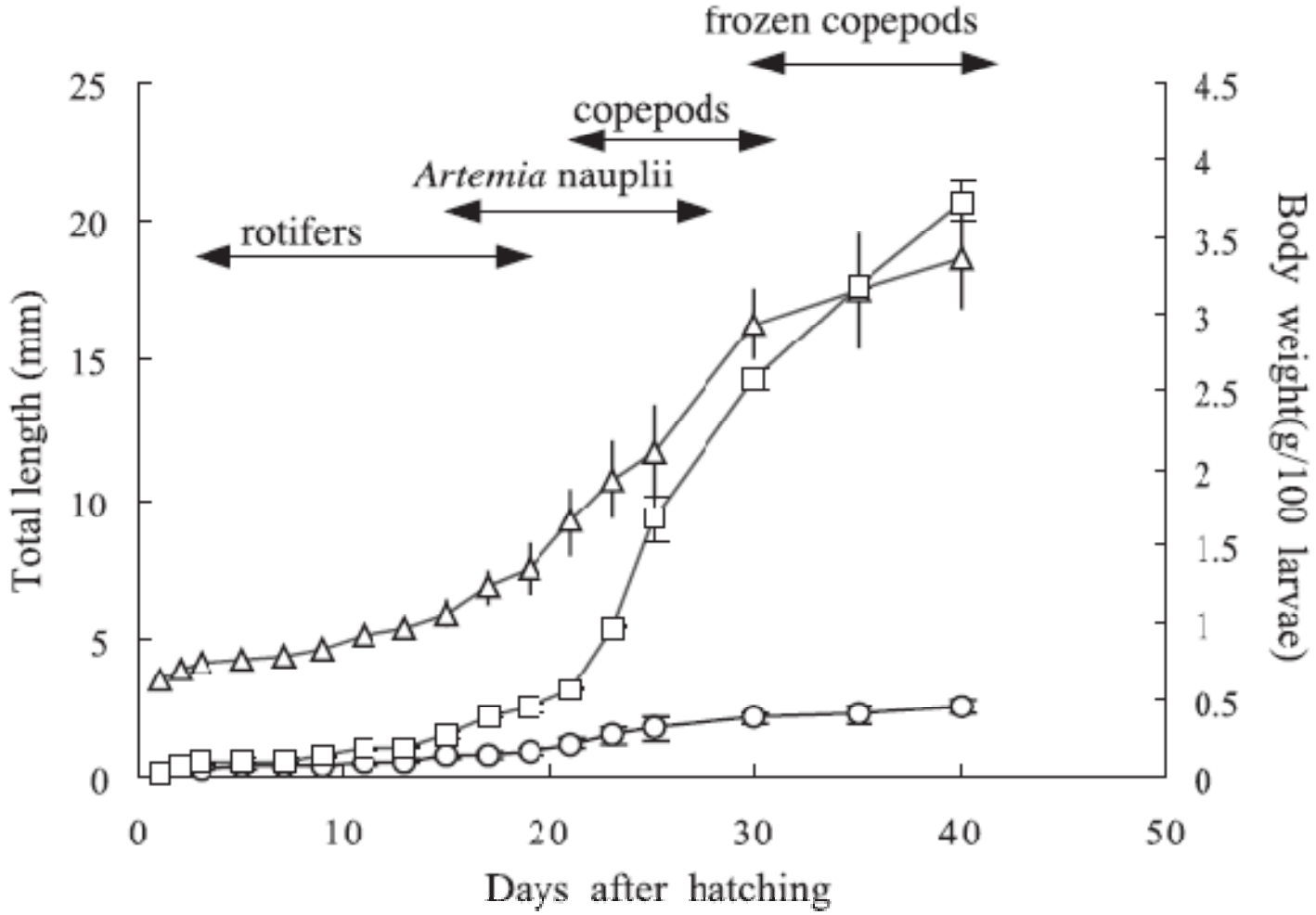



Digestive system matured between day 23 and 25.

Enzyme data & mouth enlargement indicating: the larvae could be fed successfully with a compound diet, at least from day 23

Fig. 5. Specific activity of aminopeptidase N and alkaline phosphatase in intestinal segment homogenate (O) and in purified brush border membrane of intestine (♦) during larval and juvenile development of *P. crocea*. Means±S.D. ($n$=4) with the same superscript letter are not significantly different ($P$>0.05).

# 2. Activities of selected digestive enzymes during larval development

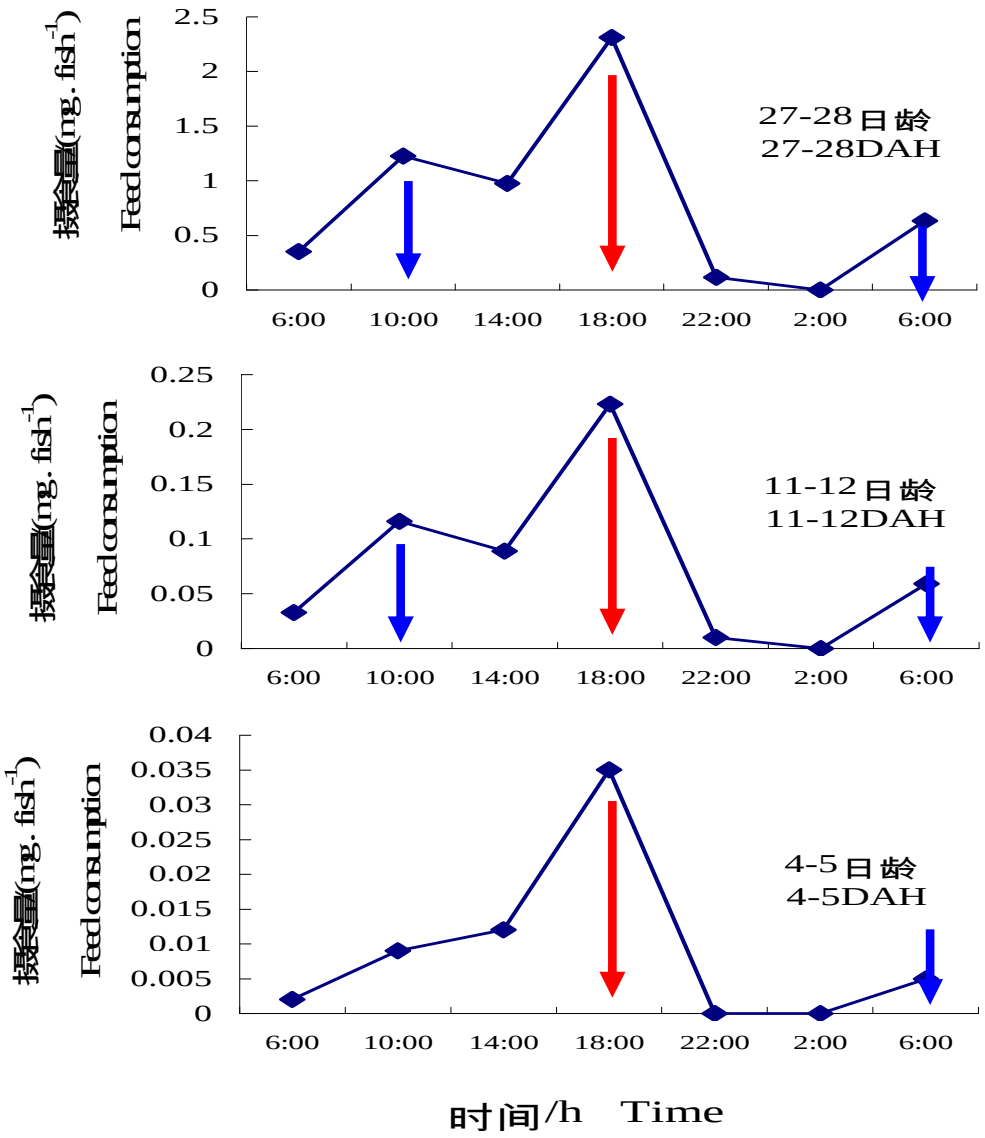



Ma et al., 2005, Aquaculture

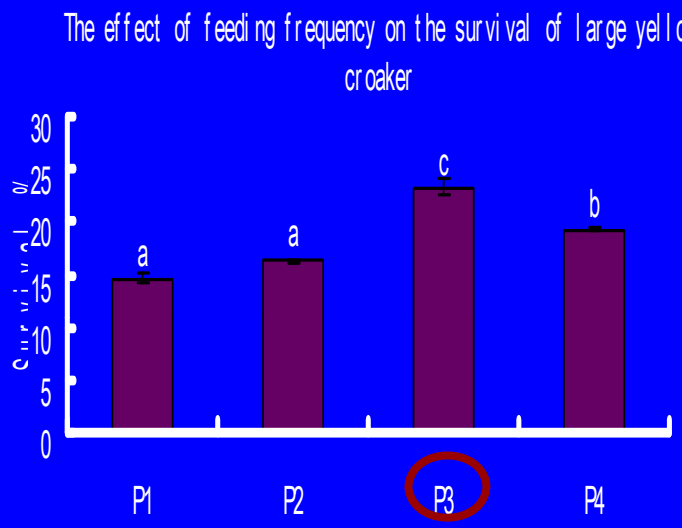
# 3. Larval Feeding Behavior

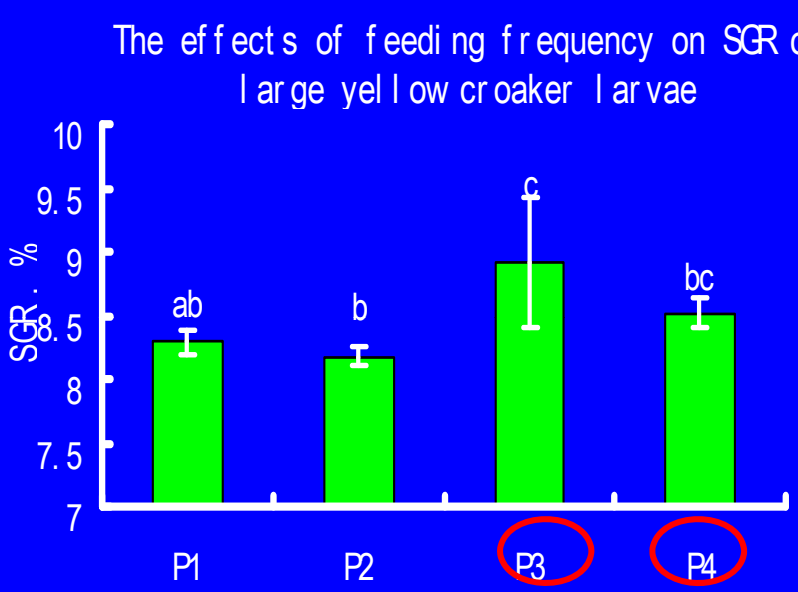
## (1) Feeding rhythm

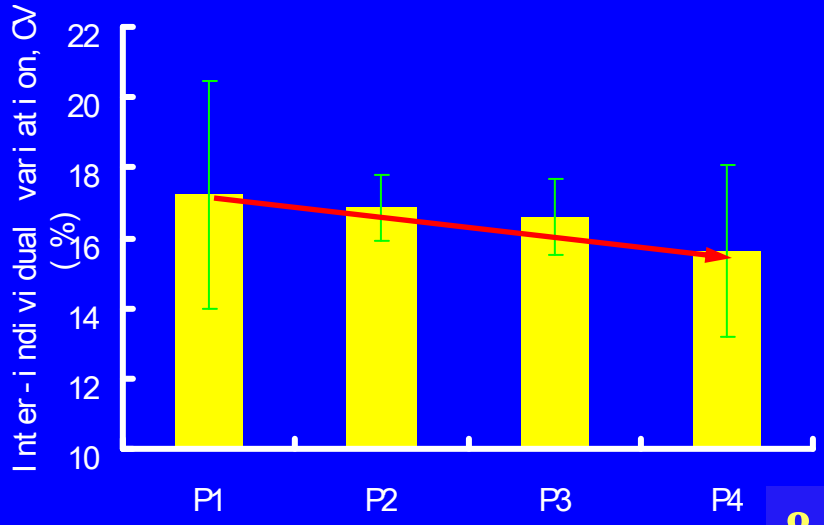
**Crepuscular feeding**



# (2) Optimal Feeding Frequency



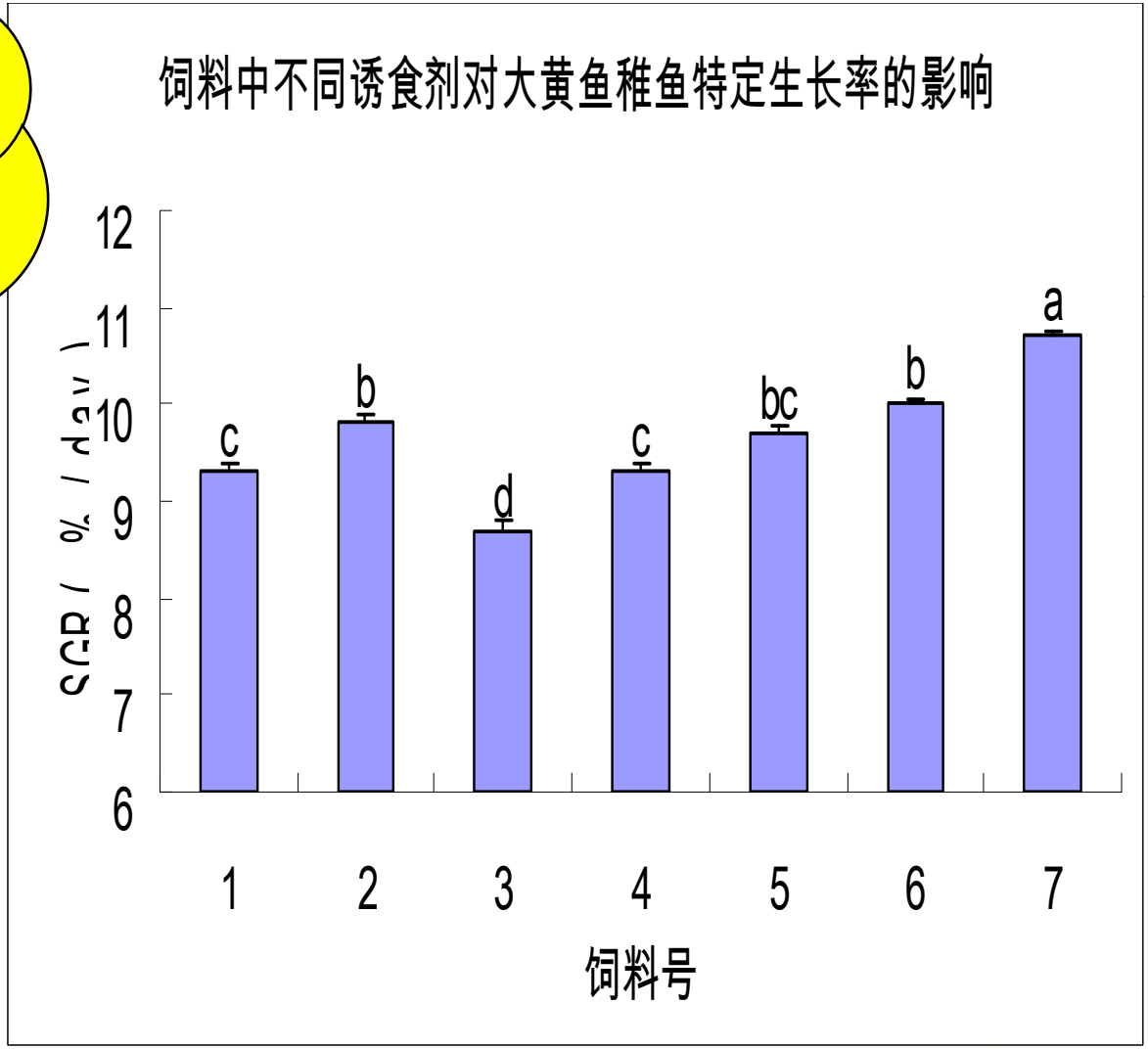

P1: 2 meal per day
P2: 4 meal per day
P3: 8 meal per day
P4: 12 meal per day

**8 meals per day is optimal**

# (3).Feeding Attractants

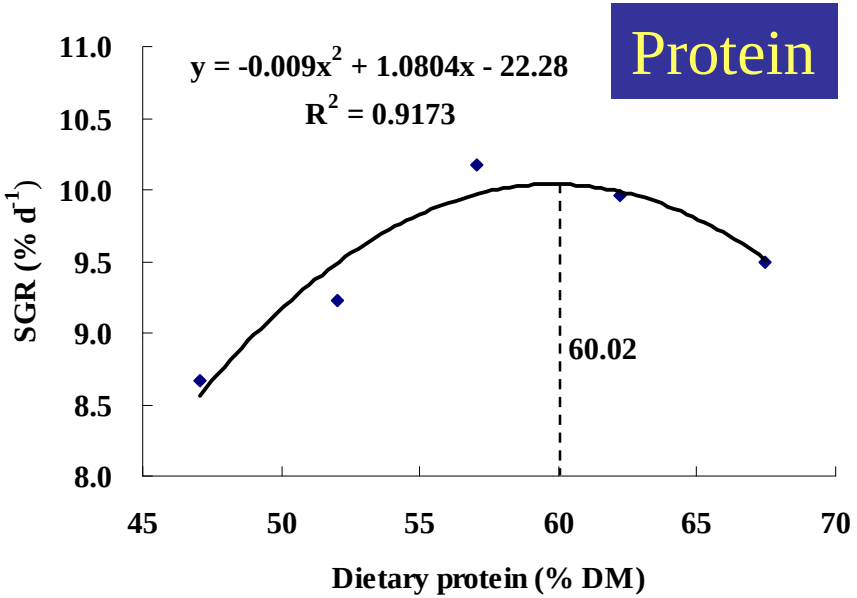
**D2 with 0.3% betaine+0.5% nucleotide+0.2%Ala +0.1% Arg was the best for the feeding and growth of larvae.**

| | |
|---|---|
| 1 | Amino acid mixture |
| 2 | Betaine + nucleotide + Ala+Arg |
| 3 | Extract from clamworm |
| 4 | Chinese traditional herbs |
| 5 | Commercial attractant |
| 6 | Marubeni Nisshin Feed Co., Ltd |
| 7 | Live prey |

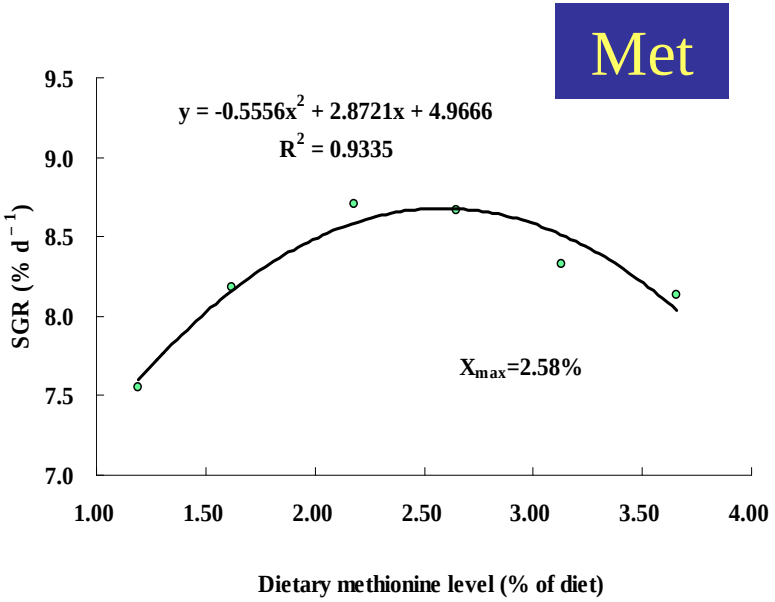


# 4. Nutrient Requirements

Protein



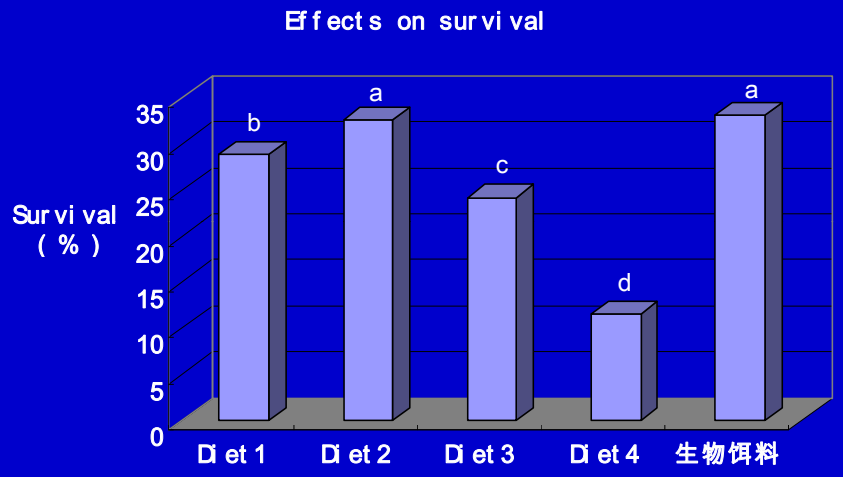

Met



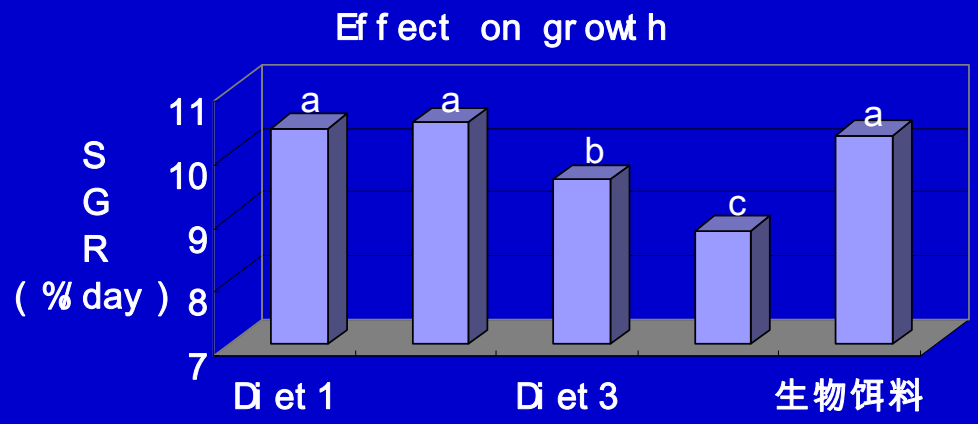

Higher compared with juvenile

# 4. Nutrient Requirements

## Optimal level of Protein hydrolysate



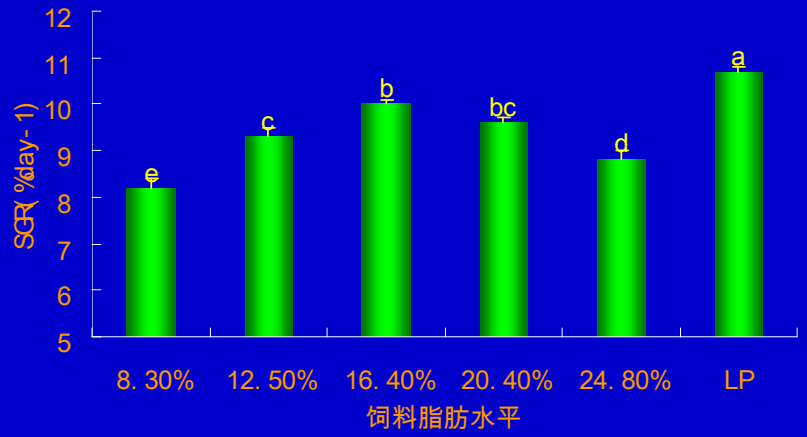

Diet1 （0%）
Diet2 （25%）
Diet3 （50%）
Diet4 （75%）

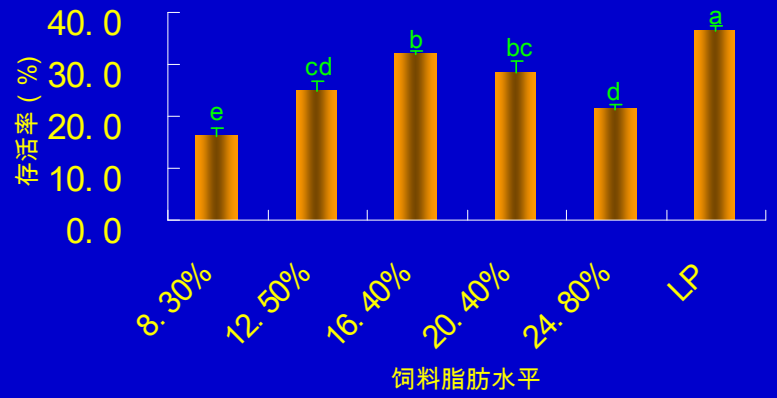


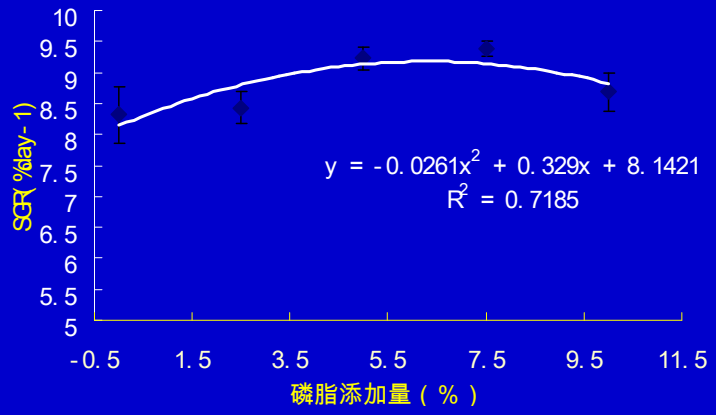

**25% is optimal**

# 4. Nutrient Requirements

## Lipid and phospholipids




**Optimal lipid: 17.5%**

**Optimal phosphlipids:5.5%**

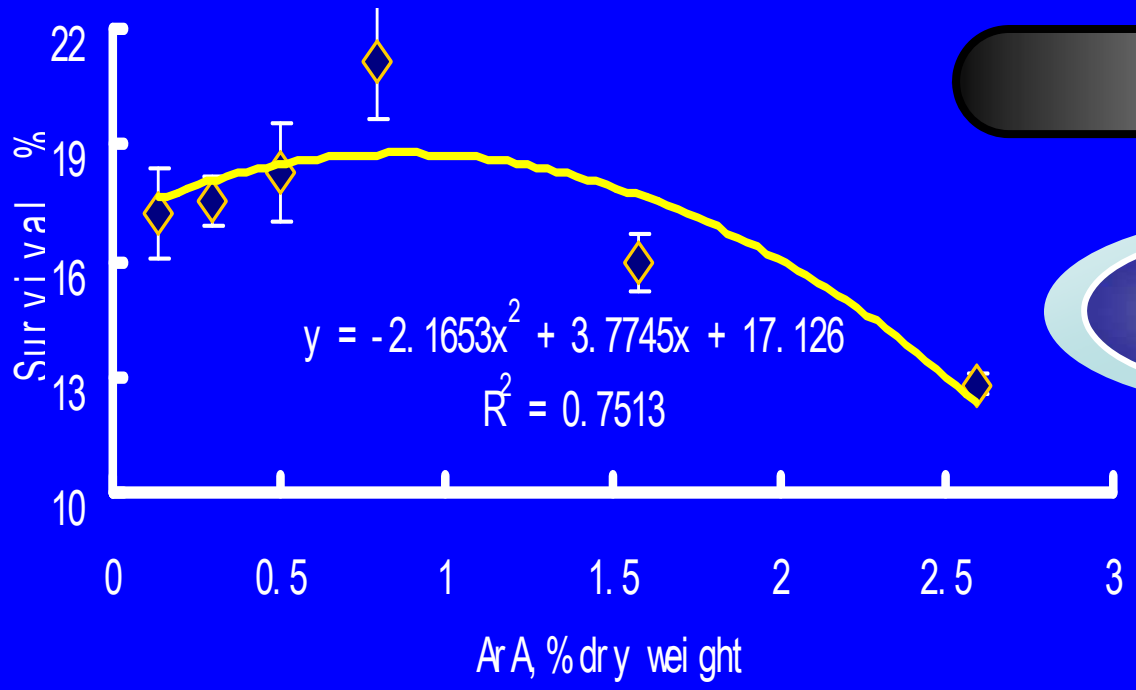
# Essential fatty acids

EPA+DHA

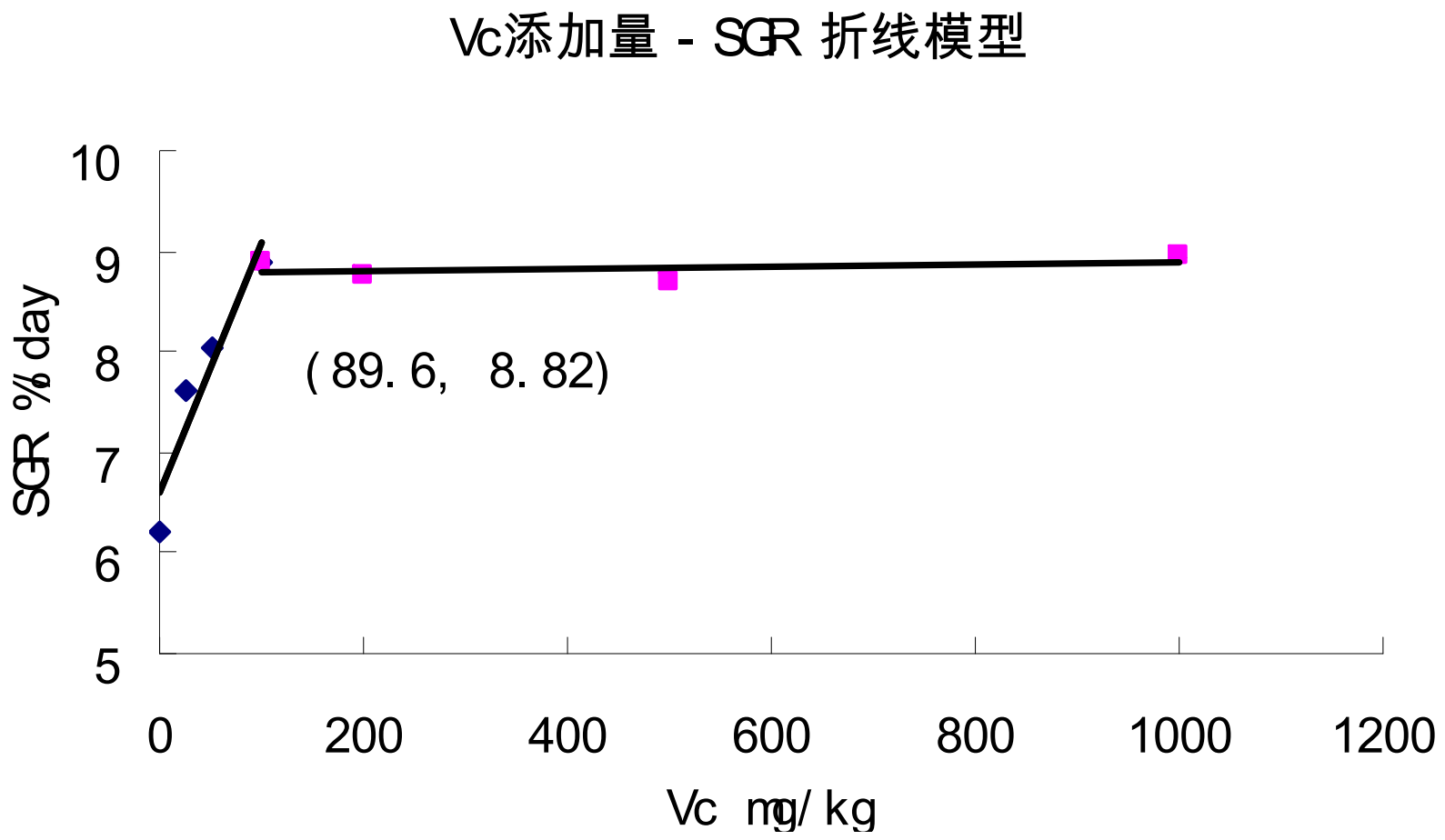
1.86%

ARA

0.87-0.93%

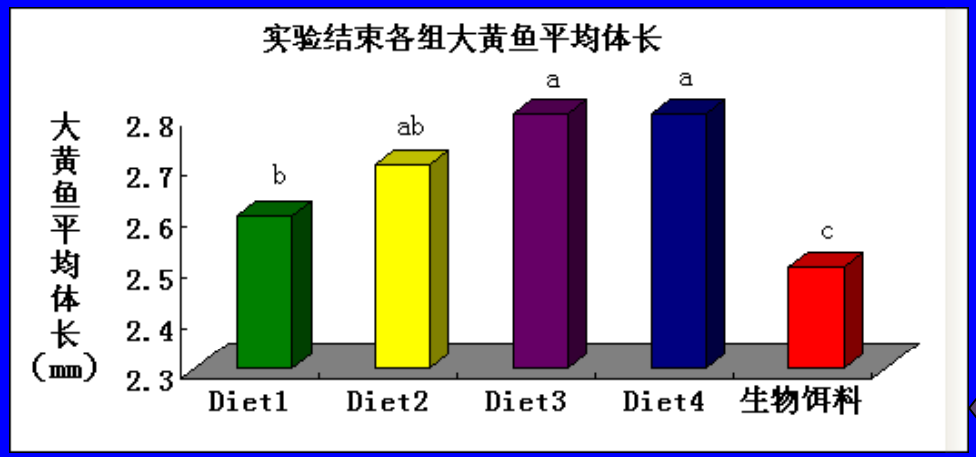


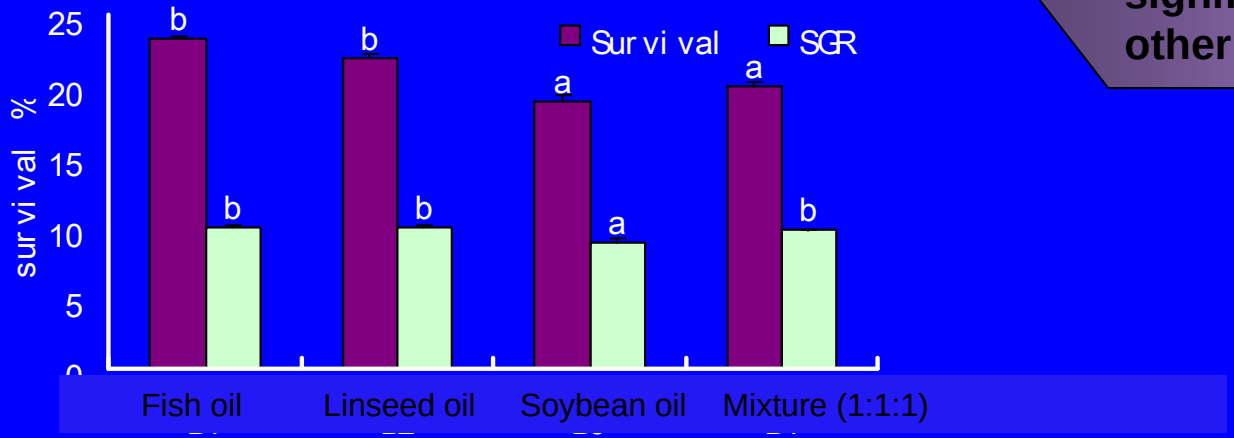
# Optimal Dietary Vitamin C



# 5 Protein and lipid sources

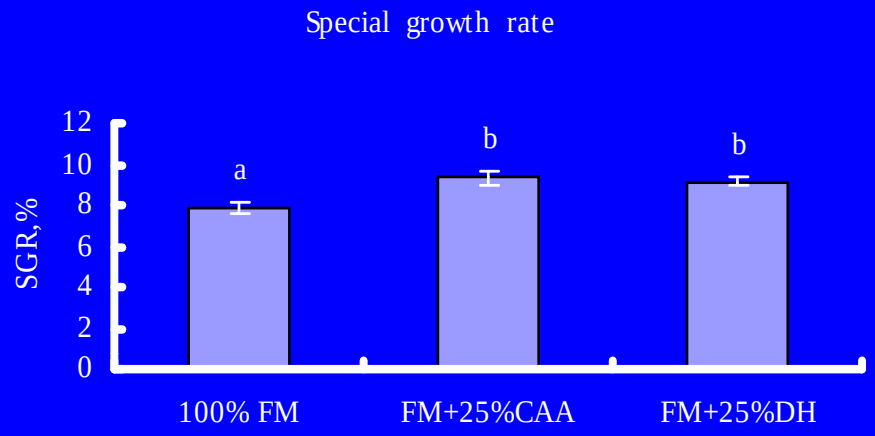
**Shrimp meal + mussel meal + fish meal (50%): good!**

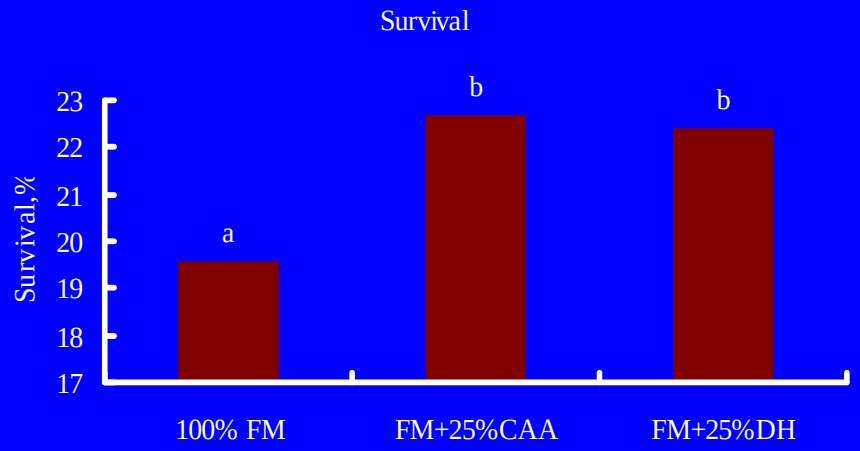



**Survival in FO and LO was significantly higher compared with SO and MO. SGR in SO was significantly lower than other groups.**

# 6 Utilization of Nitrogen Sources




**FM: fish meal**

**DH: fish protein hydrolysate**

**CAA: mixture of crystalloid amino acids**

***Growth and Survival***

**1. SGR**

**100%FM treatment was significantly lower than other groups.**

**2. Survival**

**100%FM treatment was the lowest.**

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# 7 Artificial microdiet

## 7-1 Size of microdiet

**Diet must be prepared as microparticles whose size must be adapted to the size of the larvae mouth.**

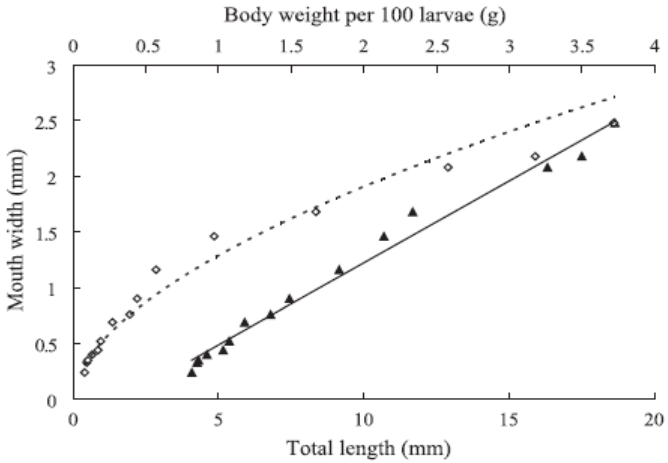
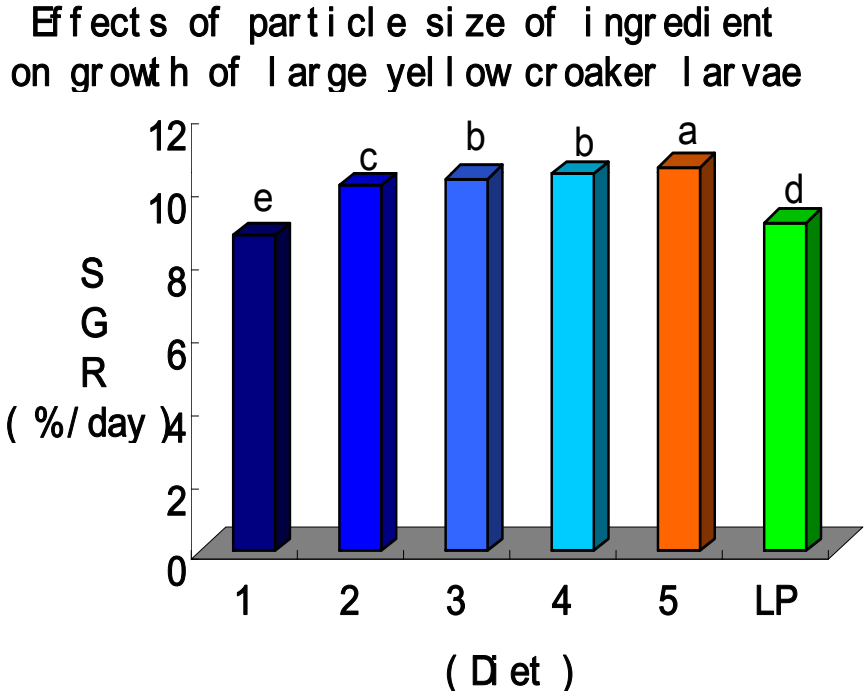



Fig. 2. Mouth width (gape) as a function of total length (continuous line) or body weight (100 larvae) (dashed line) in *P. crocea* larvae.

**(Ma et al., 2005)**

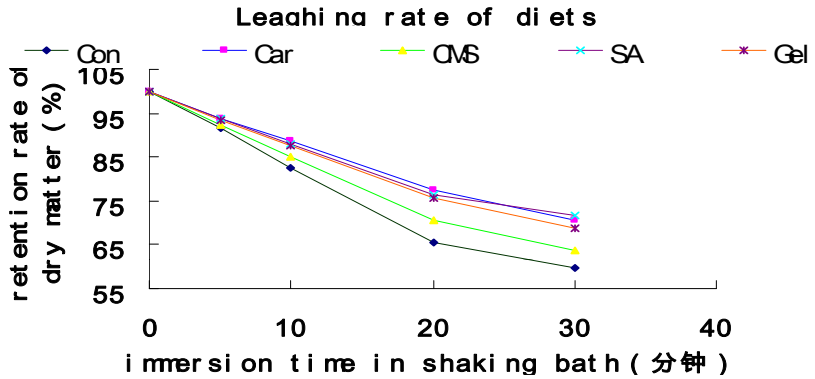
# 7-1 Particle size of ingredients

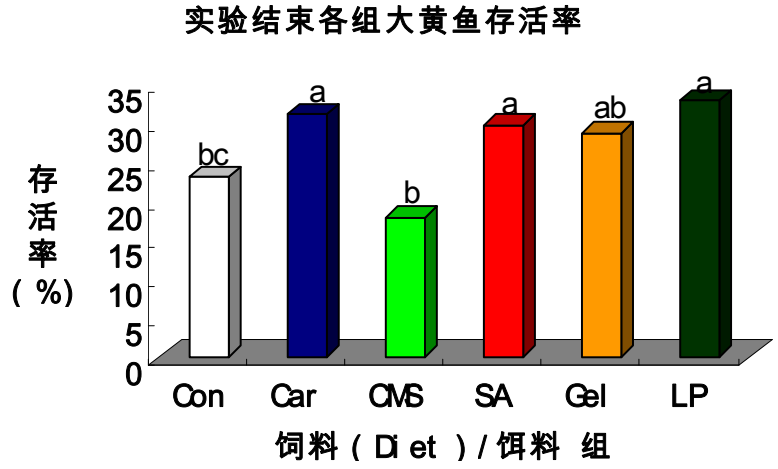


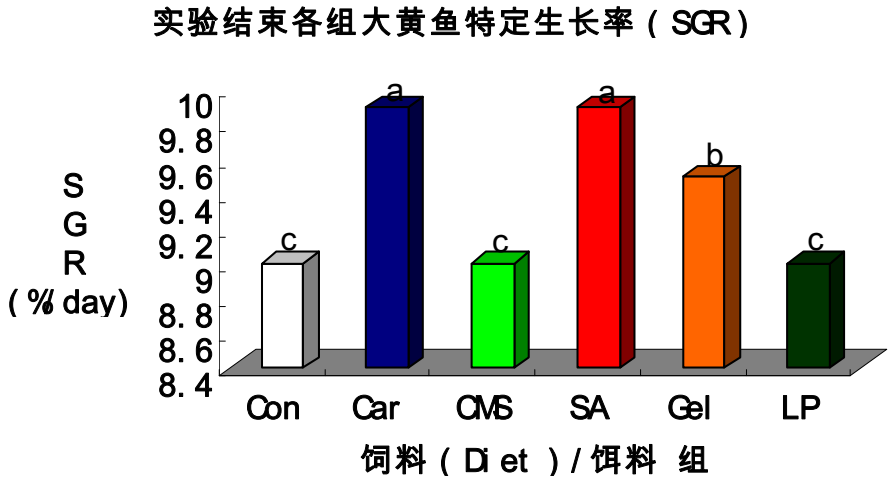

**Diet 1: 100μm**
**Diet 2: 71μm**
**Diet 3: 48μm (suitable)**
**Diet 4: 25 μm**
**Diet 5: Commercial diet**
**Live prey**

# 7-2 Binder selection for micro-diets

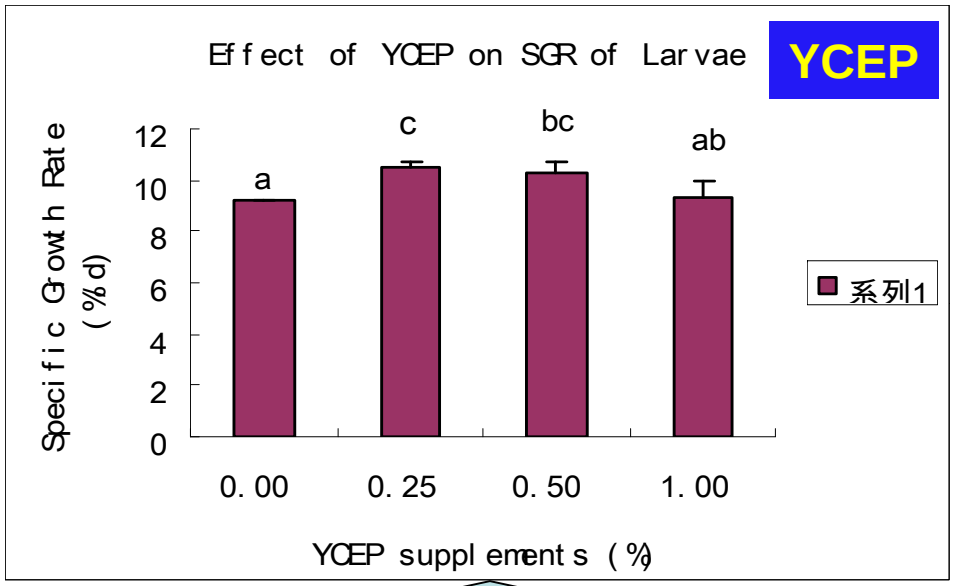
Control: No specific binder
Car: Carageen
CMS: Carboxyl methyl Cellulose Na
SA: Alginate Na
Gel: Gelatin
LP: Live prey



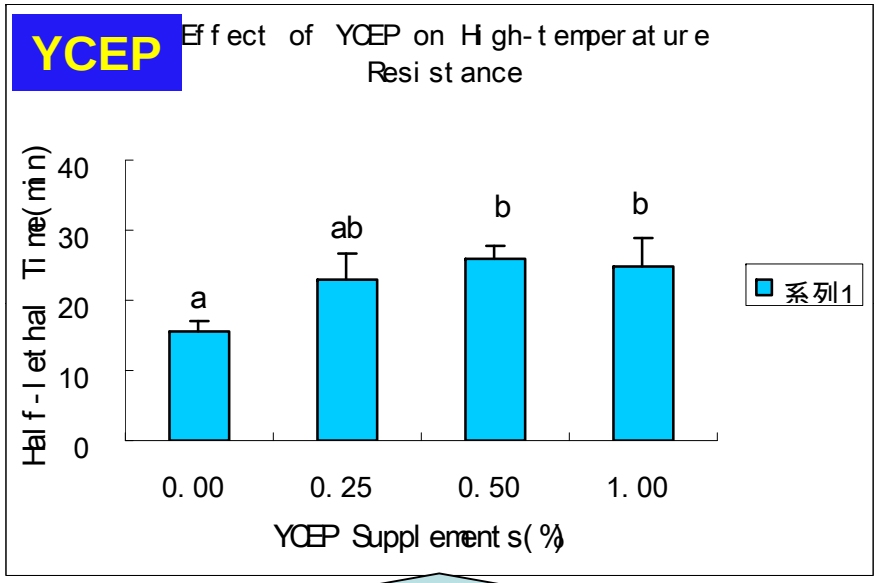



# 8 Additives: Yeast Cell Extracted Polysaccharide (YCEP)

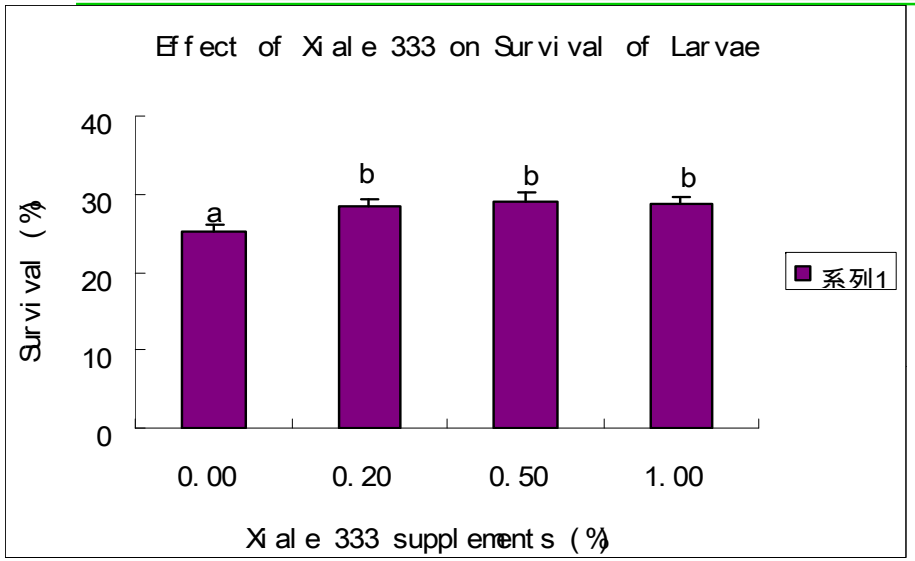



**Addition of YCEP significantly improved growth of larvae.**

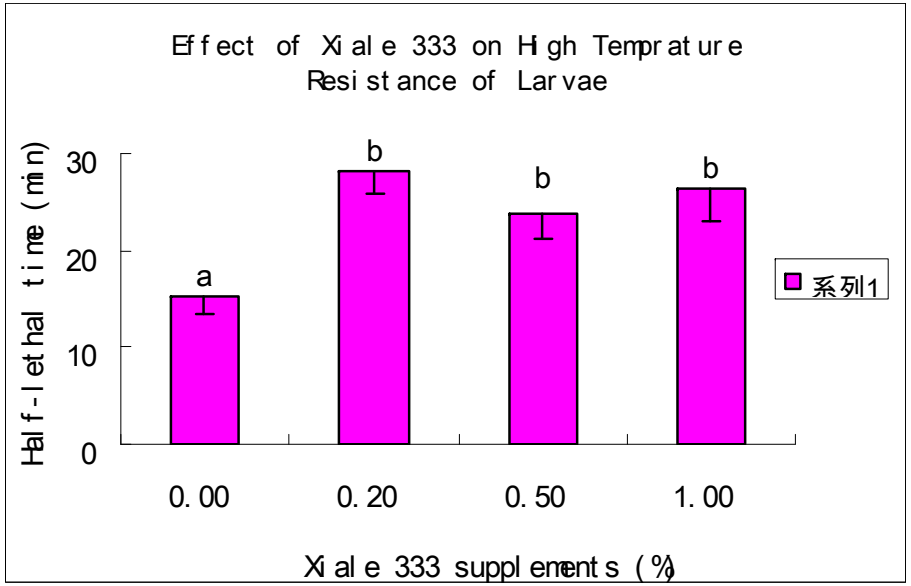



**Addition of YCEP significantly elongated the half-lethal time of larvae against high temperature (32 ℃ )**

# 8 Additives: Probiotics--Xiale 333




**Survival in larvae fed the diets with 0.2%, 0.5% and 1.0% supplementation were significantly higher than that of control group.**




**The supplementation of Xiale333 significantly elongated the half-lethal time of larvae against high temperature (32 ℃ )**

# Summary

1. Pro-larvae: 0 – 5 DAH;Post-larvae: 6 – 20 DAH; Juvenile : after 21 DAH
2. Digestive system matured between day 23 and 25.
3. Larvae could be fed successfully with formulated diets, at least from day 23.
4. Crepuscular feeding behavior.
5. Optimal Feeding Frequency: 8 meals/day
6. Mixture of betaine,nucleotide, Ala & Arg was effective feeding attractant.
7. Optimal dietary levels: protein 60%, met 2.58%, lipid 17.5%, phosphlipids 5.5%, EPA + DHA 1.85%, ARA 0.9%, Vc 90 mg/kg

# Summary

8. Mixed proteins (Shrimp meal + mussel meal + fish meal (50%)), FM with CAA & fish protein hydrolysate better.
9. Particle size of ingredients in micro-diets: < 48μm.
10. Carageen & alginate Na are suitable binders of microdiets.
11. Yeast cell extracted polysaccharide & the probiotics were able to improve growth and stress resistance of larvae

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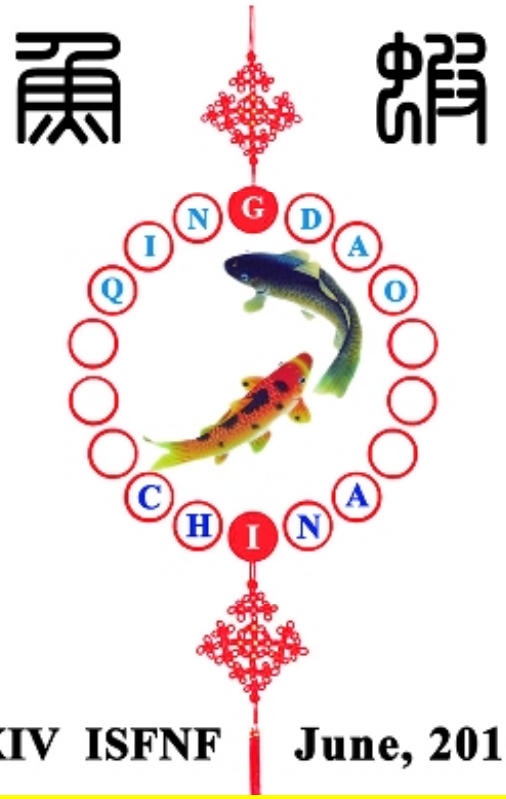
# 14th International Symposium on Feeding and Nutrition of Fish

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