鱼类饲料替代蛋白源研究中的科学研究与技术创新

Scientific Research and Technical Innovation on Alternative Protein Utilization in Aquafeed

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Feed Research Institute, CAAS
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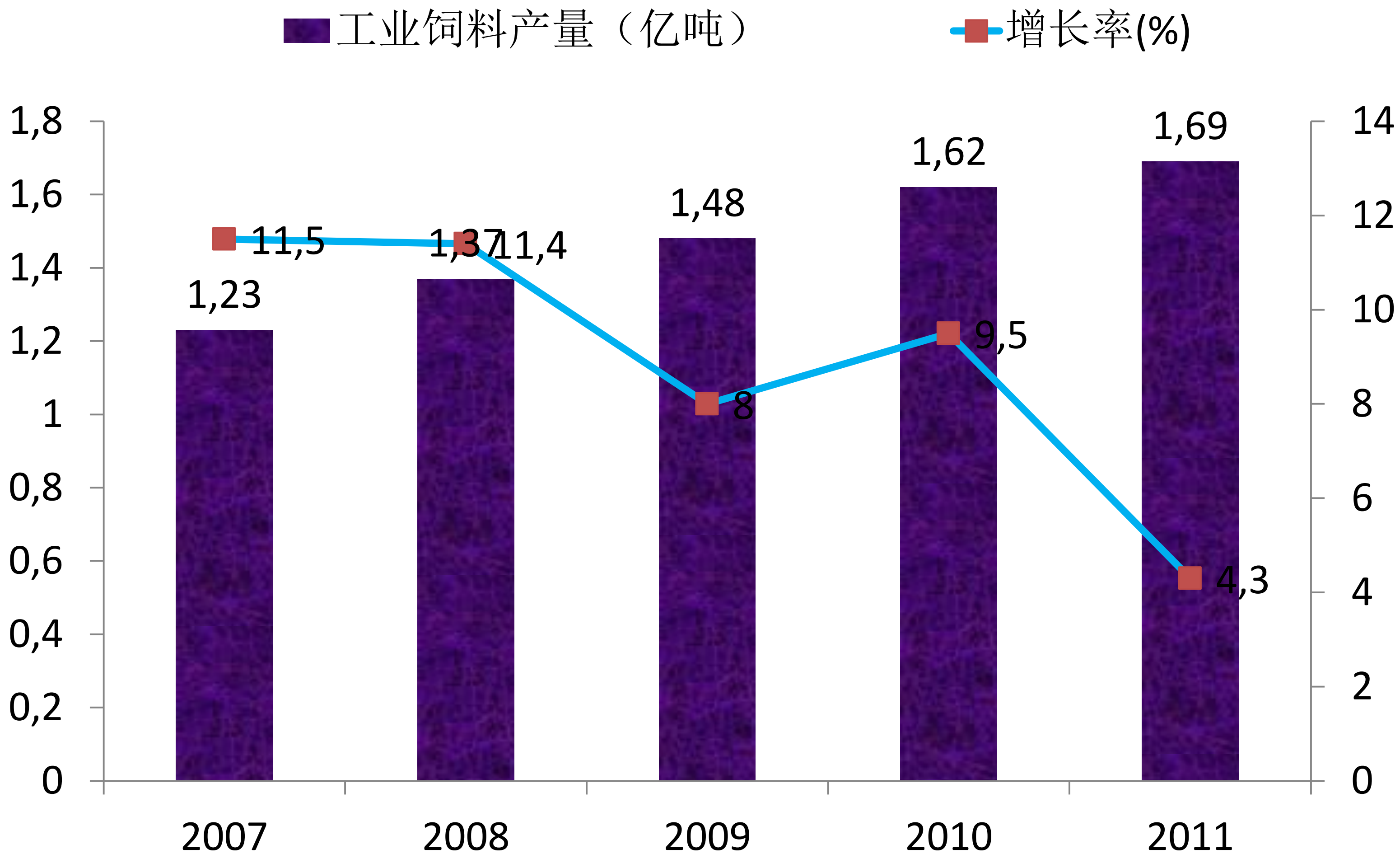
Feed industry of China during 2007-2011



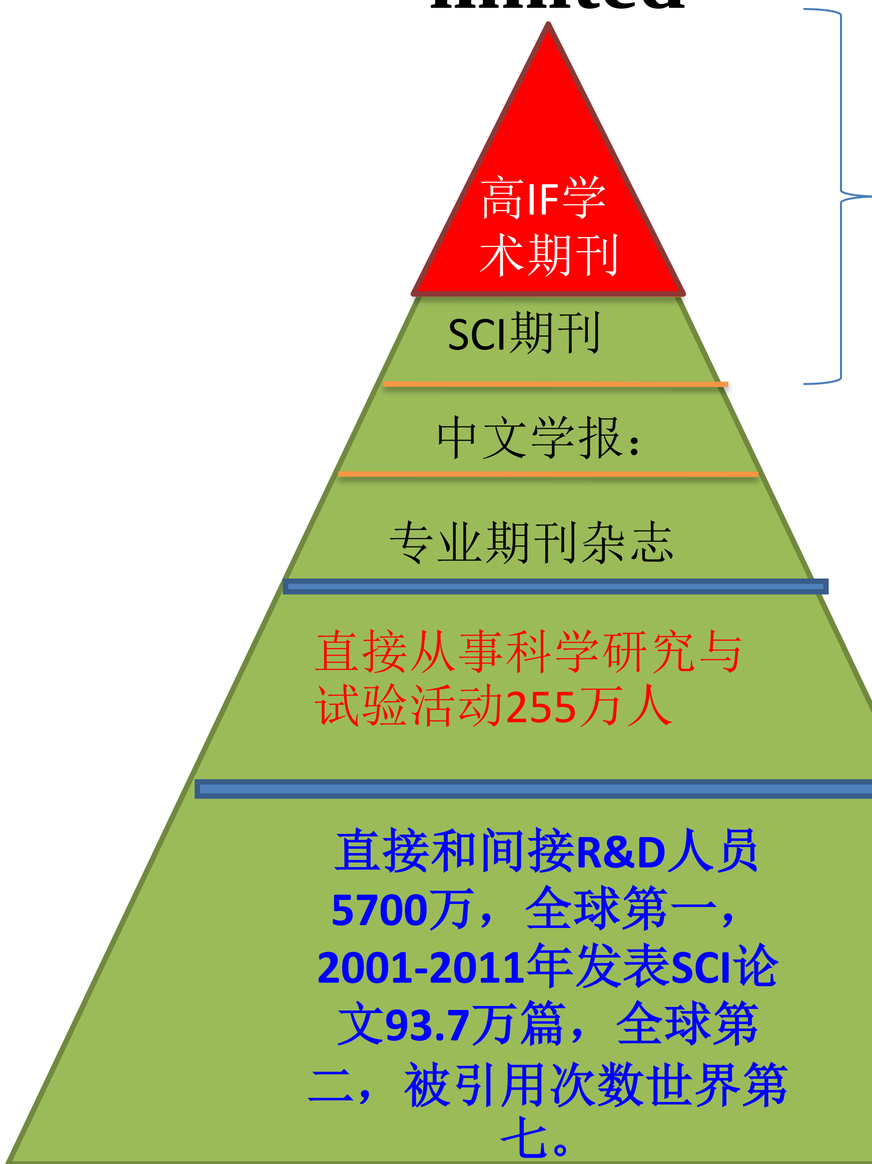
2011：Aquafeed 15.40MT，increased 3%

China will be the a main battleground of global Research, Utilization and Technique distribution

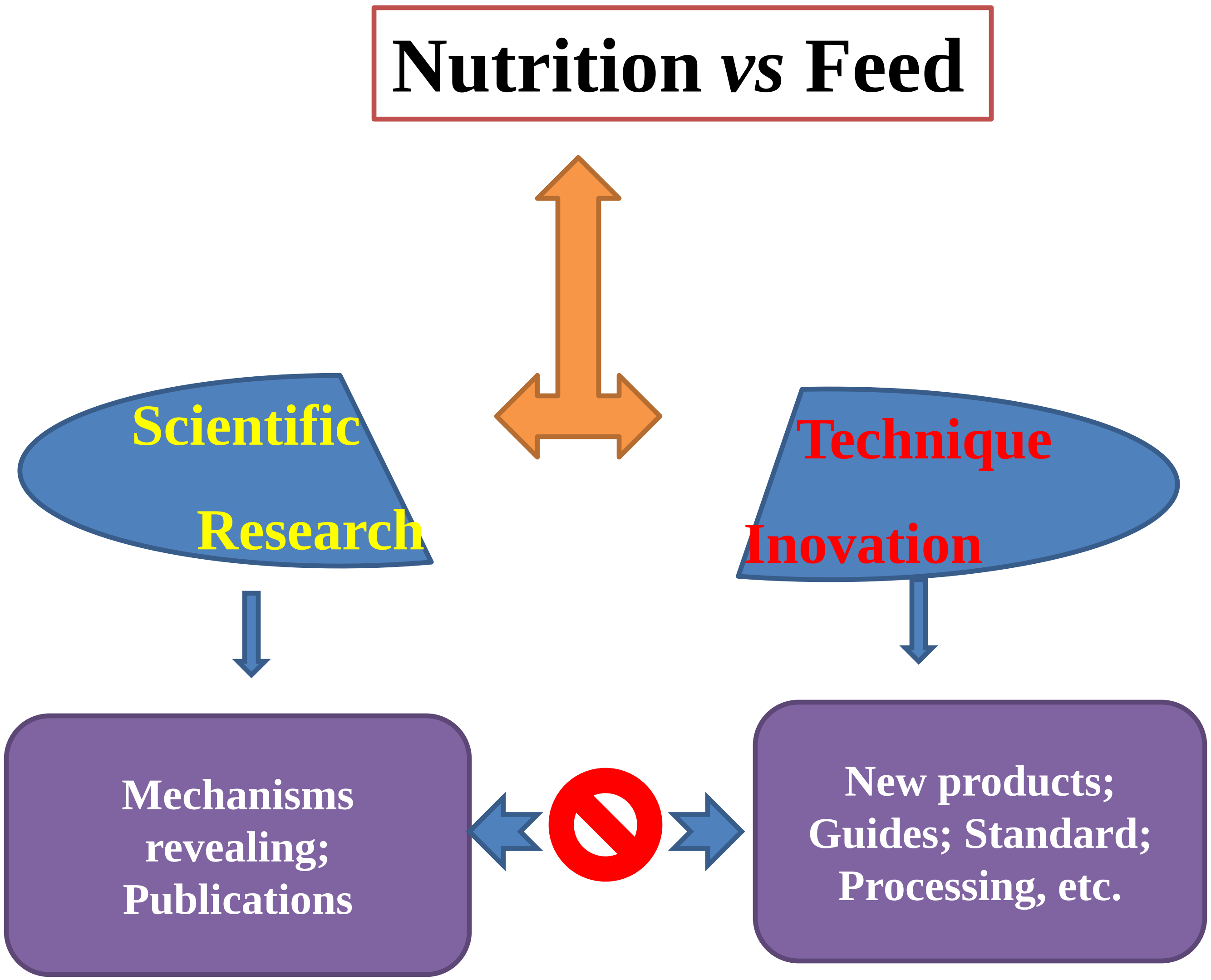
Dilemma faced for Aquafeed producter

- **High price of fishmeal and soybean meal**
- **“New” Regulation of animal feed**
- **Poor economic situation, low price of the harvest**
- **Poor immunity response induced by irrationally reduced cost of feed.**

More high level articles were published on International periodicals, but readers are limited



Most readers are scientists and partial enterprise R & D researchers


Nutrition *vs* Feed
Scientific Research
Technique Inovation
Mechanisms revealing; Publications
New products; Guides; Standard; Processing, etc.

Scientific Research & Technique Innovation

- E.g：Alternative protein
- Low feed intake and growth induced by high plant protein diets
  - SR: Why and What?---Mechanism
  - TI: How ?---Methods and solutions

Functions of Enterprise R & D

- Nutrition
- Aquaculture
  - Culturing models
  - Water quality control
  - Disease control
- Commercial feed formulation
- Quality control
- Producing management and processing
- Breeding (Nutrients regulation）

- **Feed producers should be the technology consolidators from genotype selection to consumer's tables**

Great demand of today

Low cost and safe feed formulation

1. **Low utilization of diets**
2. **Poor application of alternative proteins**
   - **Digestion, absorption, feeding, growth, metabolism, health and environment.**

2012年中国水产业十大前沿技术

1. 中国水产科学院黄海水产研究所 :病原快速高灵敏度检测技术
2. 中国水产科学院渔业机械仪器研究所：淡水池塘养殖小区构建技术
3. 工厂化循环水养殖系统；
4. 中国水产科学院黄海水产研究所 :水产动物多性状复合育种技术；
5. 水产疫苗
6. Nutrico Skretting: 饲料微平衡技术（micro balance)：low fishmeal fish feed
7. 深水抗风浪网箱；
8. 生物絮团健康养殖技术；
9. 微孔增氧技术
10. 鱼类性别控制遗传育种技术

www.fishfirst.cn

Micro Balance

- Three balance：
  - Micro-nutrients balance；
  - Amino acid balance；
  - Fatty acid balance
  - “Specific enzyme”

Fishmeal analogues

Skretting techniques

AQUACULTURE

MICROBALANCE

The MicroBalance concept was launched in Norway in 2010 for Atlantic salmon, then in other salmon producing countries the following years. With its proven effectiveness, MicroBalance was successfully applied to other species in 2012. Skretting companies in the Mediterranean introduced MicroBalance for the important sea bass and sea bream industry, thereby achieving significant reductions in fishmeal levels. Skretting Japan has also successfully used MicroBalance in yellowtail diets to reduce fishmeal levels from over 50% to around 30%.

PREMIUM DIET

The grower feed Optiline Premium is based on metabolic activators that improve the salmon's utilisation of digestible energy. The result is faster growth, higher slaughter yields and more marketable salmon.

HIGH TEMPERATURE DIETS

Fish exposed to temperatures that are higher than the optimum growing temperature range may suffer from loss of appetite and slower growth. New diets were developed and introduced to customers by Skretting in 2012 to counter high temperatures for Atlantic salmon, sea bass and rainbow trout, for markets in Australia, Spain, France, Italy and Turkey.

Skretting 领先技术

DEVELOPING SPECIFIC HEALTH SOLUTIONS

In response to increasing challenges from parasites such as sea lice in the salmon farming industry in Western Europe, ARC has continued to run various research studies to gauge the impact of exposure on the gills and skin of salmon and to measure the potential of Skretting's Protec diet to mitigate any damage. Salmon that were fed on Protec in advance of treatment showed a quicker recovery of mucous cell numbers.

protec™

NIR ANALYSES

Skretting researchers have extended the capabilities of rapid NIR (near-infrared reflectance) spectroscopy analysis used in fish feed production to cover the raw materials and finished feeds for shrimp. Any feed raw material sample is illuminated with near-infrared light, and the spectrum of light reflected by the sample is recorded. That spectrum is automatically compared with standard spectra held in a central database and the results are delivered almost instantly. Skretting has a uniquely long record of using NIR for raw material and feed analysis.

Feed intake control

General and Comparative Endocrinology 175 (2012) 118–134

Contents lists available at SciVerse ScienceDirect

General and Comparative Endocrinology

journal homepage: www.elsevier.com/locate/ygcen

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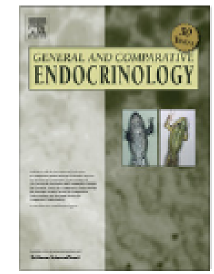

Ghrelin is involved in voluntary anorexia in Atlantic salmon raised at elevated sea temperatures

E.M. Hevrøy [a,*], R. Waagbø [a], B.E. Torstensen [a], H. Takle [b,c], I. Stubhaug [a,d], S.M. Jørgensen [b], T. Torgersen [e], L. Tvenning [f], S. Susort [g], O. Breck [f], T. Hansen [e]

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Broodstock nutrition

Journal of Fish Biology (2012) **81**, 1391–1405
doi:10.1111/j.1095-8649.2012.03425.x, available online at wileyonlinelibrary.com

The effect of dietary lipid content and stress on egg quality in farmed Atlantic cod *Gadus morhua*

A. S. Bogevik*†, S. Natário*‡, Ø. Karlsen*, A. Thorsen§, K. Hamre‖, G. Rosenlund¶ and B. Norberg*

**Institute of Marine Research, Austevoll Research Station, 5392 Storebø, Norway, ‡University of Algarve, Faculty of Sciences and Technology, 8005-139 Faro, Portugal, §Institute of Marine Research, PB 1870, 5817 Bergen, Norway, ‖National Institute of Nutrition and Seafood Research, PB 2029 Nordnes, 5817 Bergen, Norway and ¶Skretting Aquaculture Research Centre, PB 48, 4001 Stavanger, Norway*

Well done?

Fishmeal analogues =? Fishmeal

Fishmeal =? Fishmeal

Protein ≠ Amino acids

---Are study findings influenced by study design

- Basal diets：Sole or formulated with other proteins?
- Fish meal sources and quality
- Qualities and processing way of Alternative protein
- Amino acids balance? Determination or digestive levels?
- Mineral balance? Fatty acids balance? Feeding behavior, immunity responses, conditional amino acids…
- Fish body weight and density
- Facilities, does fish growth normally?
- Other parameters besides growth
- Repeatable results?
- ……

Main technique problems

1. Digestion and intestinal health；
2. Feed intake；
3. Ideal protein profile and amino acids balance；
4. Lipids metabolism and liver health;
5. Carbohydrate utilization, low cost formulation；
6. Flesh quality control and retreat
7. ……

Nutrients balance

Feed additives

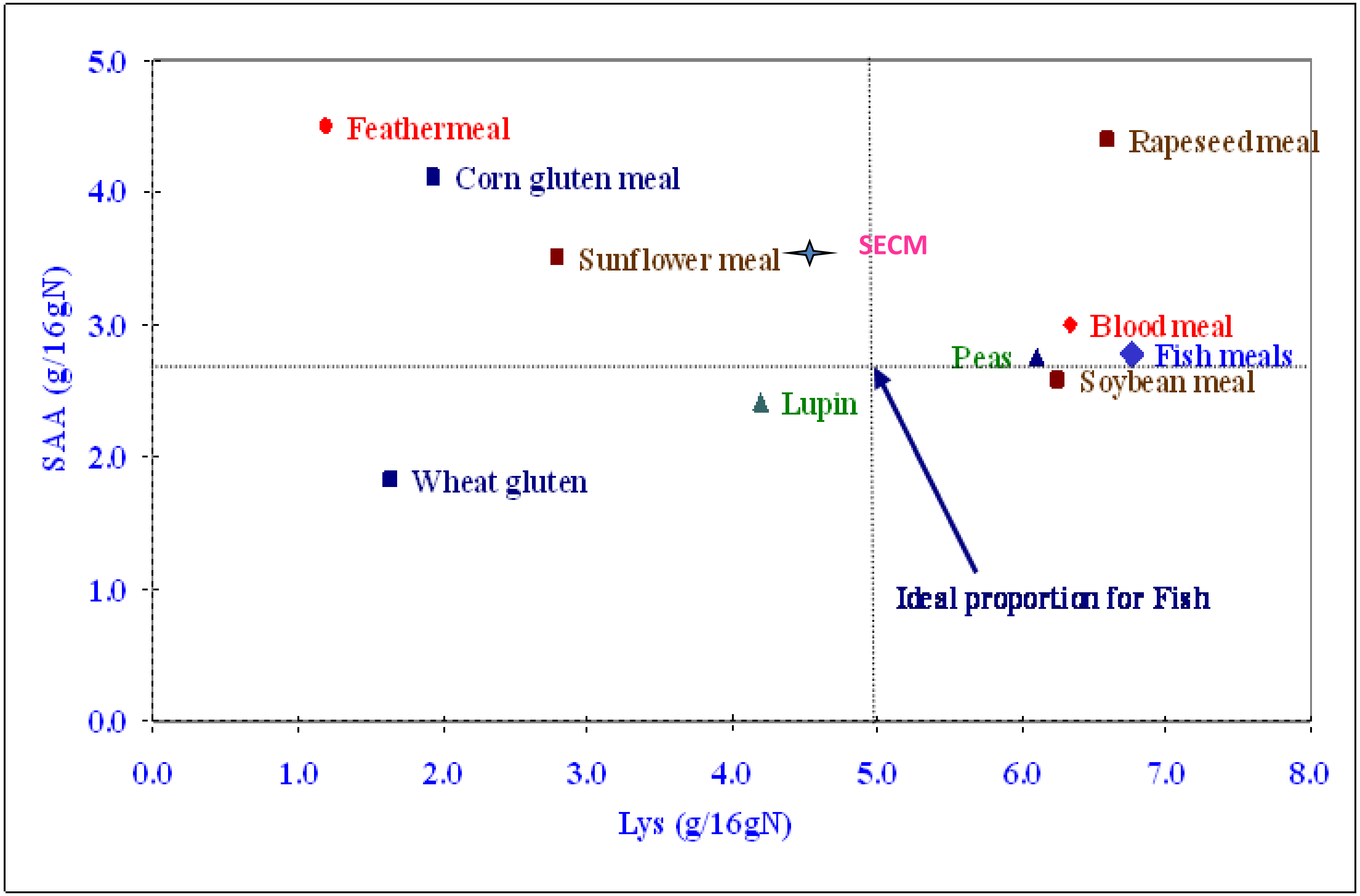
Feed processing

- Digestible and metabolizable nutrients of ingredients is basis for precise formulation of aquafeed.

- Nutrients sources is more important than crude nutrients level.

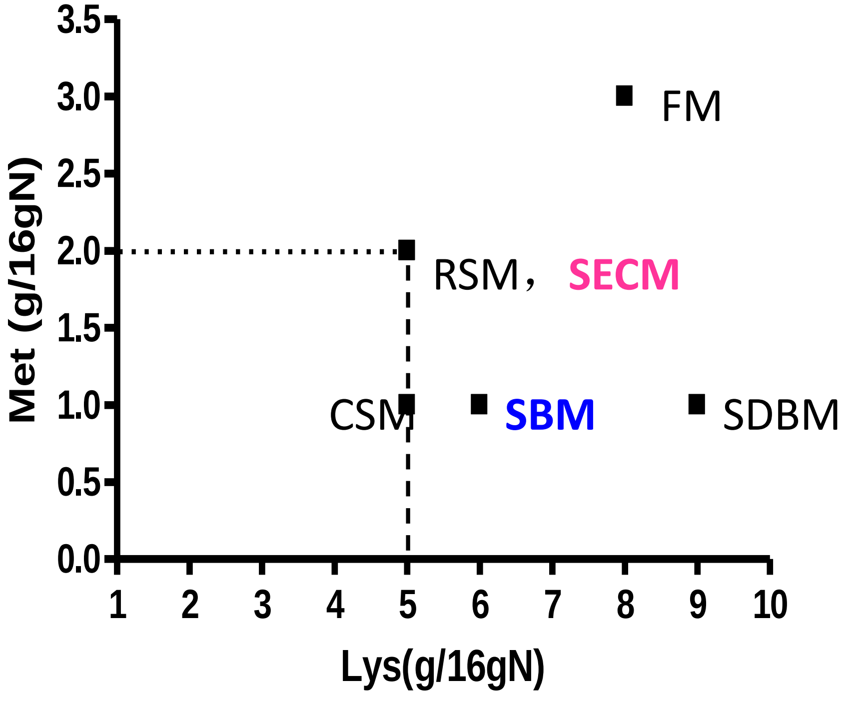
- **It is important to base both the recommendations and feed formulations on digestible rather than determined amino acid contents**

Lys and SAA contents of selected protein sources compared with the requirements by fish

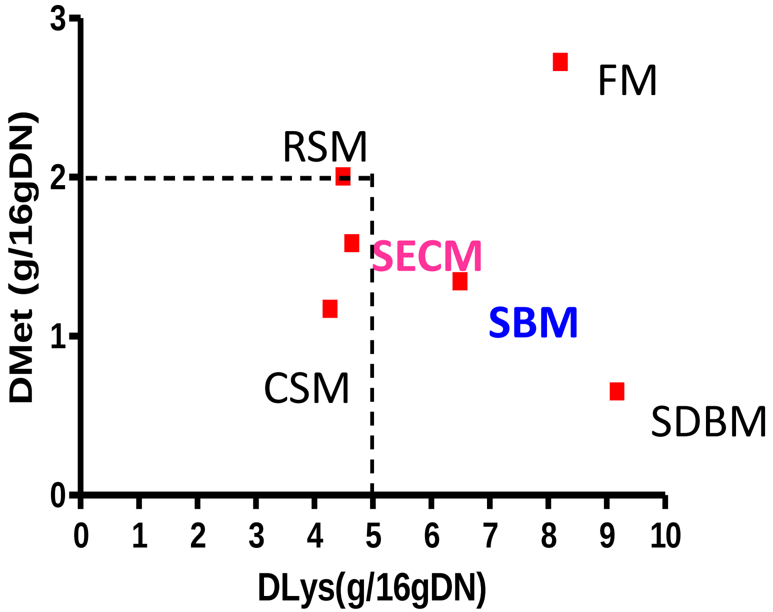


Kaushik & Seiliez, 2010)

Different based on digestible and determined AA profile



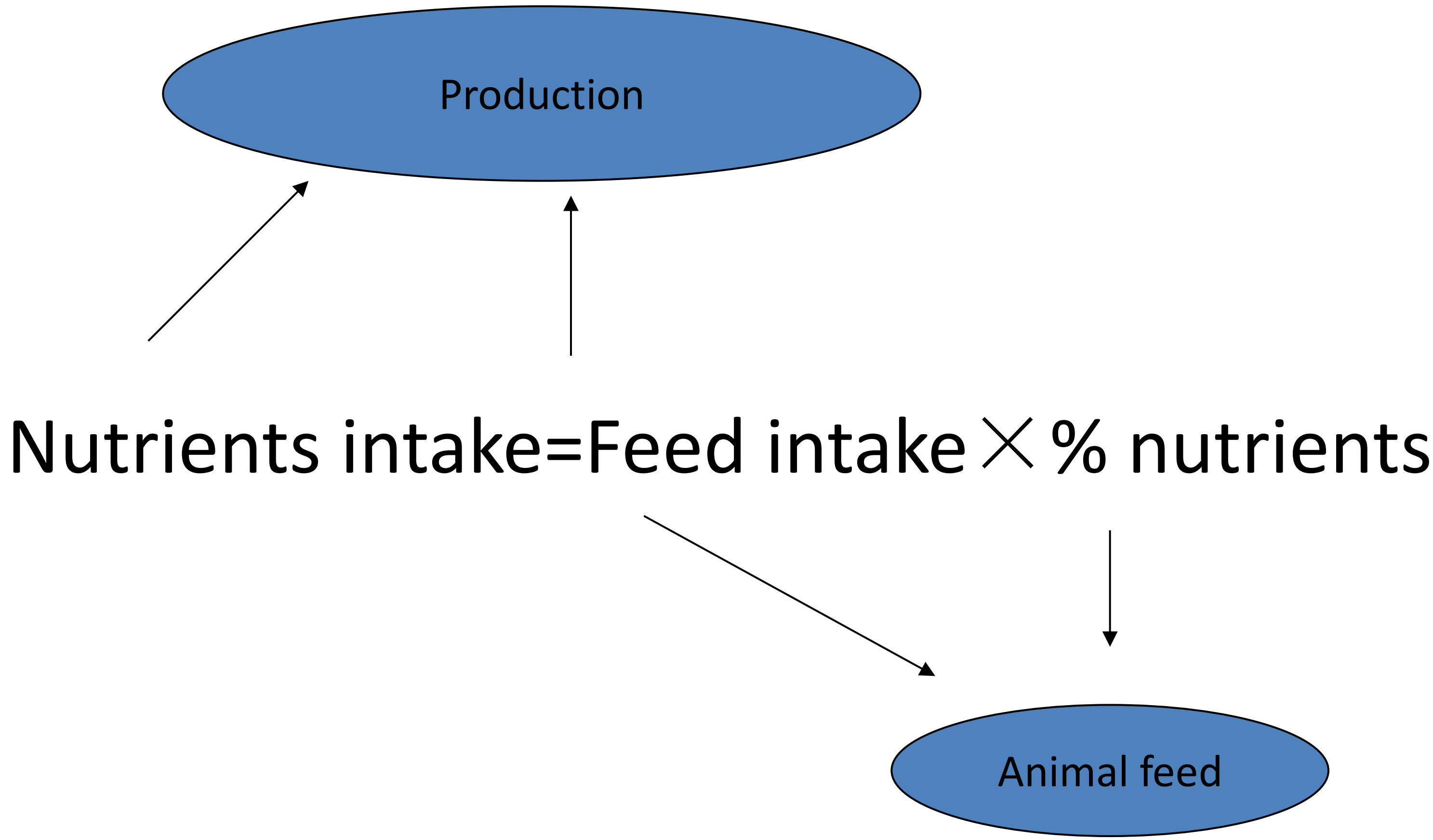
Determined level



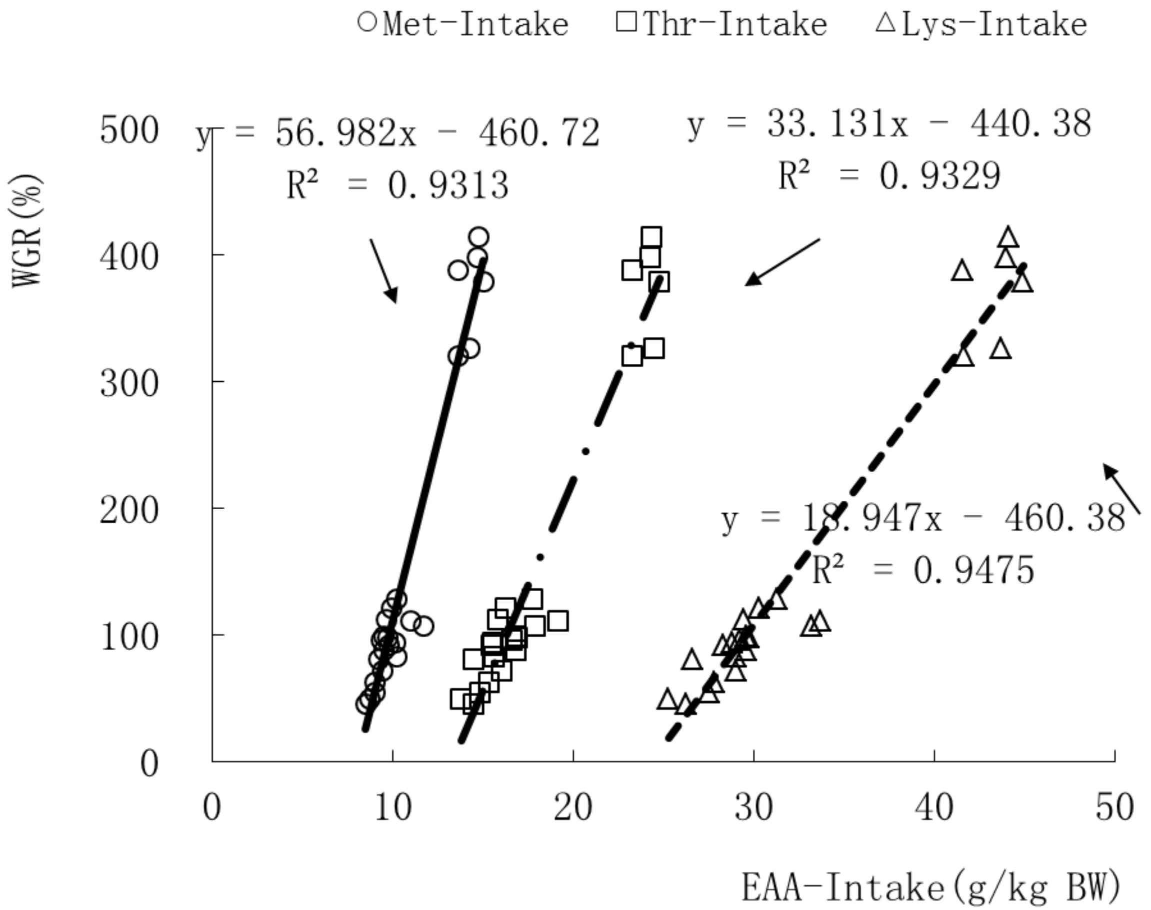
Digestible level

- **Feed intake is the first issue for feed design**



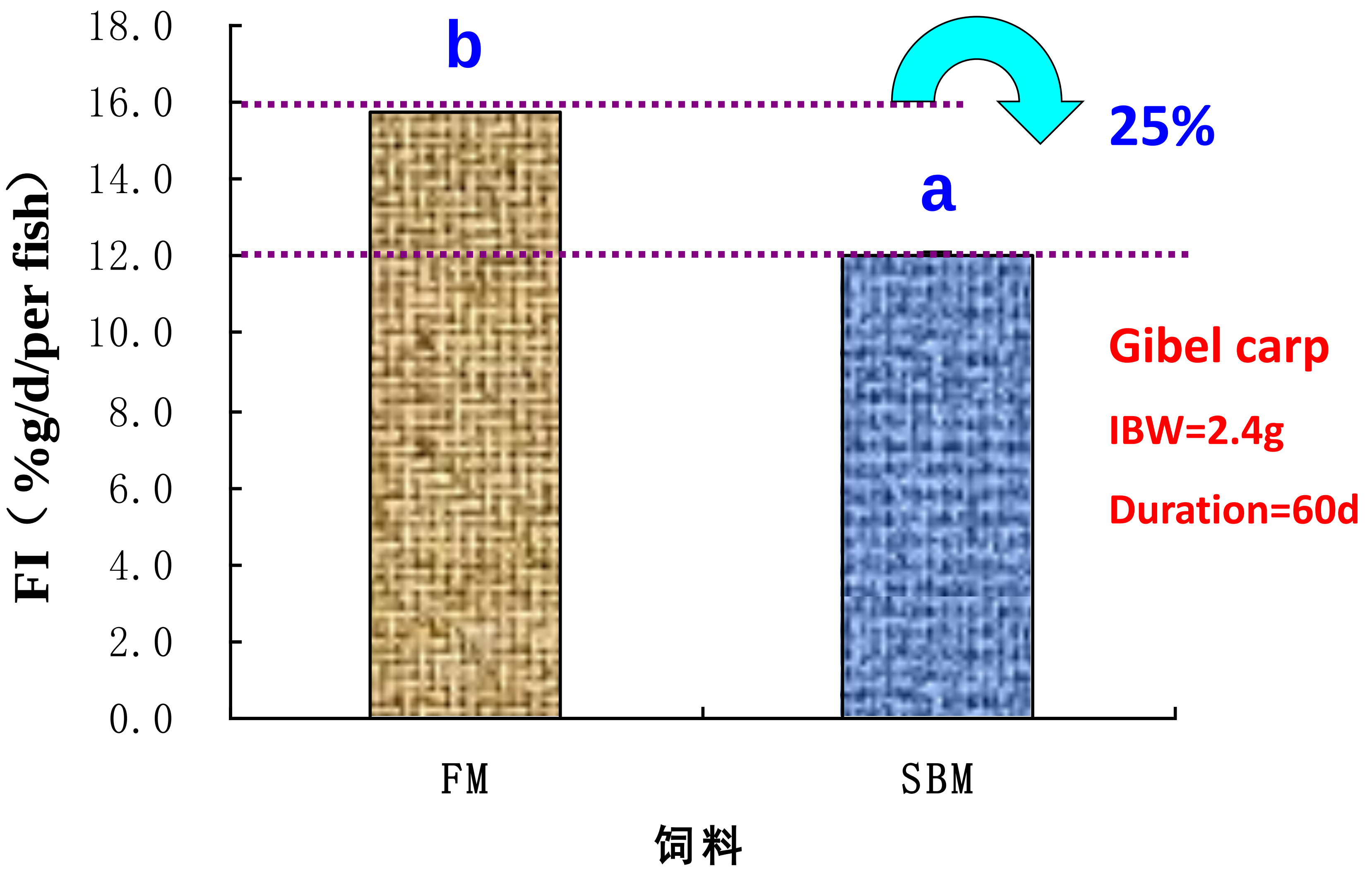

Production
Nutrients intake=Feed intake × % nutrients
Animal feed

EAA Intake *vs* WGR

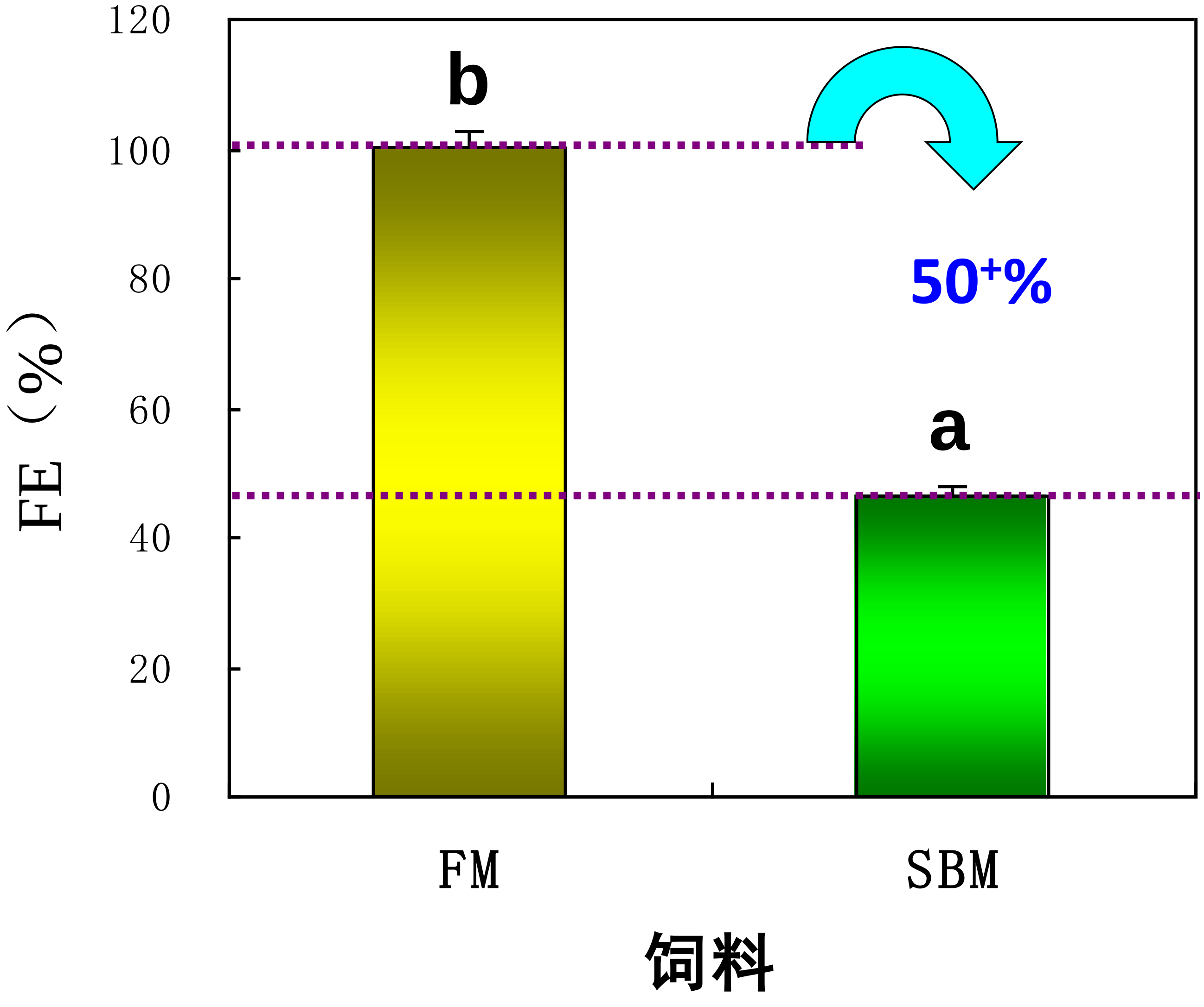


Met and Thr might more important than Lys in low fishmeal feed.

Feed intake per day



Feed conversion efficiency



Gibel carp

IBW=2.4g

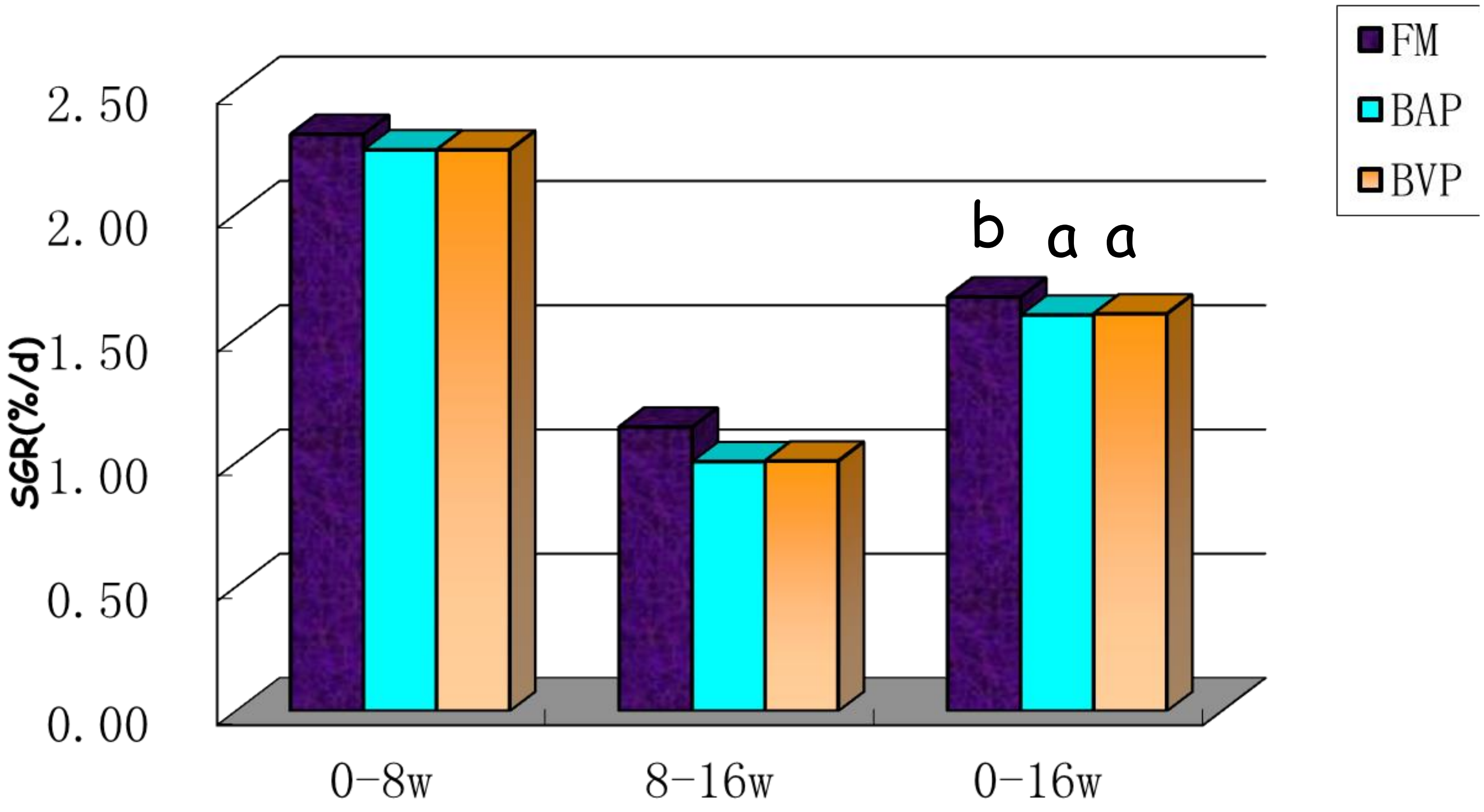
Duration=60d

Formulation and proximate composition of experimental diets ($g.kg^{-1}$, wet basis)

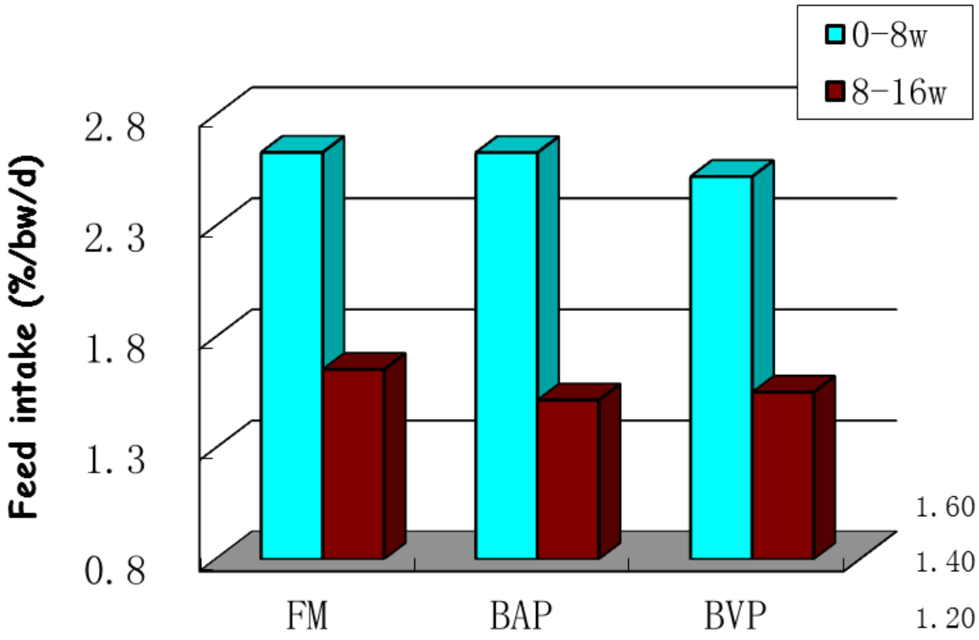
Ingredients	FM	BAP	BVP
Fishmeal	483.00	0.00	0.00
BAP	0.00	451.00	0.00
BVP	0.00	0.00	596.80
Wheat flour	330.00	355.40	165.00
$Ca(H_2PO_4)_2$	6.00	6.00	31.50
Lysine(50%)	0.00	4.60	16.00
Methionine(98%)	0.00	3.00	3.20
Threonine(98%)	0.00	3.00	3.50
Oils	67.00	63.00	110.00
Others	114.00	114.00	74.00
Total	1000.00	1000.00	1000.00

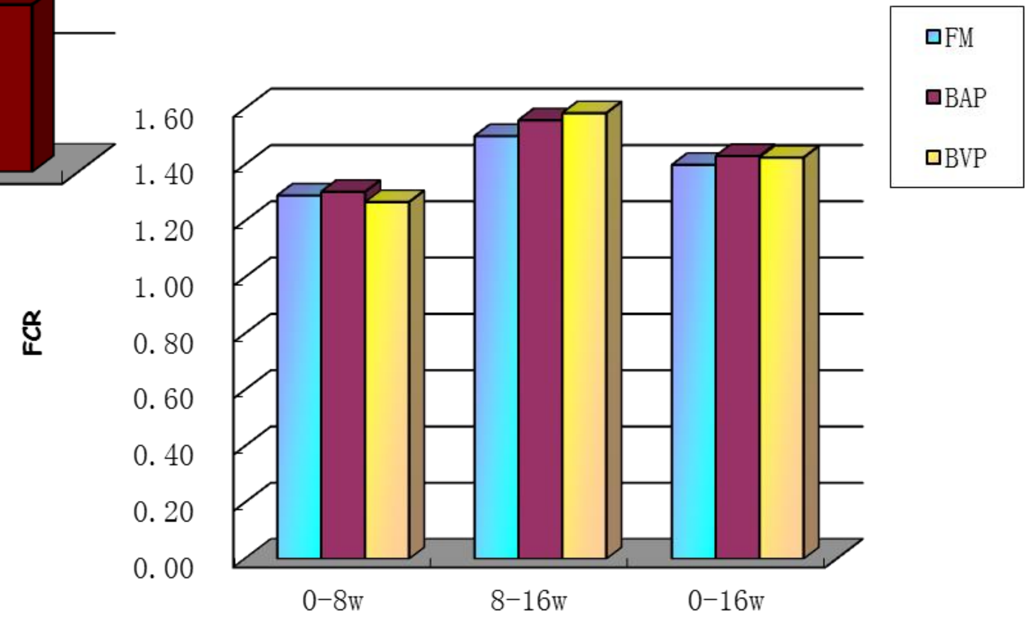
Siberian sturgeon, Sheng et al.2007

特定生长率SGR



Feed intake & FCR



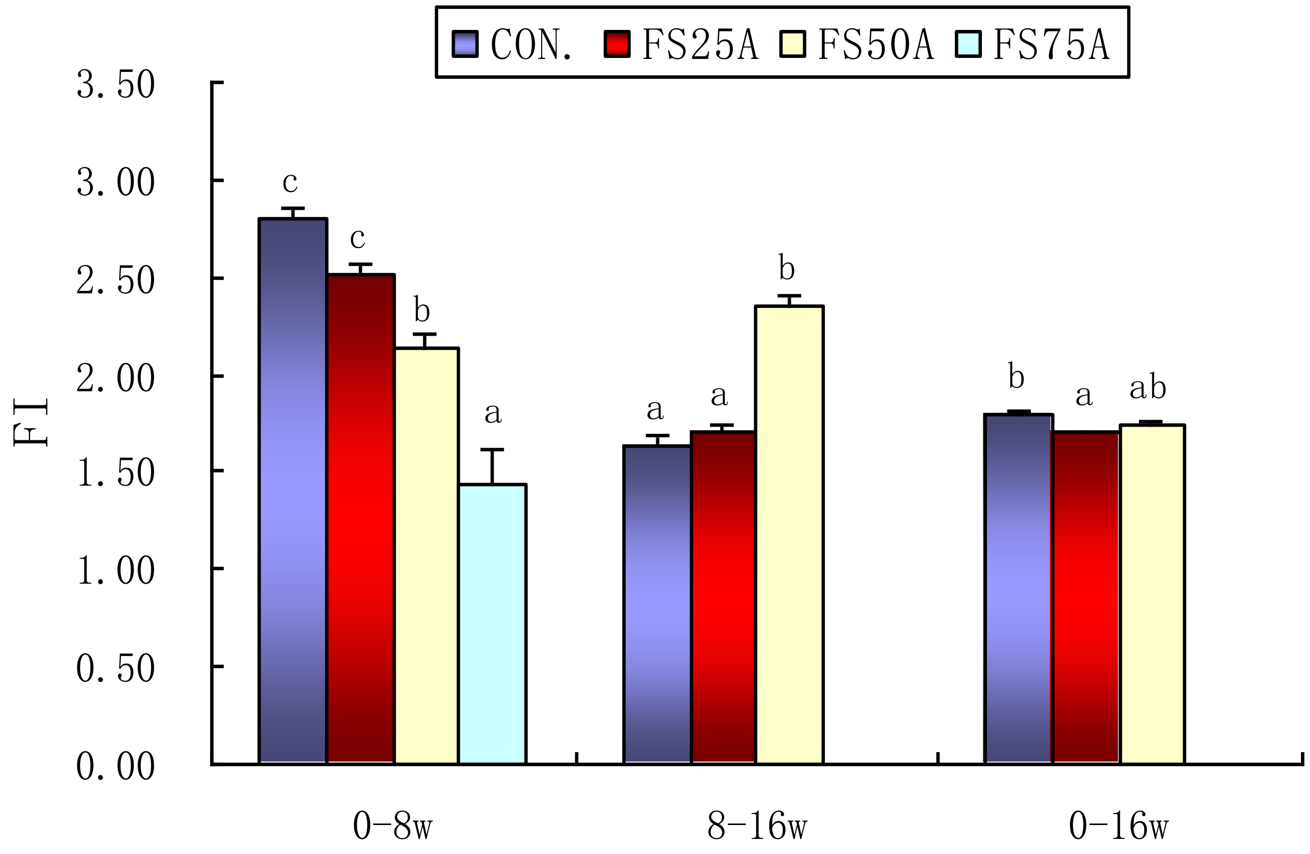


Formula of seabass

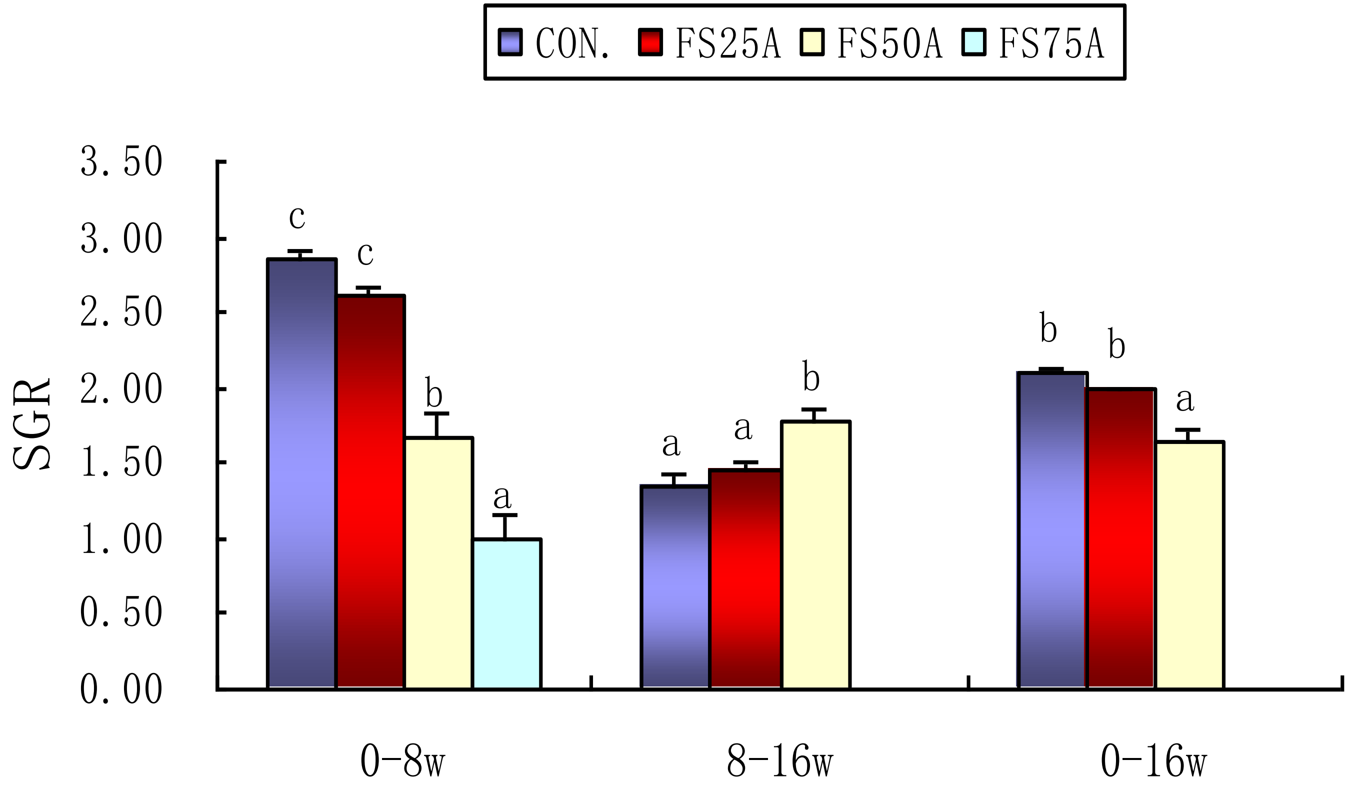
Ingredients	CON.	FSM25A	FSM50A	FSM75A
LT-FM	36.00	27.00	18.00	9.00
FSM	0.00	11.00	22.00	33.00
SBM	18.00	18.00	18.00	18.00
Wheat flour	22.00	22.00	22.00	20.00
FO	5.50	5.50	5.90	6.30
$Ca(H_2PO_4)_2$	0.60	0.60	0.60	0.60
Pre-mix	1.00	1.00	1.00	1.00
L-Lys(50%)		0.39	0.80	1.21
DL-Met(98%)		0.14	0.29	0.44
L-Thr(98%)		0.07	0.15	0.23
Others	16.80	14.80	12.40	12.00
总计	100.00	100.00	100.00	100.00

Seabass, Hu et al., 2008

Feed intake (Mean±S.E.)



SGR（Mean±S.E.)

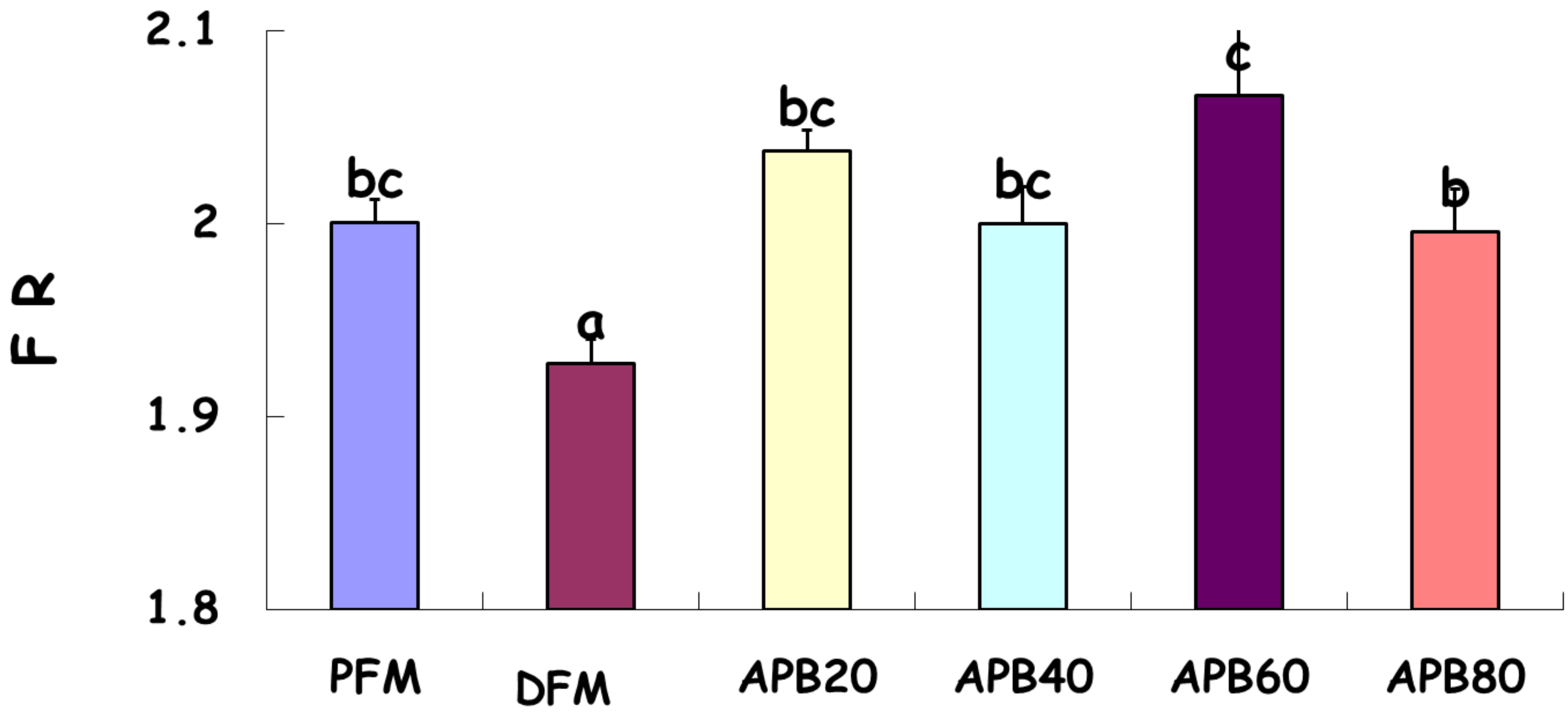


CON.
FS25A
FS50A
FS75A
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
SGR
c
c
b
a
a
a
b
b
b
a
0-8w
8-16w
0-16w

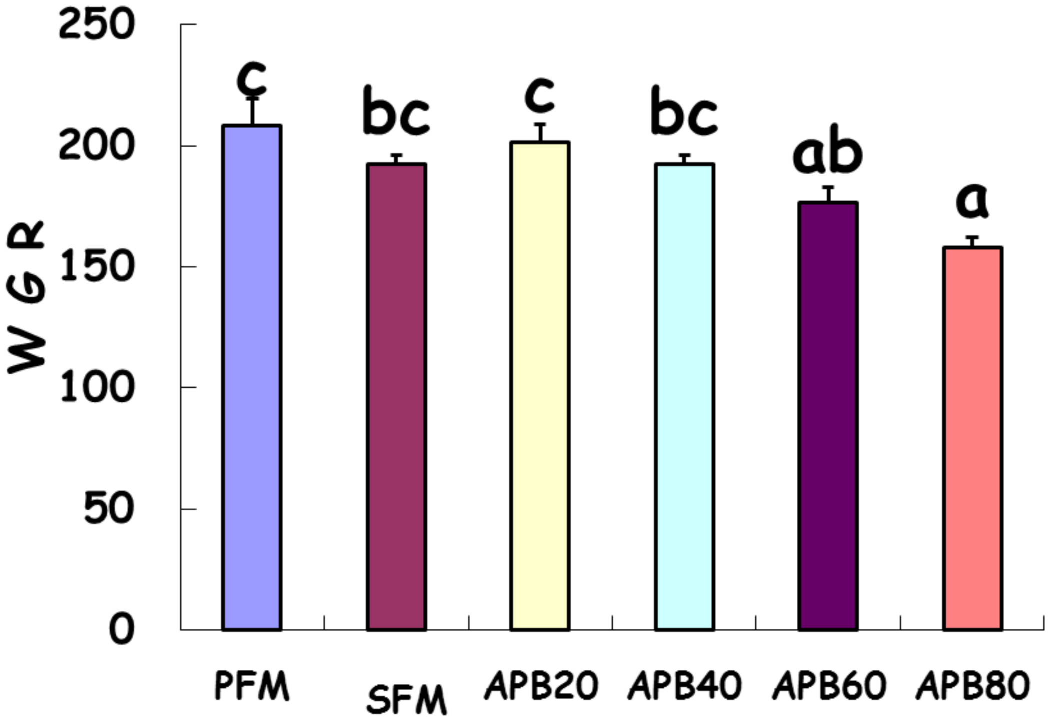
Fishmeal quality and terrestrial animal protein utlization

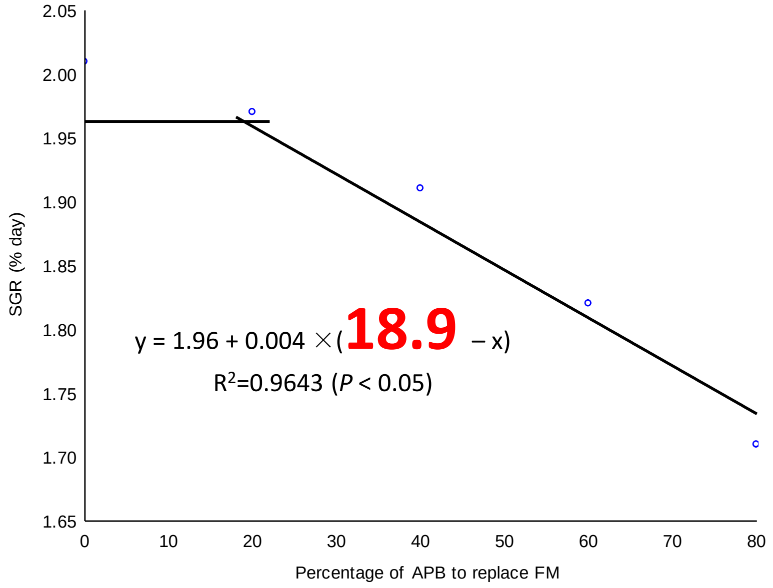
Ingredients	PFM	SFM	APB20	APB40	APB60	APB80
Peru fish meal	400.00	0.00	320.00	240.00	160.00	80.00
Domestic fish meal	0.00	500.00	0.00	0.00	0.00	0.00
Animal protein blend	0.00	0.00	80.00	160.00	240.00	320.00
Soybean meal	210.00	110.00	210.00	210.00	200.00	200.00
Wheat flour	220.00	220.00	220.00	220.00	220.00	220.00
Fish oil	50.00	42.00	46.30	43.60	49.30	40.60
L-lysine(50%)	0.00	0.00	2.46	4.93	7.91	10.34
DL-methionine(98%)	0.00	0.00	0.72	1.45	2.24	2.94
L-threonine(98%)	0.00	0.00	0.49	0.97	1.60	2.07
Others	120.00	128.00	120.00	119.00	119.00	124.00

Feed intake of JSB during the experiment



Weight gain rate (WGR) of JSB during the experiment

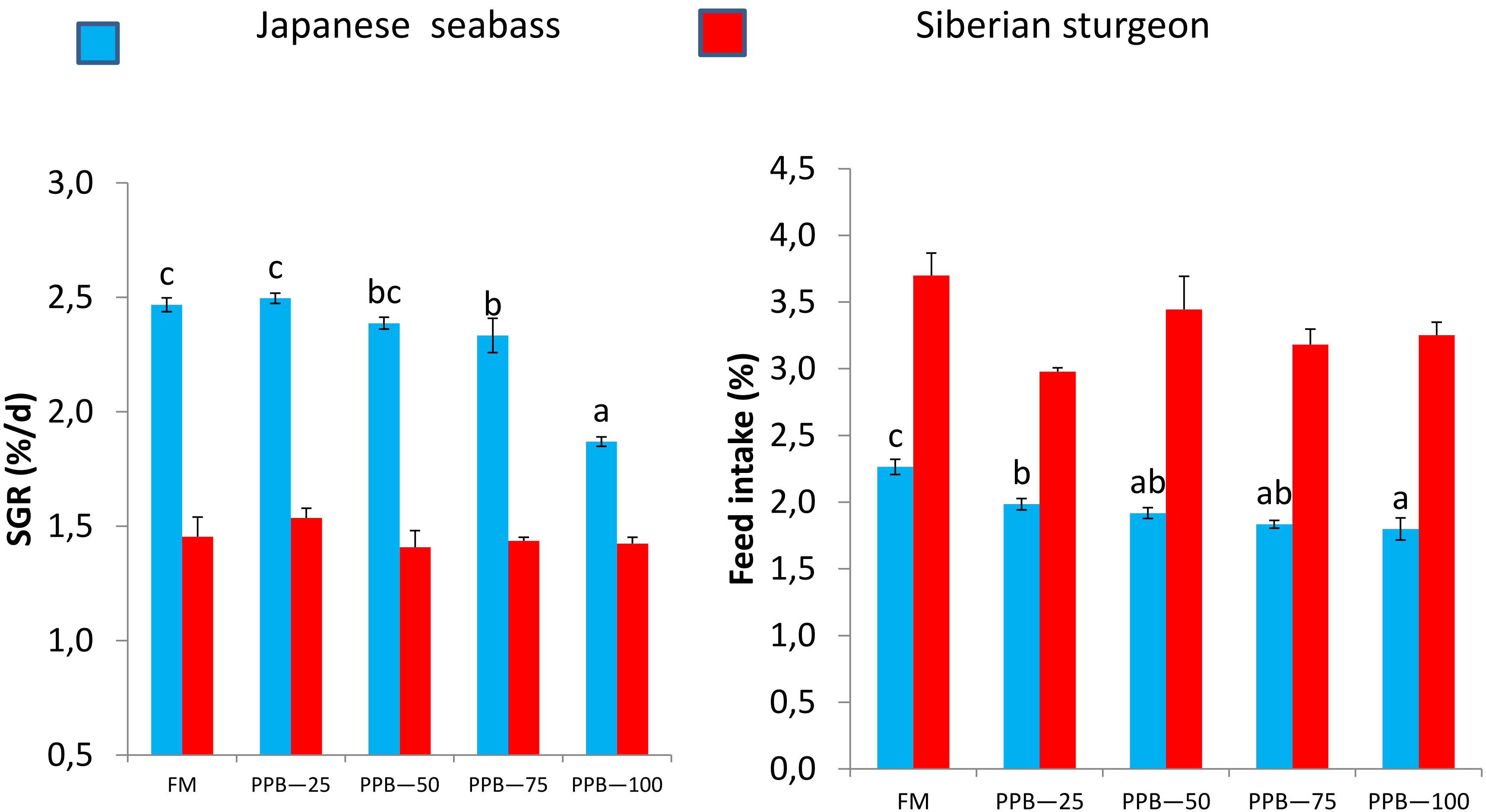




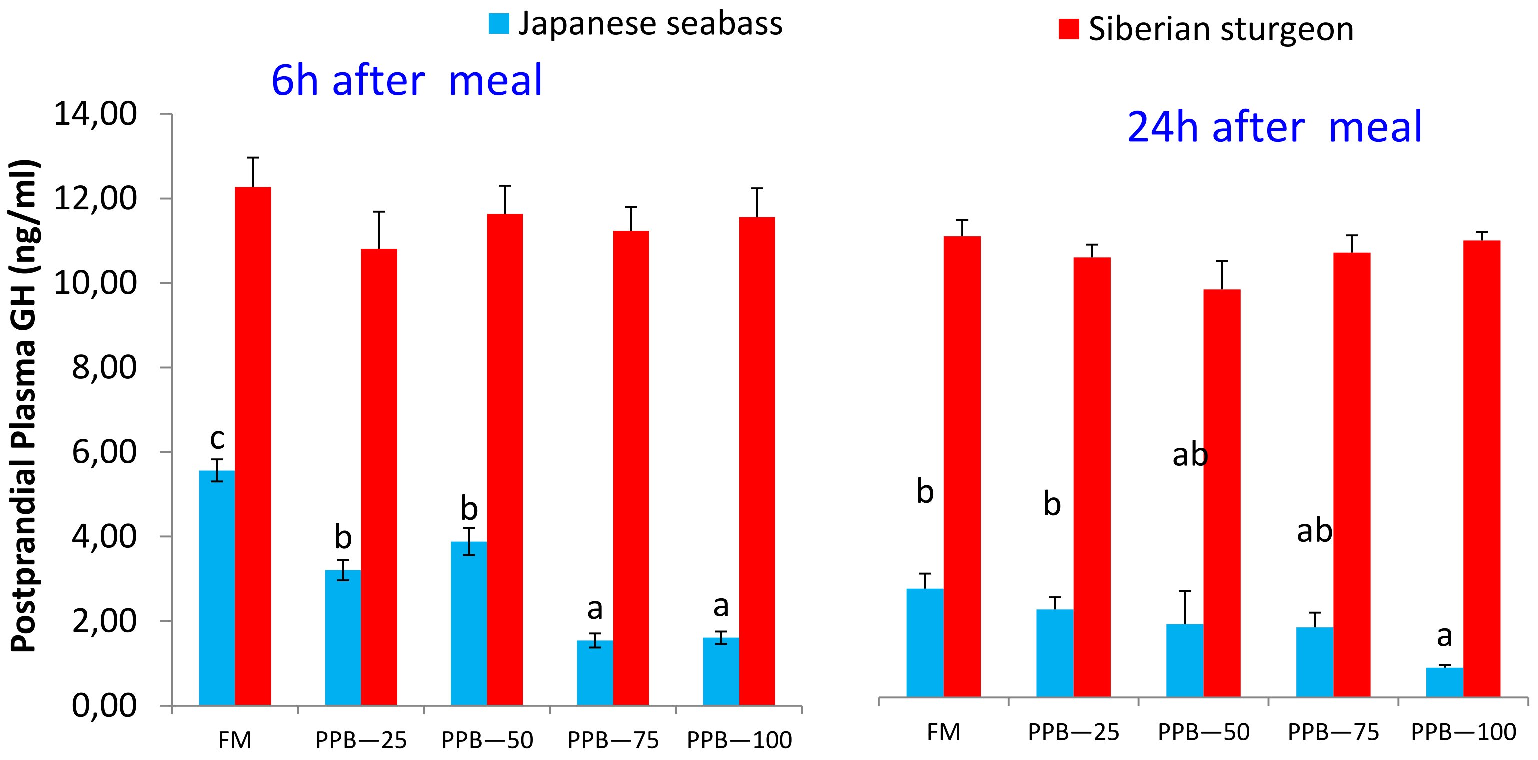
Repeatability of results

实验设计Experiment design	鲟Siberian Sturgeon	鲈Japanese seabass
对照组Control diets		
鱼粉LT-FM contents (%)	51	56.9
饲料蛋白水平Protein level（%）	36	40
总能Gross energy (MJ/kg)	20	20
实验组Test diets		
替代蛋白源Alternative protein	Plant protein blend (Soybean meal: wheat gluten meal=1:1.67) with protein level at 65%	
替代水平Substitution level	0,25%, 50%, 75%, 100%	
命名Naming	FM, PPB25, PPB50, PPB75, PPB100	
氨基酸平衡EAA balance	Lys, Met, Thr	
养殖管理System and husbandry		
系统System	In same recirculation system	
初始体重IBW	49.48±1.00g	7.34±0.01 g
重复Replicates	4	
鱼/桶Fish/tank	22	20
养殖周期Duration	16-week	

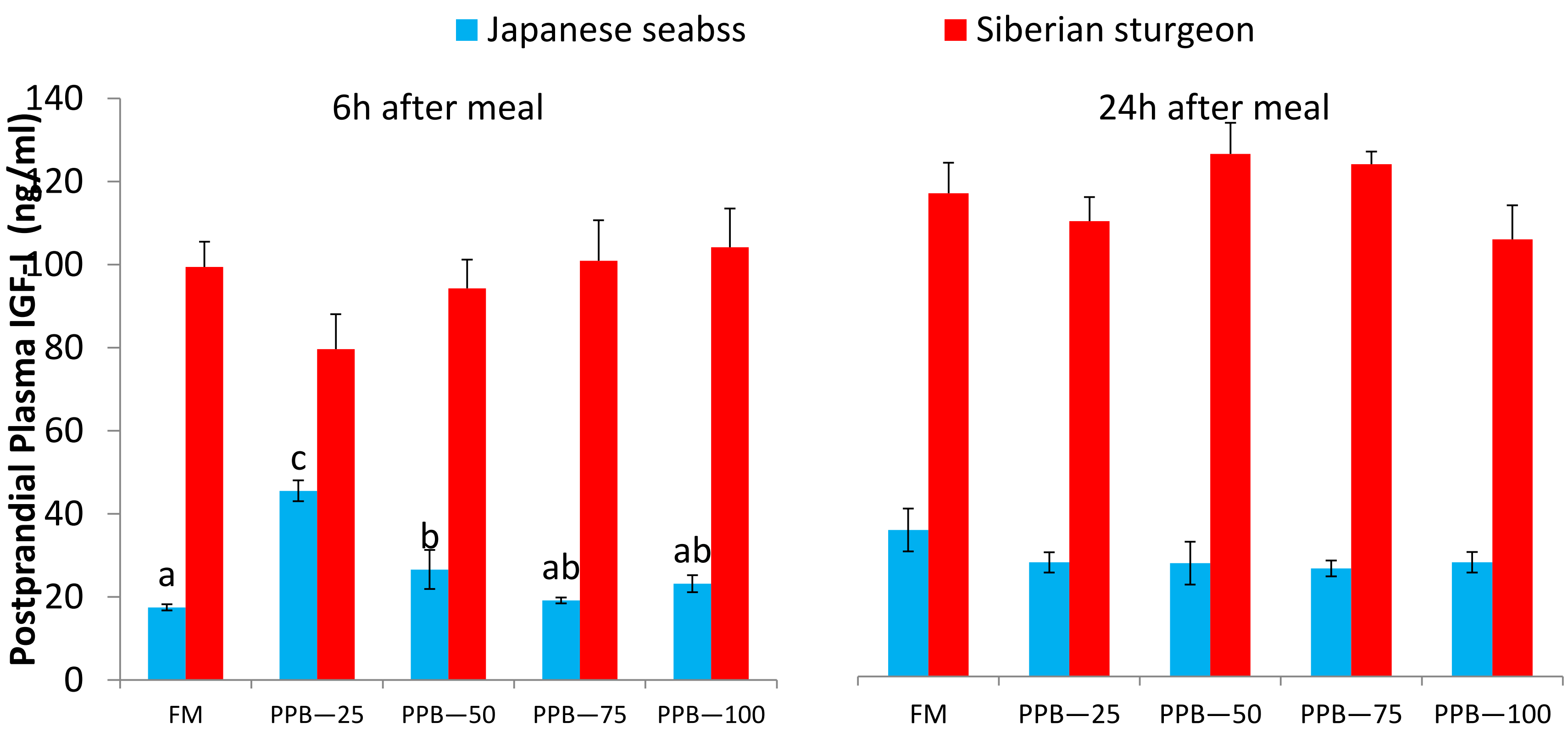
Feed intake and growth



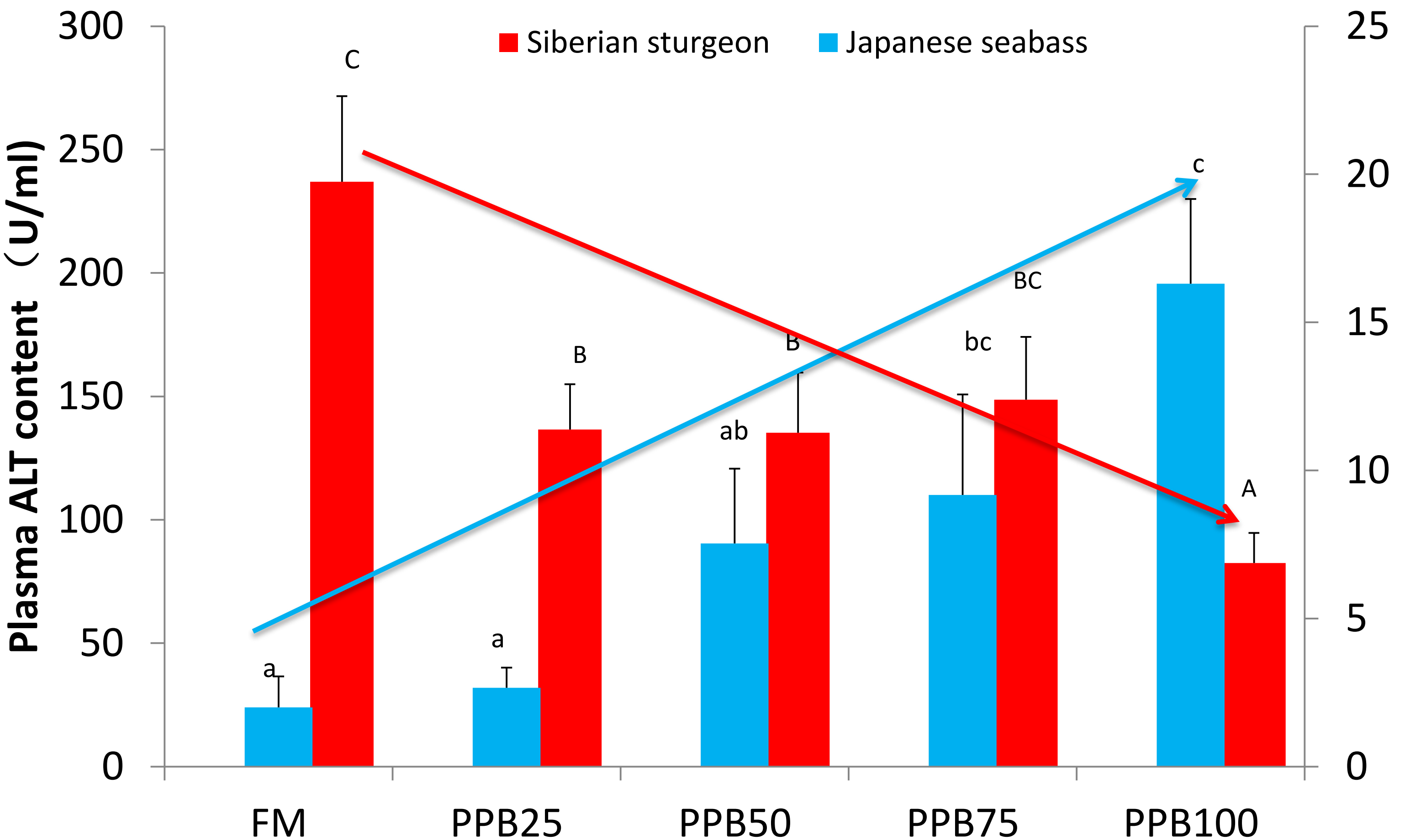
Postprandial plasma GH



Postprandial plasma IGF-I



Different effects onJapanese seabass and Siberian sturgeon fed high plant protein diets

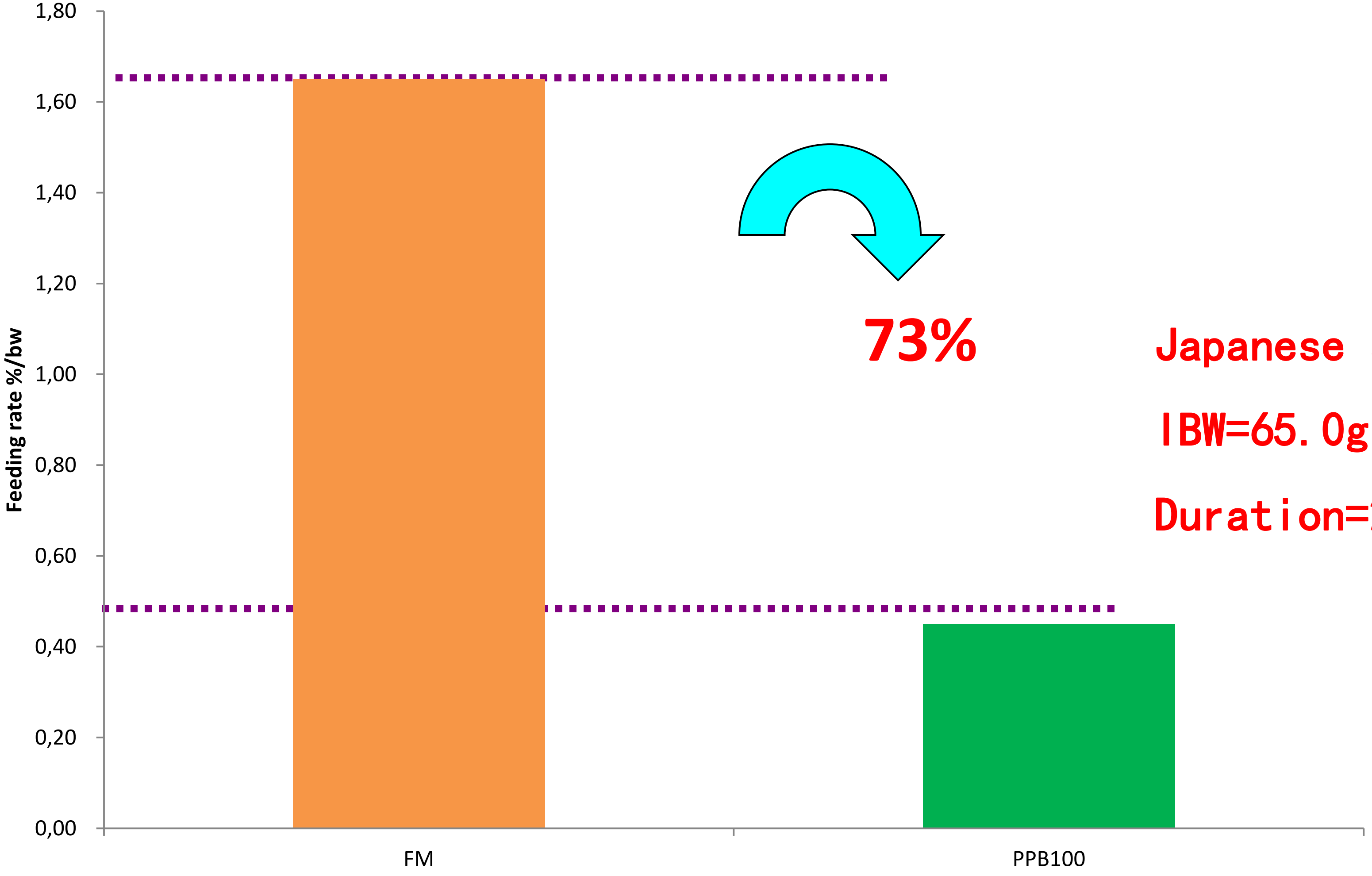


Short term feeding behavior and growth performance of JSM fed FM or plant protein

(3周）

	LJ-FM	LJ-PPB100
IBW(g)	64.89±0.06	65.13±0.09
FBW(g)	81.57±2.22[b]	59.18±2.26[a]
FR(%)	1.65±0.09[b]	0.45±0.11[a]
SGR(%d^{-1})	1.14±0.13[b]	-0.49±0.19[a]
FCR	1.73±0.22[b]	-0.79±0.13[a]
WGR(%)	22.56±3.67 [b]	-12.08±3.55[a]
SR(%)	97.5±1.44	93.75±2.39
CF	1.36±0.02[b]	1.17±0.05[a]

Feed intake

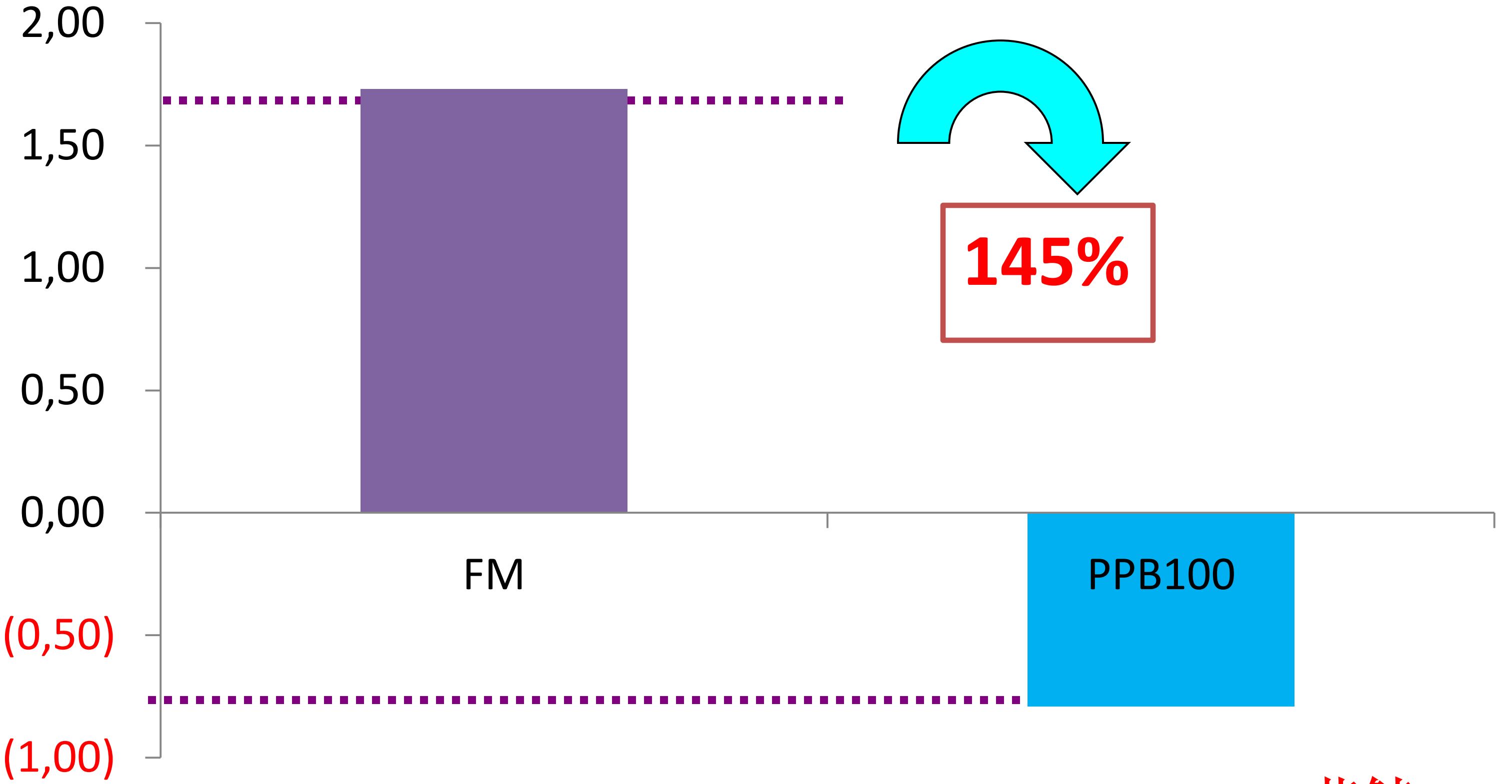


Japanese seabass

IBW=65.0g

Duration=21d

FE

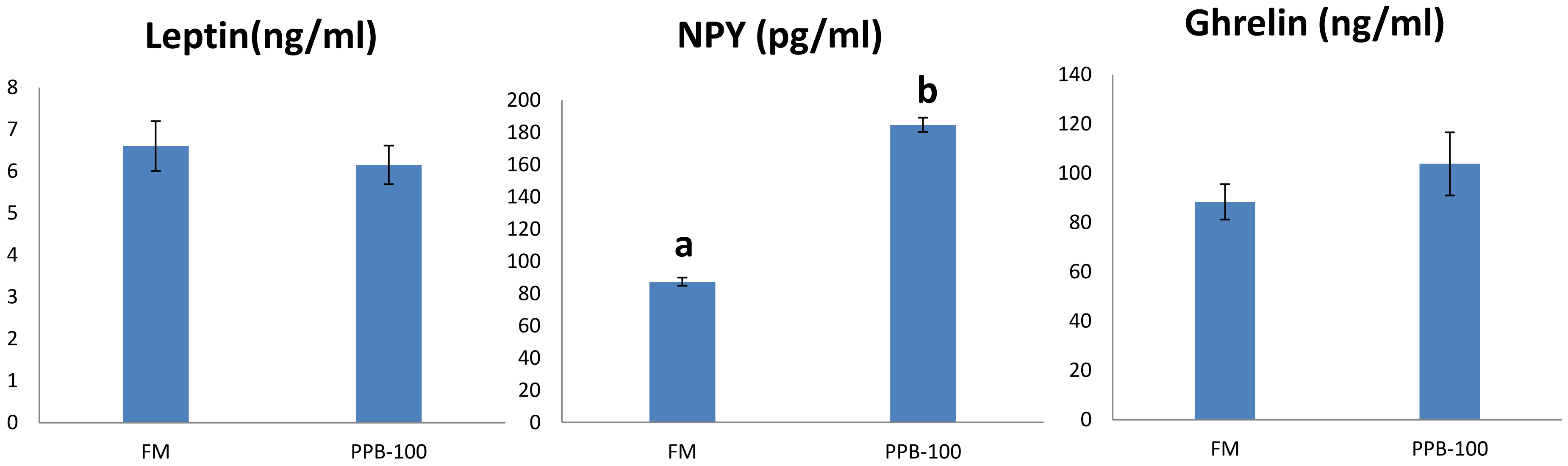


花鲈

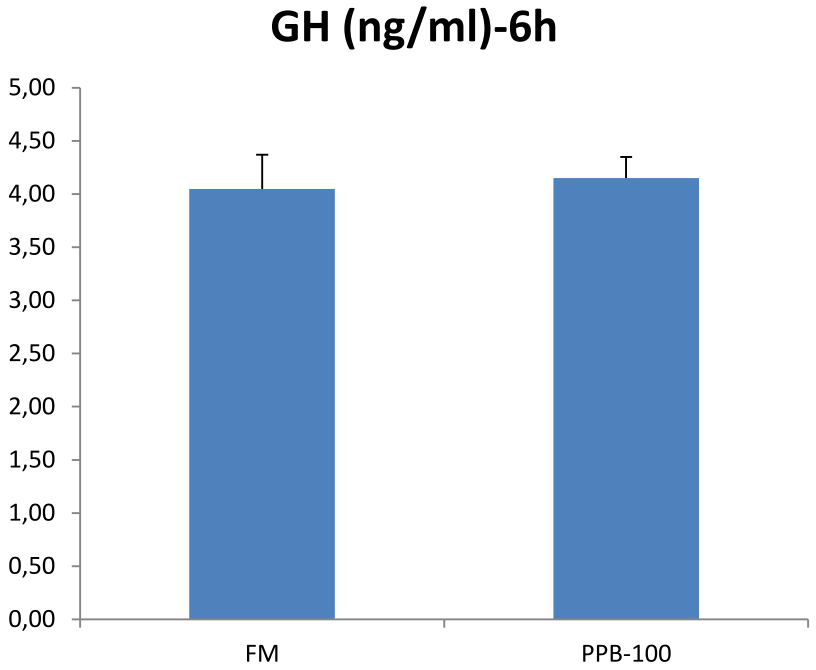
IBW=65.0g

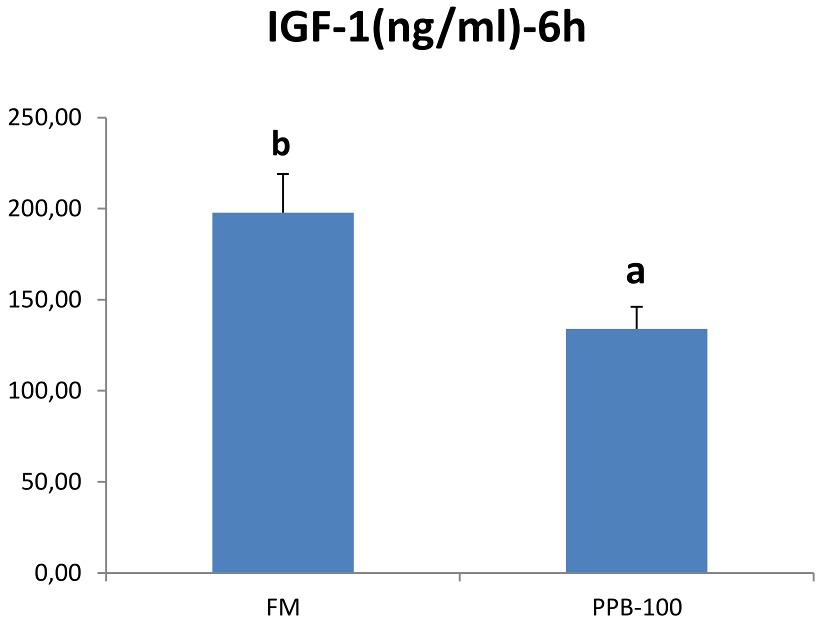
Duration=21d

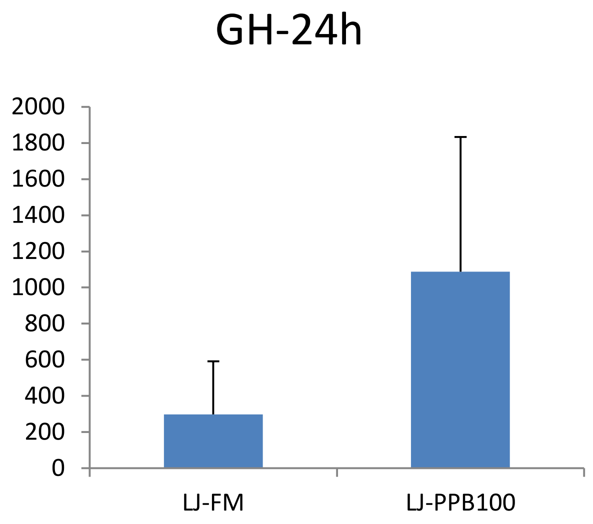
Postprandial 3h plasma feeding hormones

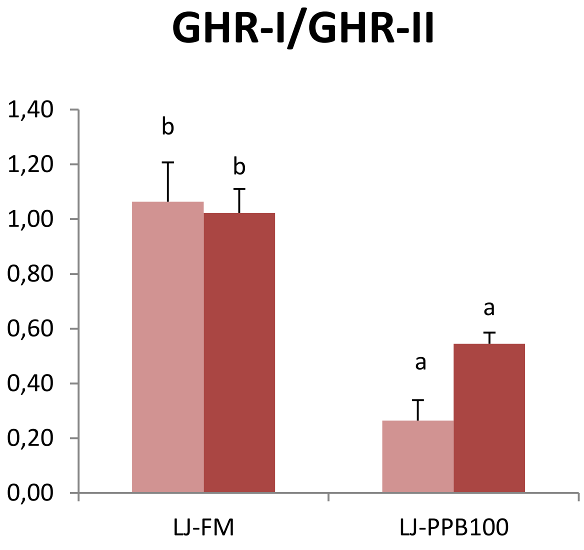


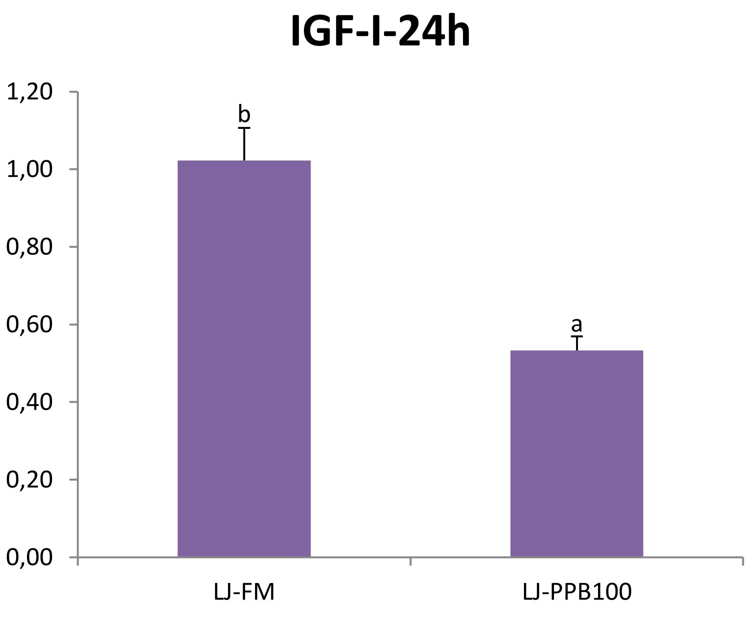
Postprandial 6h plasma GH and IGF-I



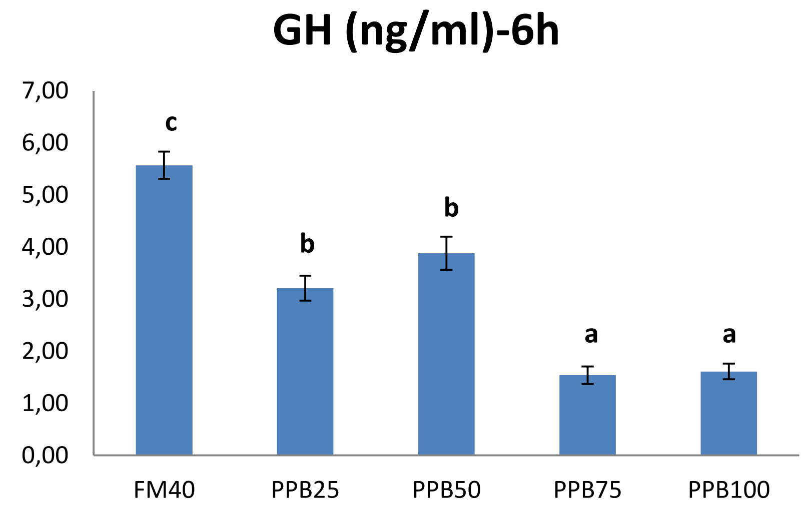


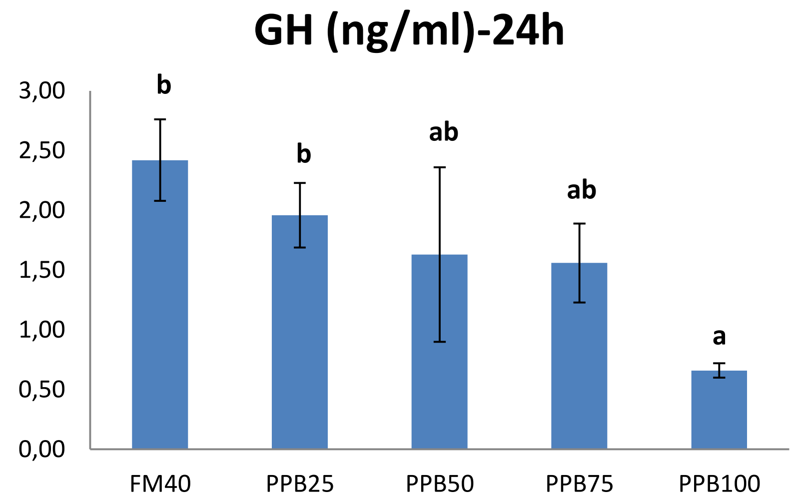

GH-24h
2000
1800
1600
1400
1200
1000
800
600
400
200
0
LJ-FM
LJ-PPB100

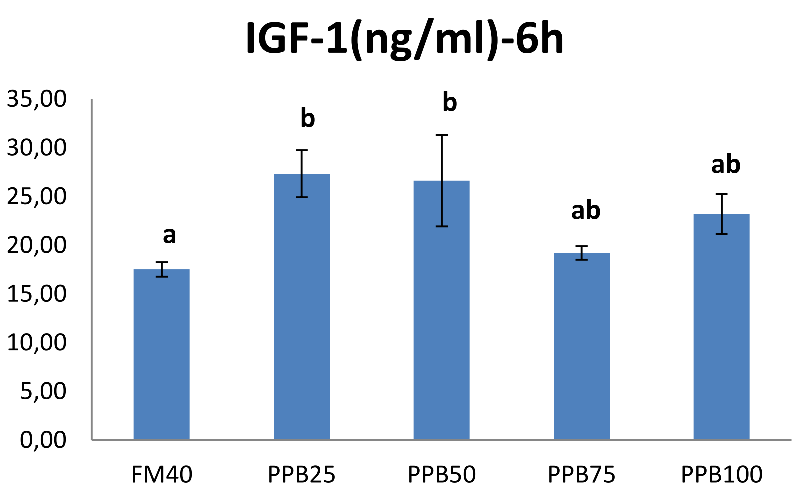

GHR-I/GHR-II
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
b
b
a
a
LJ-FM
LJ-PPB100

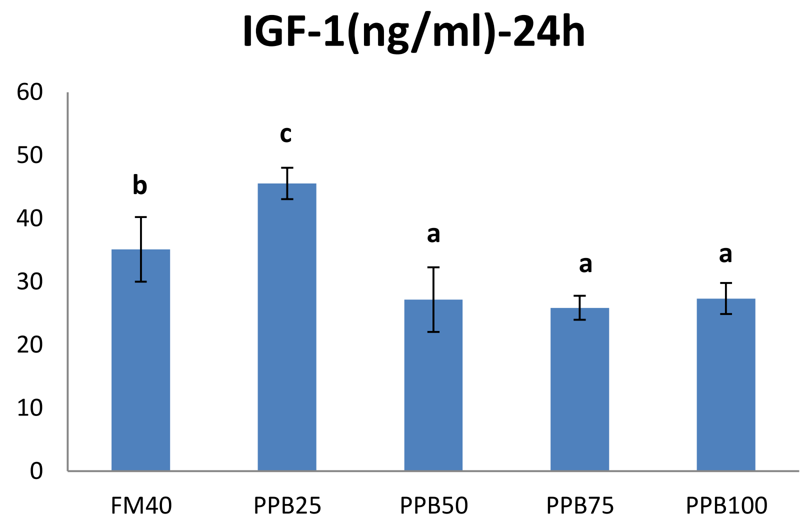

IGF-I-24h
1,20
1,00
0,80
0,60
0,40
0,20
0,00
b
a
LJ-FM
LJ-PPB100

Postprandial plasma GH and IGF-I in long term (16w) feeding trial

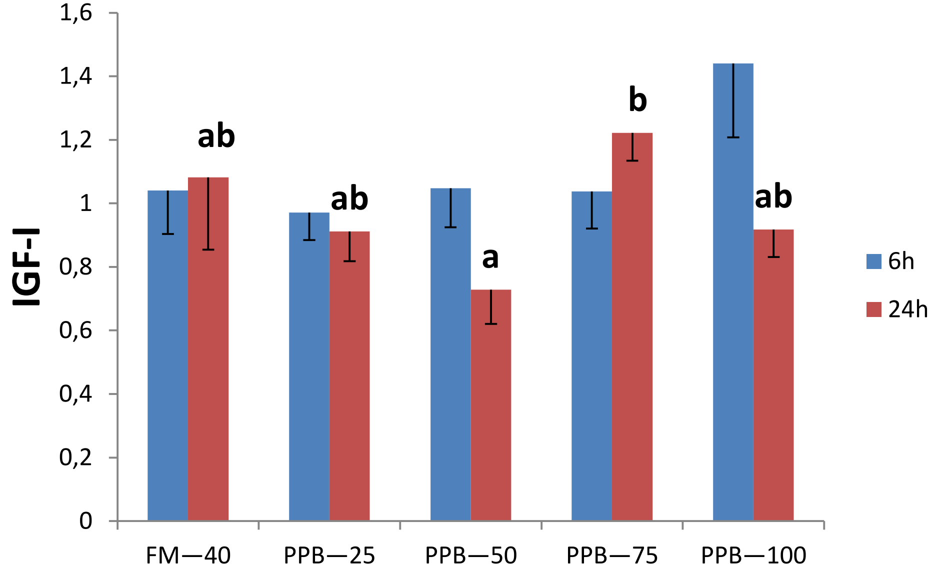


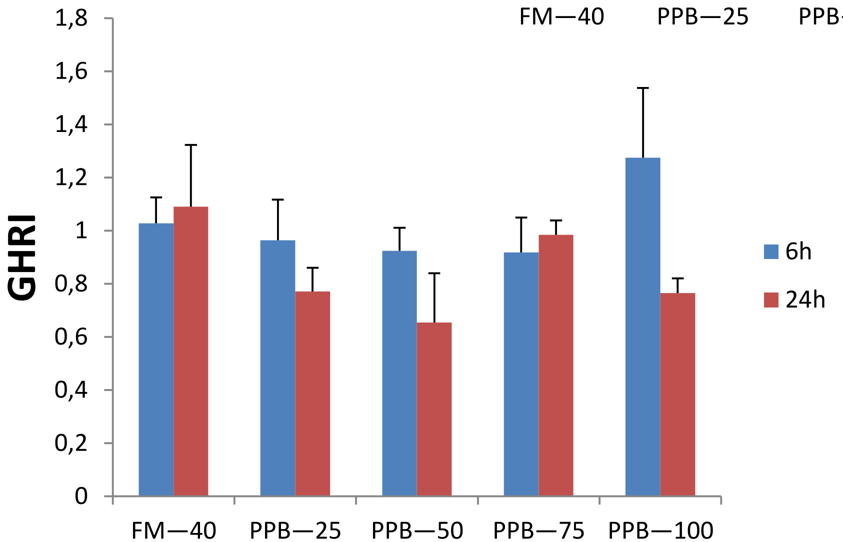


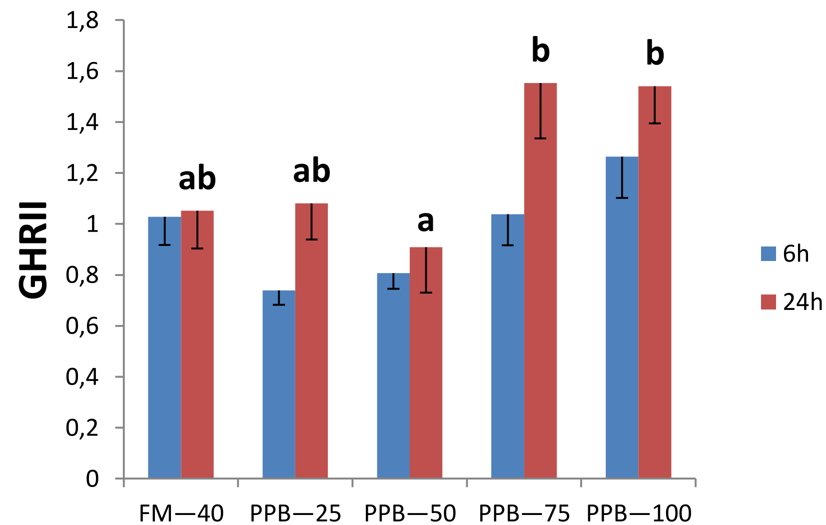




Express of genes in GH/IGF-I axis in long-term trail







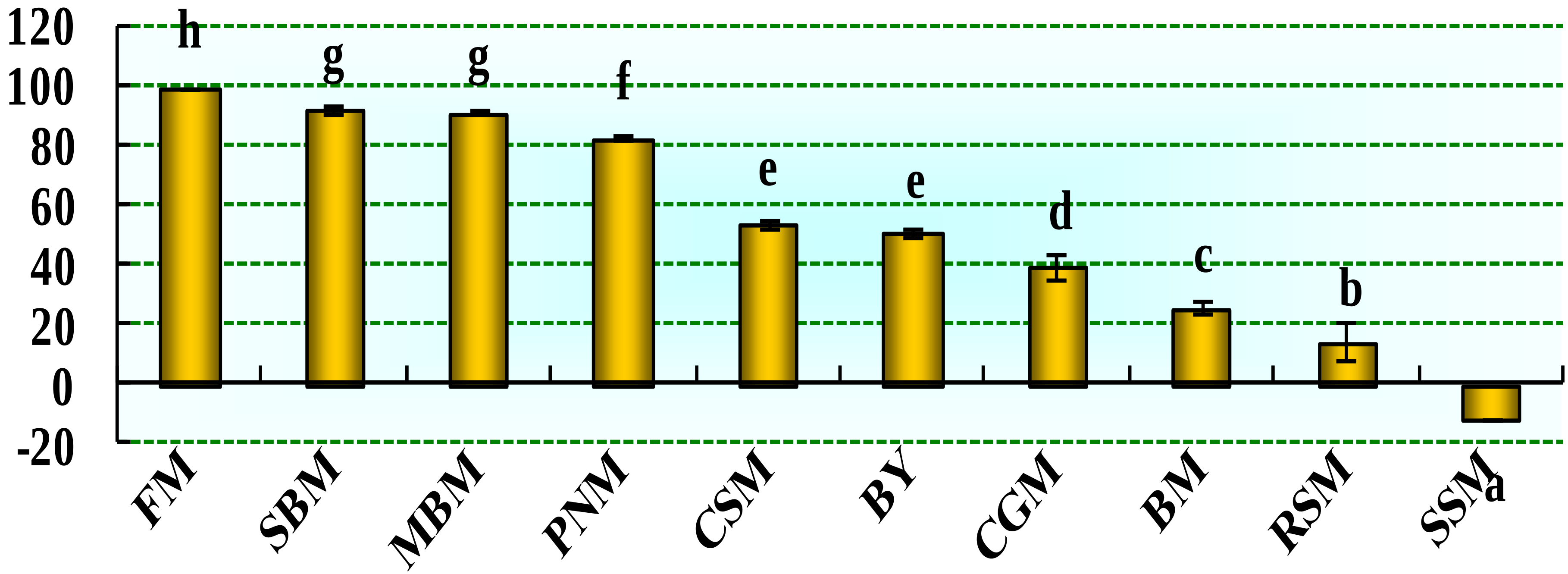
- **Siberian sturgeon is not carnivours species, which can utilize free fishmeal diet well;**
- **At lest 24% of high quality fishmeal need to be used in Japanese seabass diets.**

- Voluntary inhibited feed intake is typical reaction for carnivorous fish species when FM was replaced by plant proteins；
- Appetite and energy requirement could not induce intake for Japanese seabass. Low survival and poor growth were induced by long-term voluntary anorexia;
- However, the feeding inhibition-feeding adaptation – feeding compensation phenomenon could be found for many species.

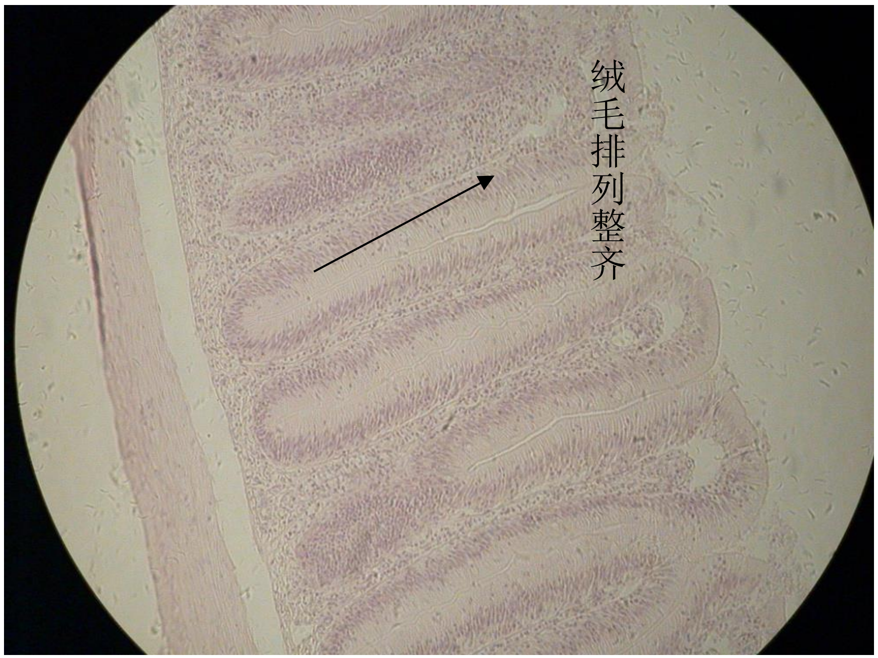
- Micro-ecology
- Intestine Health---Microflora



Utilization various protein sources ----- Biological Value



Histopathology of intestine



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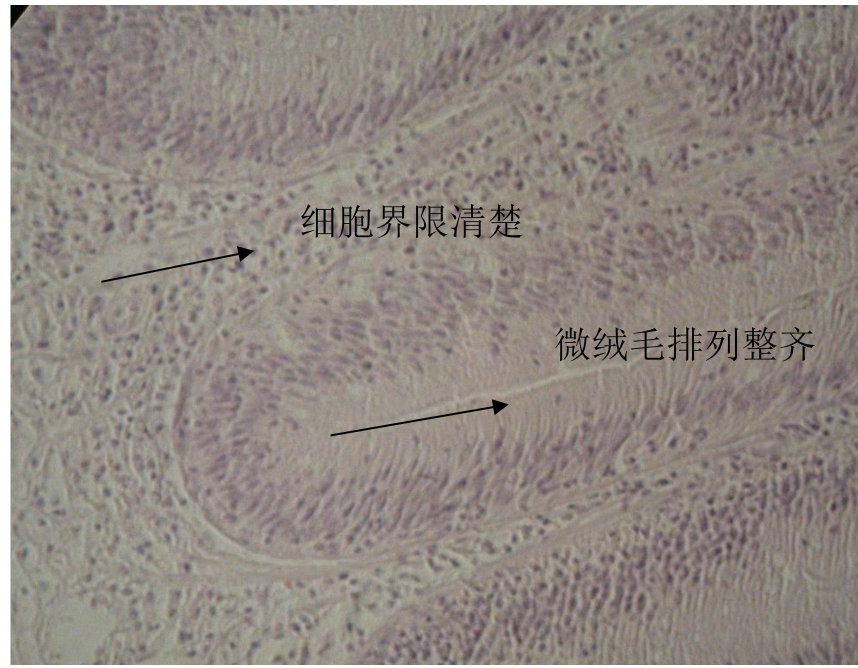
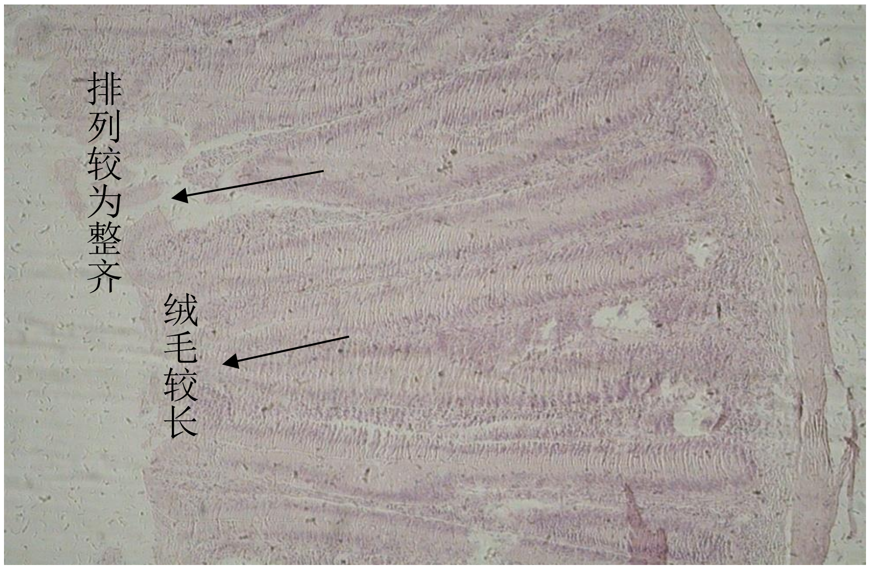


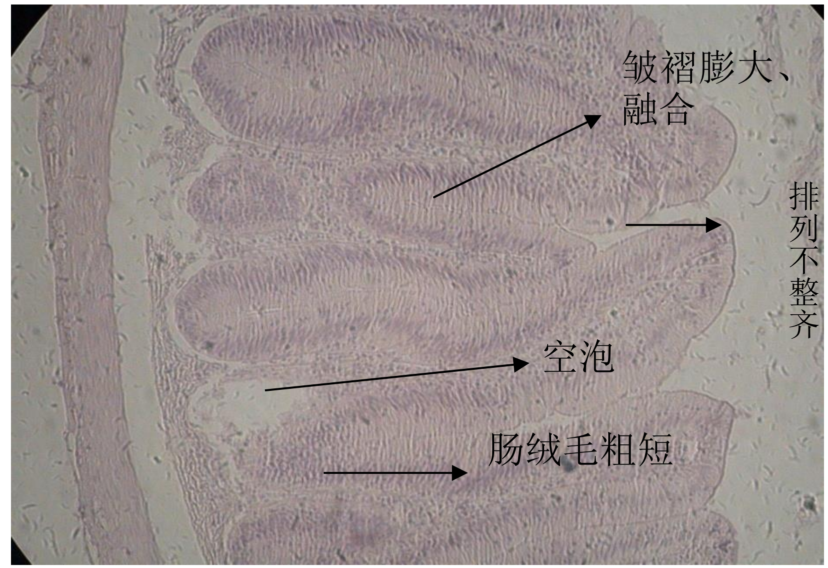
×400

FM group

Histopathology of intestine



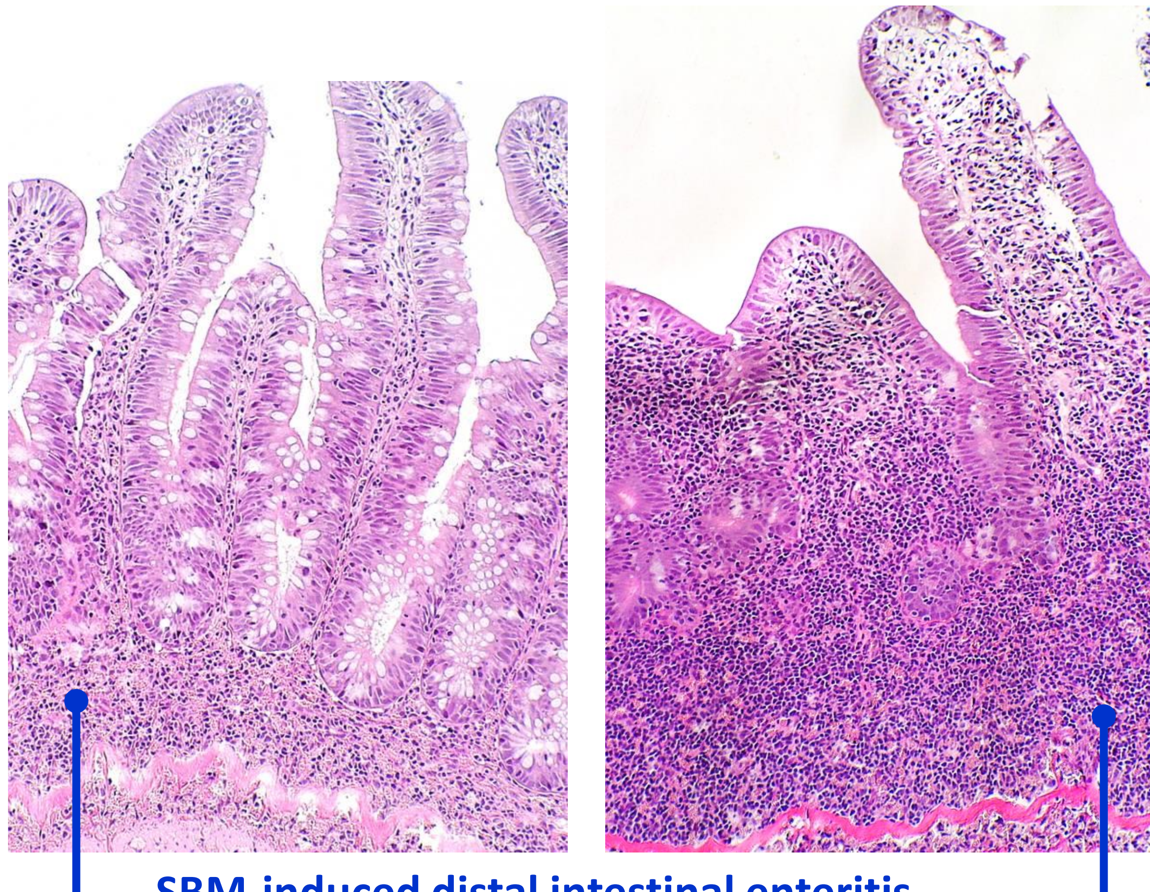
Brewers yeast group



RSM group

SBM-induced enteritis

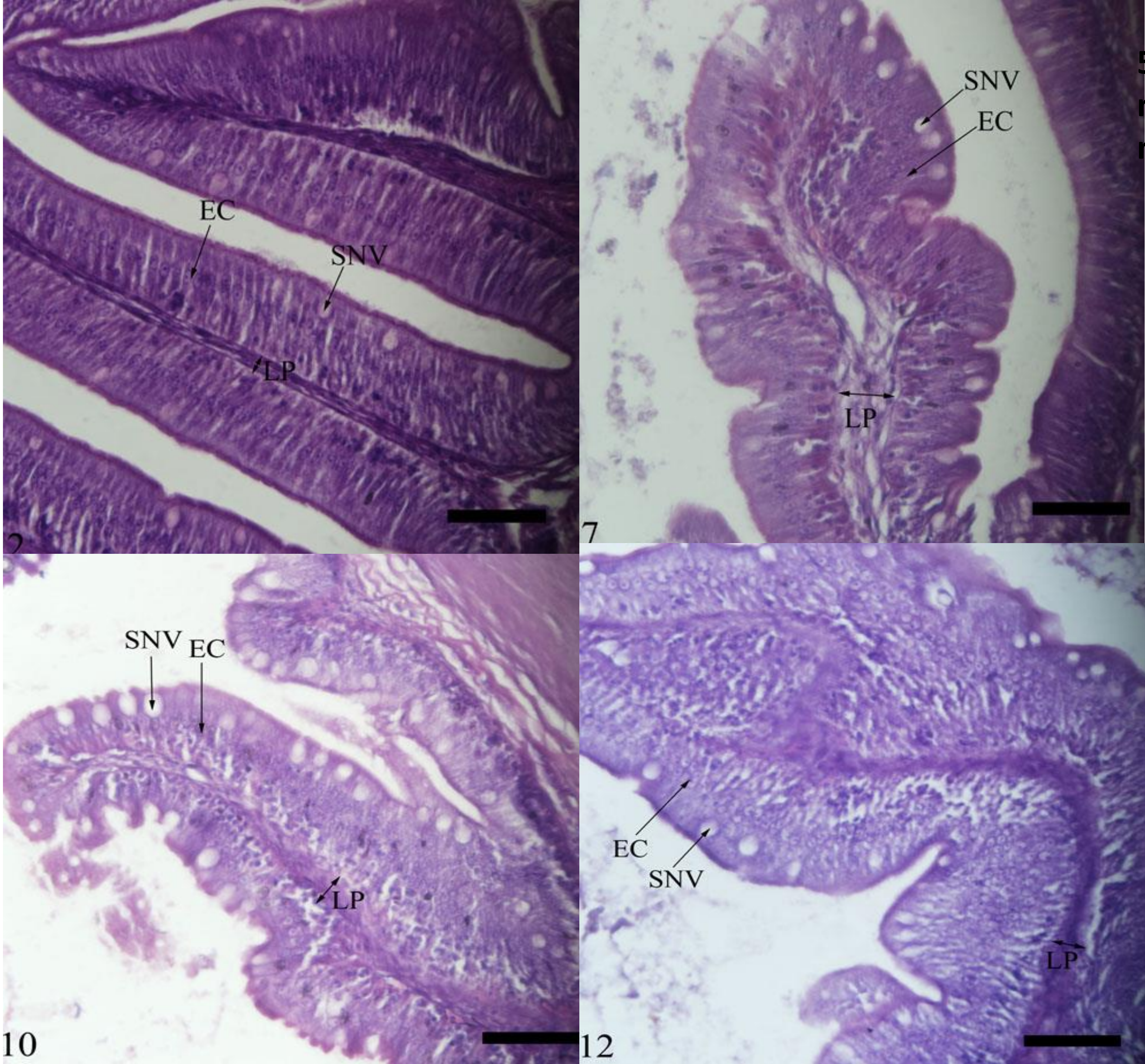
Normal



SBM-induced distal intestinal enteritis

FM

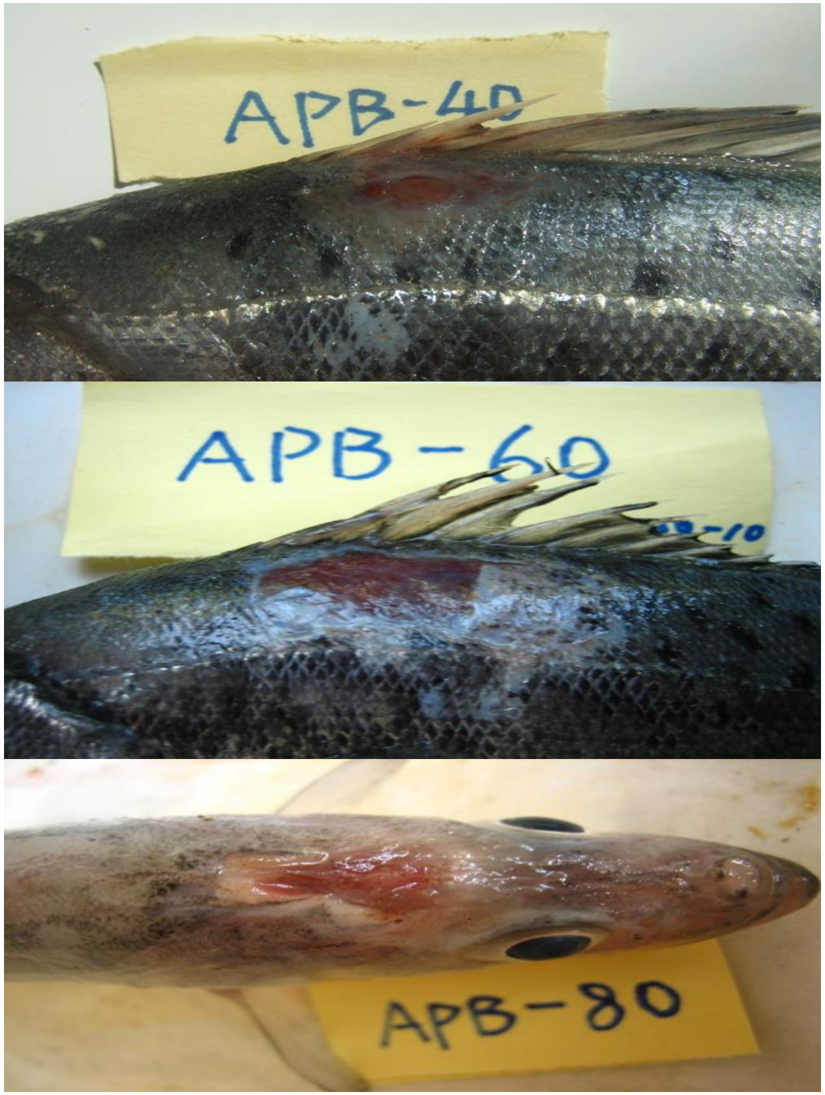
50%Peanut meal



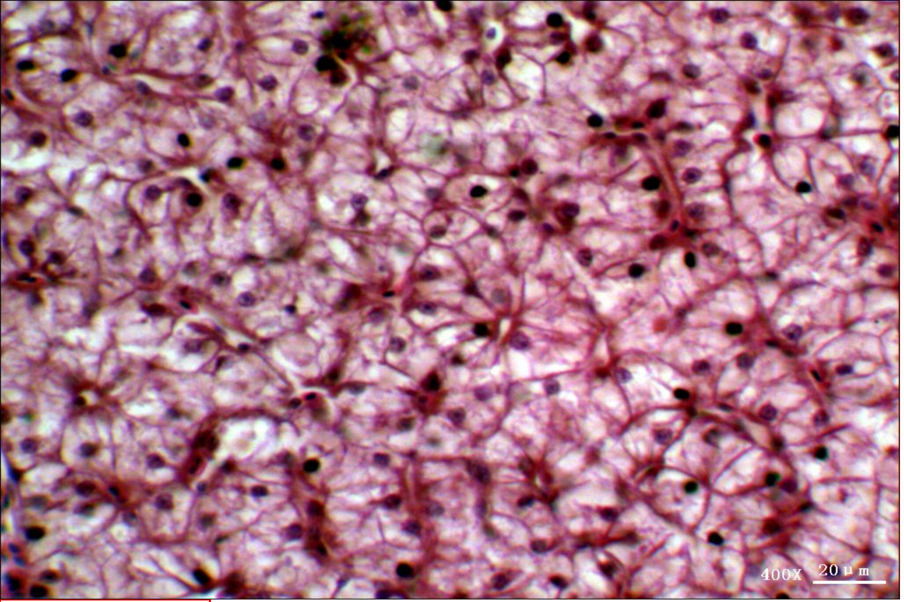
50% RSM

50% CSM

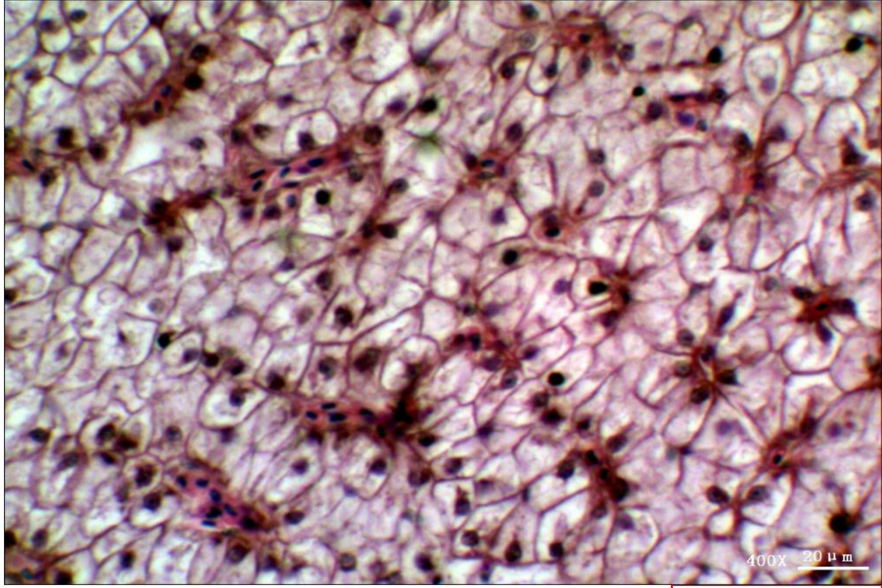
Visual pathological changes related with diets



Besides group PFM, fish fed the other 5 diets displayed symptoms of skin-inflammation in the middle of the experiment, however, fish in group LFM & APB20 were self-cured in the end of the trial. Survival of all groups are higher than 97%.

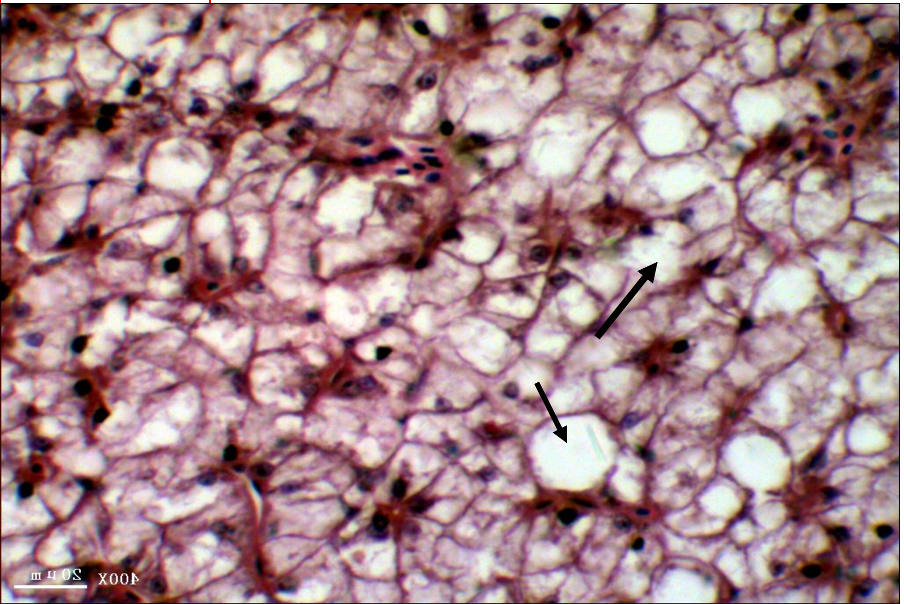


PFM

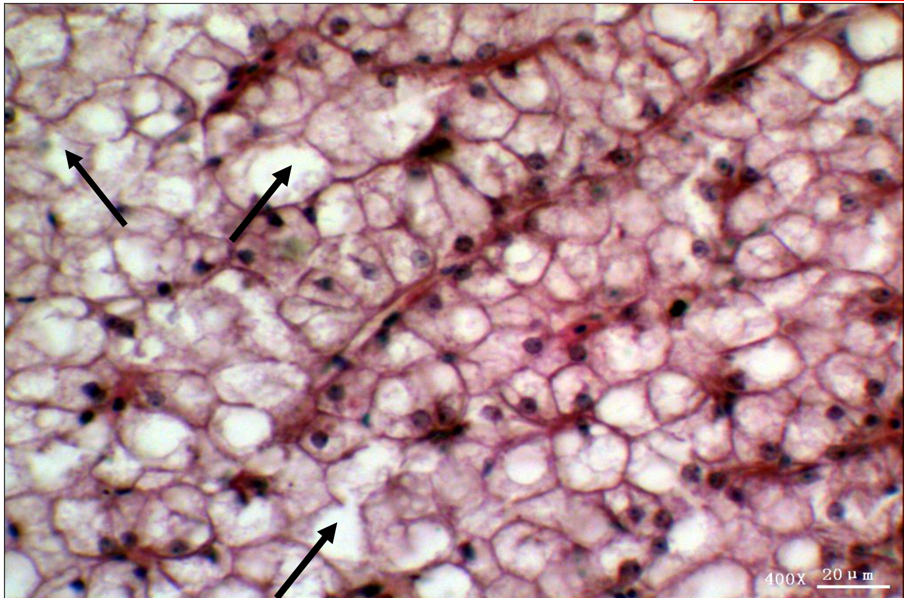


SFM

APB-60 Fatty liver symptom



Fatty liver symptom APB-80



Scientific Research in alternative proteins

1. Mechanism of effects on digestion and intestinal health;
2. Mechanism of feed intake；
3. Mechanism of protein and AA metabolism；
4. Mechanism of lipids and FA metabolism；
5. Mechanism of Carbohydrate and CL metabolism

能量代谢

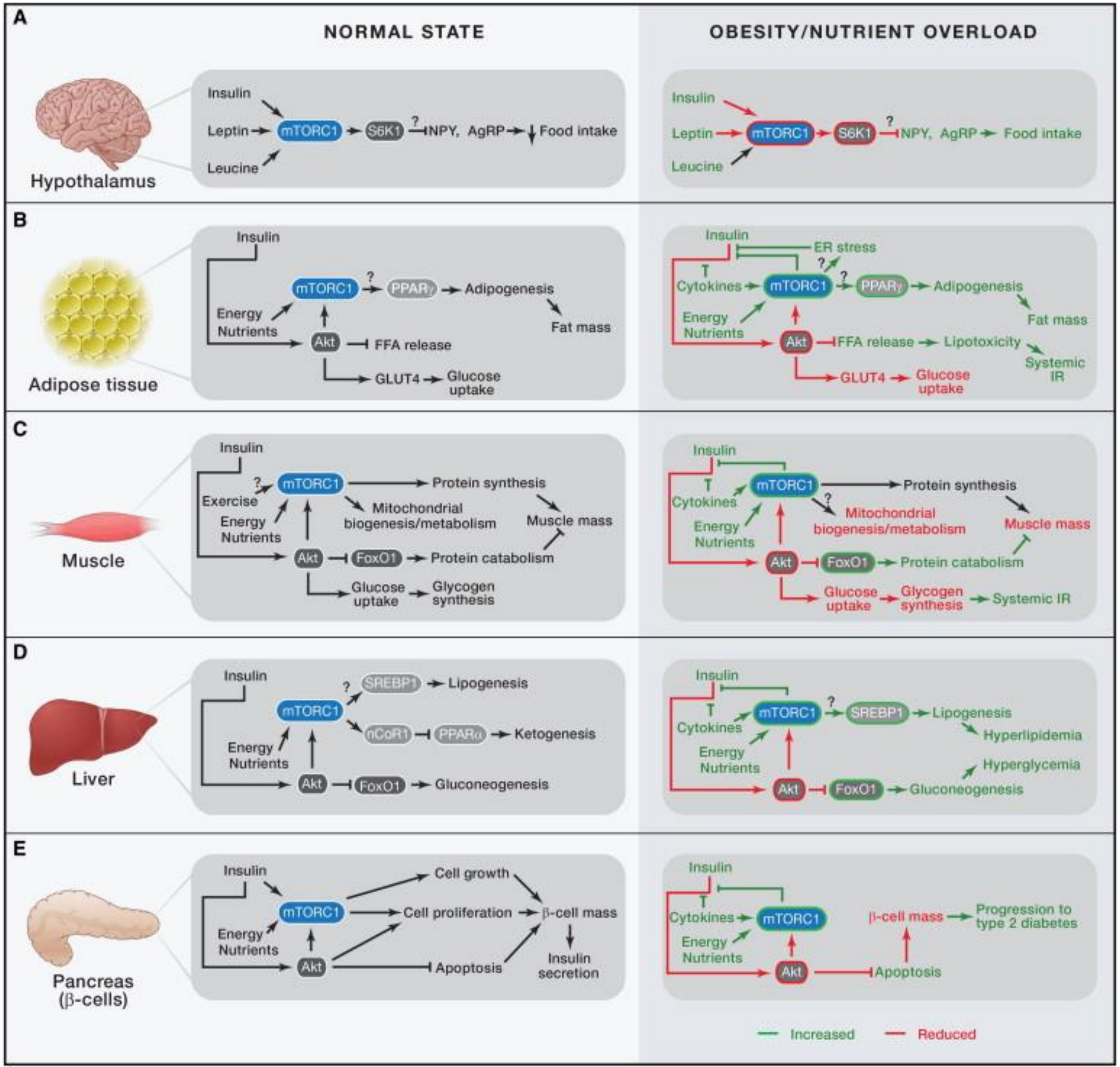
TOR signal

GH----IGF-1 axis

Myostatin and myosin genaration

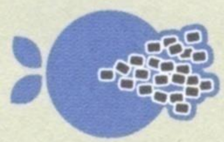
⋮

mTOR signaling and metabolism



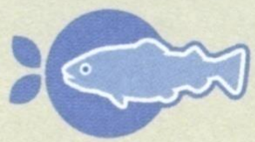
A world project

- EU Framework project-Aquamax， Aquaexcel



Programme 1: Sustainable feed

This programme aims to develop novel aquafeeds enabling the production of healthy and contaminant free: carpe, rainbow trout, Atlantic salmon and seabream.



Programme 2: Health benefits

This programme will assess the human health benefits of fish produced on new feeds.

Programme 3: Seafood safety

This programme will assess the safety of fish farmed on the new feeds.

Programme 4: Public perception

This programme will assess public perception of farmed fish and devise a framework to communicate the risk and benefits of consuming farmed fish to the public and other other stakeholders.

A world project

- The special Fund for Agro-Scientific Research in the Public Interest (201003020; 201203015);
- 973 project guide of 2014;
- Enterprise R & D

Haid Group invested in FM factory

鱼油精炼罐

鱼粉贮备车间

BANK OF FM？

China Fishery Group planed to buy Copeinca

ARTICLE

Copeinca ASA Announces Details on China Fishery Group Ltd's Voluntary Cash Offer for All Shares of Copeinca ASA

Tuesday, 26 Feb 2013 02:14am EST

Copeinca ASA announced that China Fishery Group Ltd (CFGL) announced on February 26, 2013 that it intends to launch a voluntary cash tender offer for all shares of Copeinca ASA. A cash consideration of NOK 53.85 will be offered per share, which implies a total consideration for all shares of NOK 3,150,225,000 (approximately USD 556 million at the date of announcement). The offer price is not subject to adjustment as a result of the Company's proposed dividend distribution of NOK 3.5 per share to be resolved in March 2013. As of the

New sources

Insect protein

SCP：Yeast、algae meal

renewable resources

› home › process management › research: insect protein as animal feed

News

11 Sep 2012

Research: Insect protein as animal feed

PROCESS MANAGEMENT EU UK AB AGRI NUTRITION RESEARCH 2376 × 0

http://www.allaboutfeed.net/

A project to develop insect-derived feed pr
expensive soya bean meal and fishmeal in p
announced by AB Agri parent company of AB

Th
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wil
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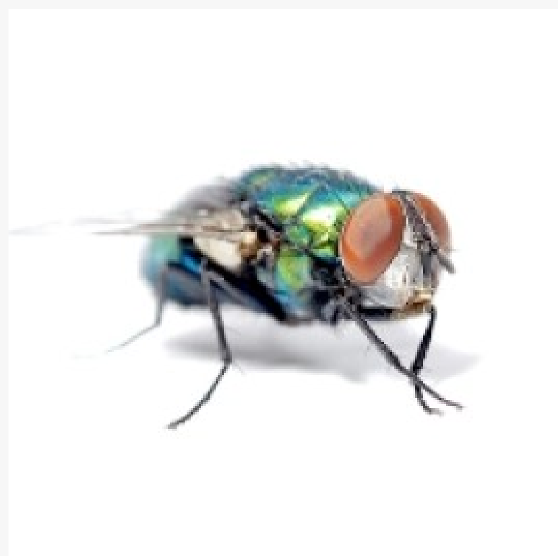
"As a bonus, the organic waste substrate is red
be used as a valuable fertiliser."

Neptune sells first insect-based aquafeed

NUTRITION AQUACULTURE FISH MEAL USDA 280 × 0

Zeigler Bros in Gardners, Pensylvania, will be the first customer of Neptune Industries, a developer of sustainable solutions for aquaculture, headquartered in Boca Raton, Florida, to purchase 40 tonnes per month of Ento-Protein™, an insect-based alternative to fishmeal.



Ento-Protein is a high quality sustainable protein derived from insects, which is intended to be a replacement for the rapidly depleting fishmeal made from wild caught feedstock species.

Founded in 1935, privately held Ziegler Bros is a manufacturer of high quality animal feeds.

Neptune plans on opening the first of its production facilities in late 2008. Deliveries are expected to begin by the

How long?

All roads lead to Rome---Early nutritional programming

Carbohydrate

- Long-term effects of early stimulant by high carbohydrate diet (Geurden et al.,2007； Gong et al., 2013).

All roads lead to Rome--- **Species strain**

营养代谢性状品种选育

- Experiences from Salmon and trout
  - High plant protein tolerance genotype；
  - Carbohydrate tolerance genotype;
  - Water temperature increase tolerance genotype；

从对饲料蛋白和能量利用角度进行对虾品种选育

Aquaculture Nutrition

Aquaculture Nutrition 2013 **19**; 128–138

doi: 10.1111/j.1365-2095.2012.00941.x

An analysis of the effect of diet and genotype on protein and energy utilization by the black tiger shrimp, *Penaeus monodon* – why do genetically selected shrimp grow faster?

B. GLENCROSS[1,2], S. TABRETT[1,2], S. IRVIN[1,2], N. WADE[1,2], M. ANDERSON[1,2], D. BLYTH[1,2], D. SMITH[1,2], G. COMAN[1,2] & N. PRESTON[1,2]

[1] *CSIRO Food Futures Flagship, Brisbane, Qld, Australia;* [2] *CSIRO Marine and Atmospheric Research, Brisbane, Qld, Australia*

Abstract

Selected (G8) and wild-type (W) genotypes of black tiger shrimp (*Penaeus monodon*) juveniles (initial weight G8 = 9.14 ± 0.36 g per animal and W = 8.44 ± 0.10 g per animal) were fed either of two diet types in a clear-water tank

their growth and impaired their potential as demonstrated by a curvilinear response of growth to intake. By comparison, those shrimp fed the HSD diet had a relatively linear growth response to intake.

KEY WORDS: energetics, genotype, maintenance

无鱼粉饲料耐受型品系选育—虹鳟

Aquaculture 295 (2009) 15–21

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Evidence of genotype–diet interactions in the response of rainbow trout (*Oncorhynchus mykiss*) clones to a diet with or without fishmeal at early growth

Mathilde Dupont-Nivet [a,*], Françoise Médale [b], Julien Leonard [a], Sandrine Le Guillou [a], Franck Tiquet [c], Edwige Quillet [a], Inge Geurden [b]

[a] *INRA, UMR 1313 Génétique Animale et Biologie Intégrative, F-78350 Jouy-en-Josas, France*
[b] *INRA, UMR1067, Laboratoire de Nutrition, Aquaculture et Génomique, F-64310 St Pée-sur-Nivelle, France*
[c] *INRA, UE750, Unité Expérimentale Piscicole, F-78350 Jouy-en-Josas, France*

ARTICLE INFO

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Received 25 November 2008
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Keywords:
Rainbow trout
Oncorhynchus mykiss
Isogenic lines
Plant-protein source
Fishmeal replacement
Genotype environment interaction

ABSTRACT

This study examined the genetic variability and genotype × diet interactions during early growth (initial mean body weight 1.2 g) among seven heterozygous clones of rainbow trout, *Oncorhynchus mykiss*. The clones were hand-fed a diet containing either fishmeal or plant proteins during a 49-day trial divided into two periods (P1, 26 days, and P2, 23 days). Weight, variation of weight within clone, feed intake, feed efficiency and mortality were calculated for both periods.
There was a highly significant effect of diet and of clone for all traits at both periods, except for feed efficiency and mortality at P1. Highly significant interactions between diet and clone were also recorded for all these traits, except for mortality at P1. The occurrence of genotype × diet interactions when feeding juvenile rainbow trout with an all plant-protein diet indicates that a highly performing genotype on a fishmeal diet may perform poorly when fed a plant-protein diet. Interactions were found for the two major determinants of growth, i.e. feed intake and feed efficiency, showing that the dietary response differs according to the

耐热型虹鳟品系选育全球合作网络项目

110-8 Increased Thermal Tolerance of Rainbow Trout by Selective Breeding at High Temperatures

Thursday, September 8, 2011: 10:15 AM
4C-2 (Washington State Convention Center)

Shigeharu Kinoshita, *The University of Tokyo, Tokyo, Japan*

- Precise feeding regime = feed saving



Trout
Fresh
Grower

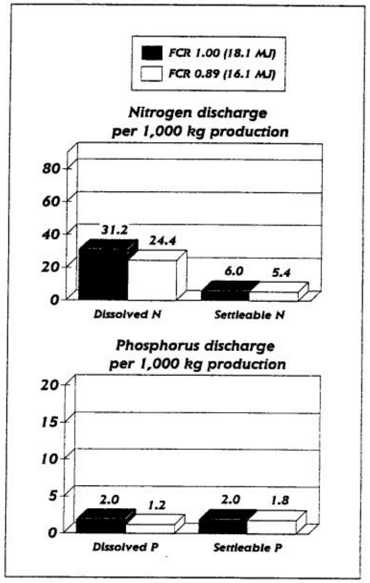
Aqualife

Aqualife 17

Declaration

Aqualife 17 Extruded	Compo-sition	Digesti-bility	Energy distribution
Gross energy	22.4 MJ	0.89	
	5350 kcal		
Metabolizable Energy	18.1 MJ		
	4317 kcal		
Crude protein	42.0%	0.91	39%
Crude lipid	22.0%	0.92	44%
NFE	19.5%	0.88	17%
Fibre	2.4%		
Ash	5.9%		
Total P	0.9%		
Available P	0.7%		
Met+Cys	1.4%		

Ecological value



Composition

Soyaprotein · Fishmeal · Fish oil
Wheat · Bloodmeal
Vitamins · Minerals

Feeding guide

% feed (kg feed per 100 kg fish per day)

Fish size g	Fish size cm	Pellet size mm	°C 2	4	6	8	10	12	14	16	18	20
15- 50	11-16	2	0.77	0.94	1.13	1.32	1.51	1.68	1.81	1.85	1.76	1.46
50- 150	16-23	3	0.56	0.68	0.81	0.95	1.09	1.21	1.30	1.34	1.27	1.05
150- 400	23-32	4	0.41	0.51	0.60	0.71	0.81	0.90	0.97	0.99	0.95	0.78
400- 800	32-40	5	0.33	0.40	0.48	0.56	0.65	0.72	0.77	0.79	0.75	0.62
800-2000	40-53	7	0.26	0.31	0.38	0.44	0.50	0.56	0.60	0.62	0.59	0.49

Oxygen table

kg oxygen per 1,000 kg fish per day when feeding cf. table

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400- 800	32-40	5	1.5	1.8	2.2	2.5	2.9	3.4	3.8	4.2	4.5	4.6
800-2000	40-53	7	1.3	1.5	1.8	2.1	2.5	2.8	3.2	3.5	3.8	3.9

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69 London Road, Twickenham
Middlesex TW1 1EE, UK
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Labeling of EU producer

Trout
Fresh
Grower

Aqualife

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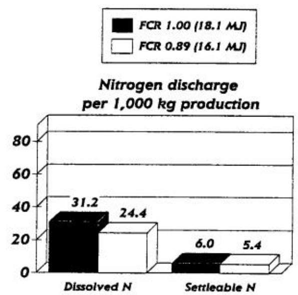

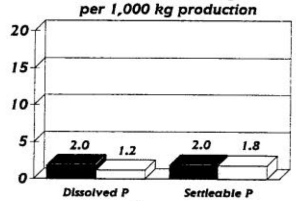

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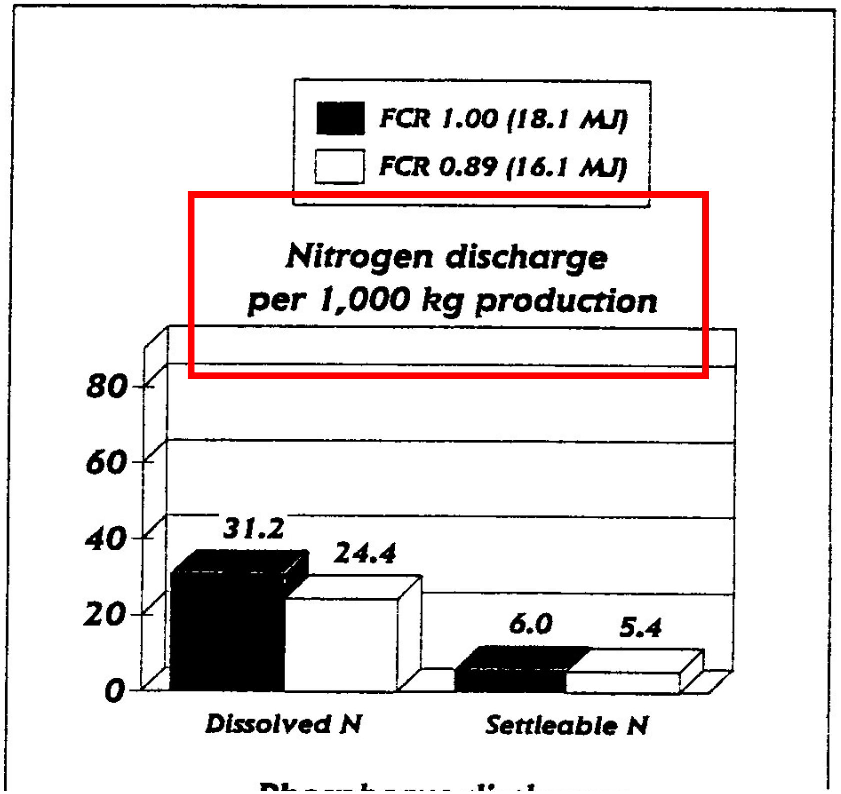

氮贮积率：55.4-62.2%

Trout
Fresh
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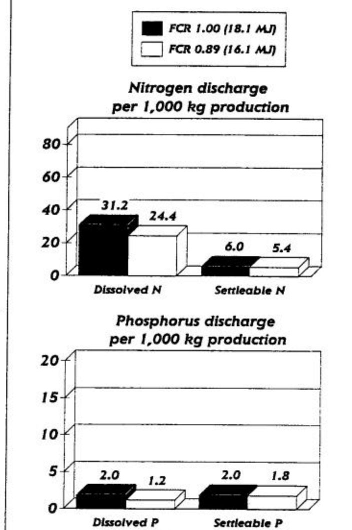

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50- 150	16-23	3	2.2	2.6	3.1	3.7	4.3	4.9	5.5	6.1	6.5	6.7
150- 400	23-32	4	1.8	2.1	2.5	3.0	3.5	4.0	4.5	4.9	5.3	5.4
400- 800	32-40	5	1.5	1.8	2.2	2.5	2.9	3.4	3.8	4.2	4.5	4.6
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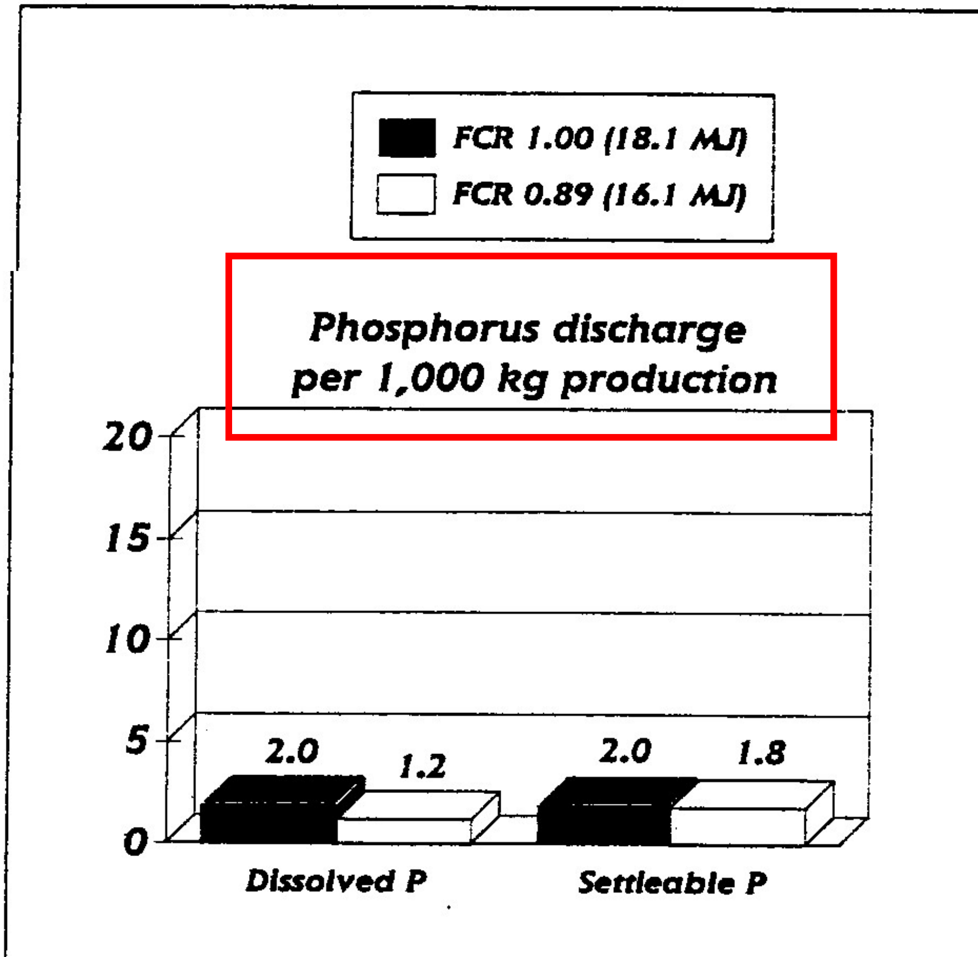
Fax 0181 892 2823

Ecological value



磷贮积率：44.4–49.9%

Feeding guide

% feed (kg feed per 100 kg fish per day)

Fish size g	Fish size cm	Pellet size mm	°C 2	4	6	8	10	12	14	16	18	20
15- 50	11-16	2	0.77	0.94	1.13	1.32	1.51	1.68	1.81	1.85	1.76	1.46
50- 150	16-23	3	0.56	0.68	0.81	0.95	1.09	1.21	1.30	1.34	1.27	1.05
150- 400	23-32	4	0.41	0.51	0.60	0.71	0.81	0.90	0.97	0.99	0.95	0.78
400- 800	32-40	5	0.33	0.40	0.48	0.56	0.65	0.72	0.77	0.79	0.75	0.62
800-2000	40-53	7	0.26	0.31	0.38	0.44	0.50	0.56	0.60	0.62	0.59	0.49

Oxygen table

kg oxygen per 1,000 kg fish per day when feeding cf. table

Fish size g	Fish size cm	Pellet size mm	°C 2	4	6	8	10	12	14	16	18	20
15- 50	11-16	2	2.8	3.3	4.0	4.6	5.4	6.2	6.9	7.6	8.2	8.4
50- 150	16-23	3	2.2	2.6	3.1	3.7	4.3	4.9	5.5	6.1	6.5	6.7
150- 400	23-32	4	1.8	2.1	2.5	3.0	3.5	4.0	4.5	4.9	5.3	5.4
400- 800	32-40	5	1.5	1.8	2.2	2.5	2.9	3.4	3.8	4.2	4.5	4.6
800-2000	40-53	7	1.3	1.5	1.8	2.1	2.5	2.8	3.2	3.5	3.8	3.9

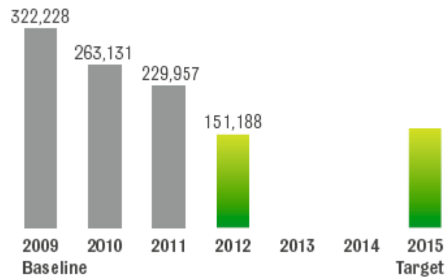
PM\FEED94UK\OFA17\240894\EJ

欧洲企业需要承担的减排义务

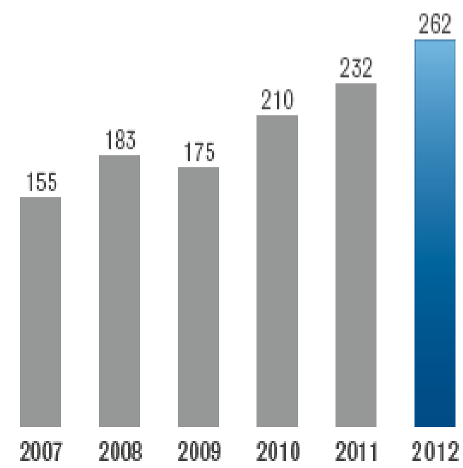
Consolidated statement of financial position (€ x million)		
Equity attributable to owners of Nutreco		
Balance sheet total		
Capital employed		
Net debt position		
Cash flow (€ x million)		
Net cash from operating activities		
Acquisitions/disposals of subsidiaries		
Acquisition of property, plant and equipment and intangible assets	-137.7	-92.4
Sustainability		
Percentage of Top 300 suppliers engaged on vendor policy**	100%	38%
CO_2 reduction percentage manufacturing (baseline 2009)	53%	36%
Number of sustainability assessments done for nutritional solutions	15	1

Carbon footprint manufacturing[1]

(tonne CO_2)

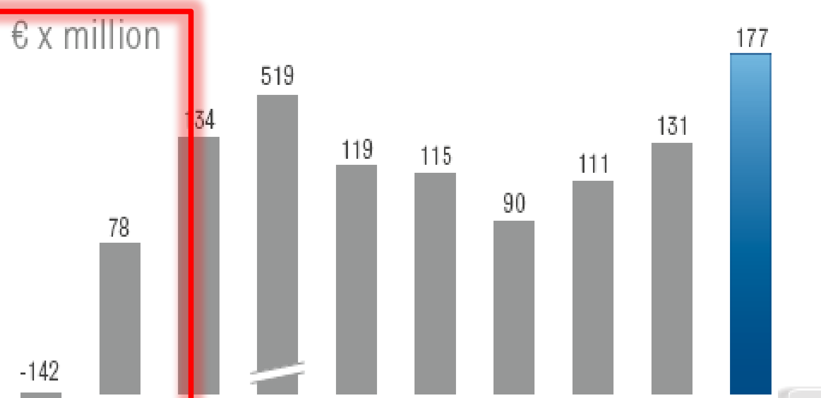


1 The reported carbon footprint refers to Scope 1 and Scope 2 emissions as defined in the GHG Protocol. These are absolute (total) figures for both 2009 and 2012. If we correct this figure for the companies acquired and sold in this period (in accordance with GHG Protocol procedures) the reduction in 2012 would have been 50.48% of the 2009 emission. 2011 data include emissions from operations acquired at the end of 2011, which were not included in the footprint reported last year.



period attributable to owners of Nutreco[3]

€ x million



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