Guangdong Entomological Institute
广东省昆虫研究所

PROteINSECT
INSECTS AS SUSTAINABLE SOURCES OF PROTEIN

Improved rearing system of housefly (*Musca domestica*) for the production of shrimps and Huxu breeders

Guangdong Entomological Institute

105 Xingang Road West, Guangzhou 510260, China

Outline of this talk

- Introduction
- System improvements
- Application technology
- Future perspectives

Livestock production

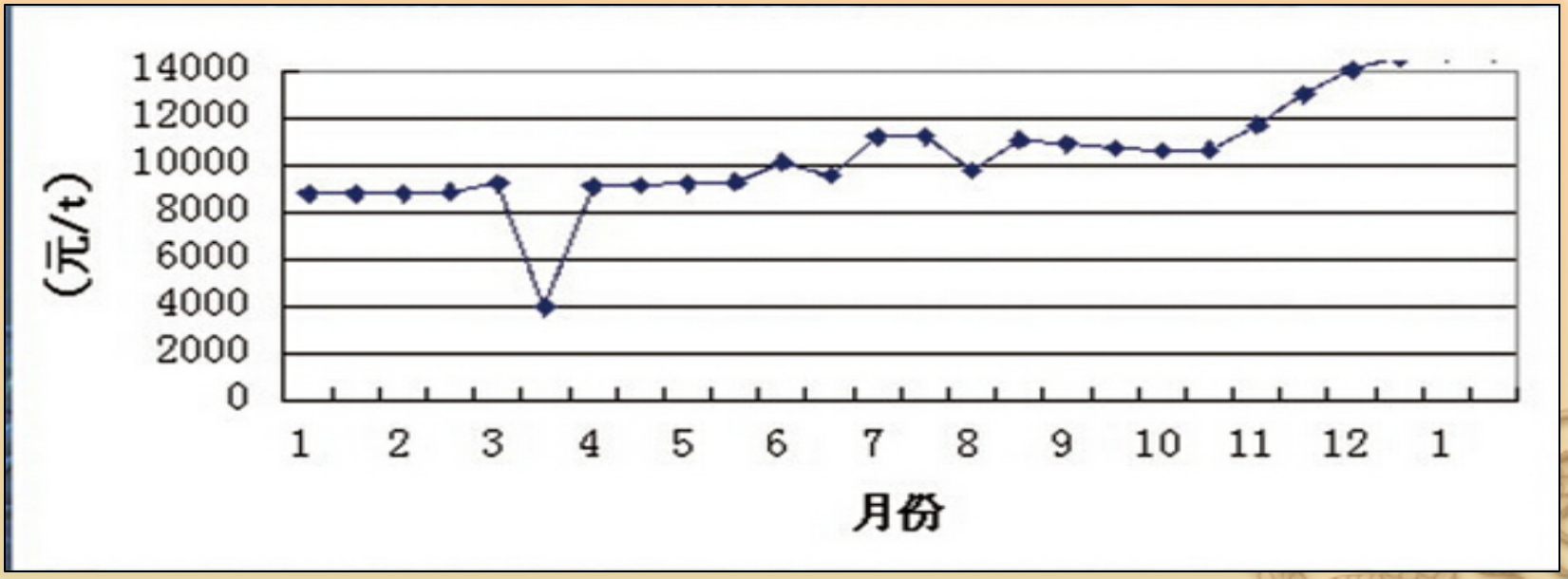
- **8.8 billion** chickens (http://www.feedtrade.com.cn) and **735 million** pigs (http://www.askci.com/news/chanye /2015/01/21/169367q9a.shtml) were produced for the world market in 2014 in China.
- **Millions of farmers** depend on livestock production for their livelihood.

Manure pollution

- About 19.2 million tons of chicken manure per year from livestock production every year.
- Pollution of the environment.

Feed production in China

In China, there are 1.02 million tons fish meal (70% of the total feed protein) imported from different countries for feed industry in 2014.



Fish meal price charts in 2014-2015 (from national bureau of statistics)

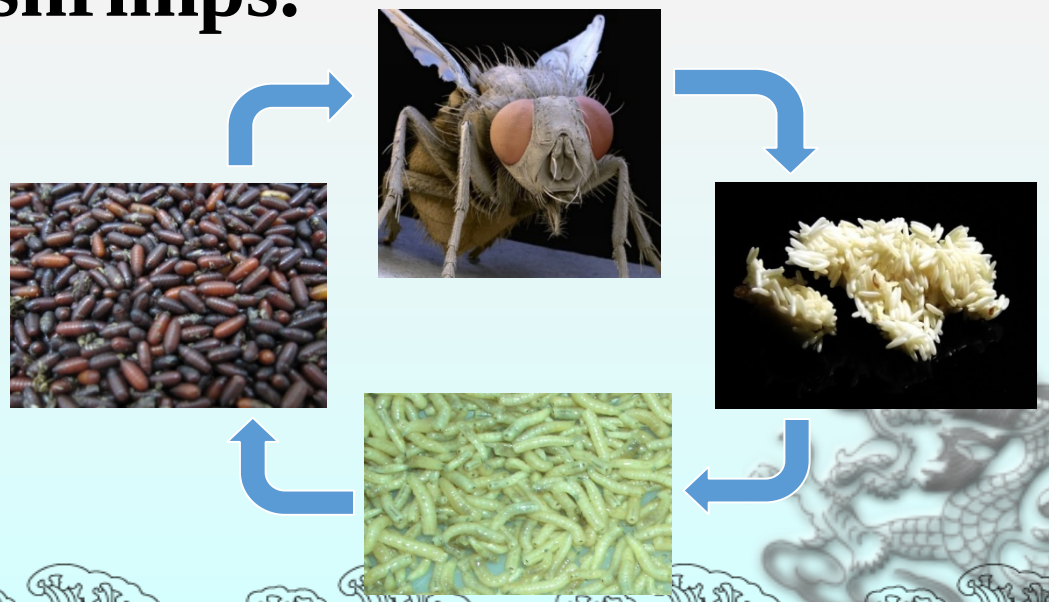
Solution to this problem

- Recycle of the chicken manure into insect proteins as feed for chicken production is a strategy to solve this problem.

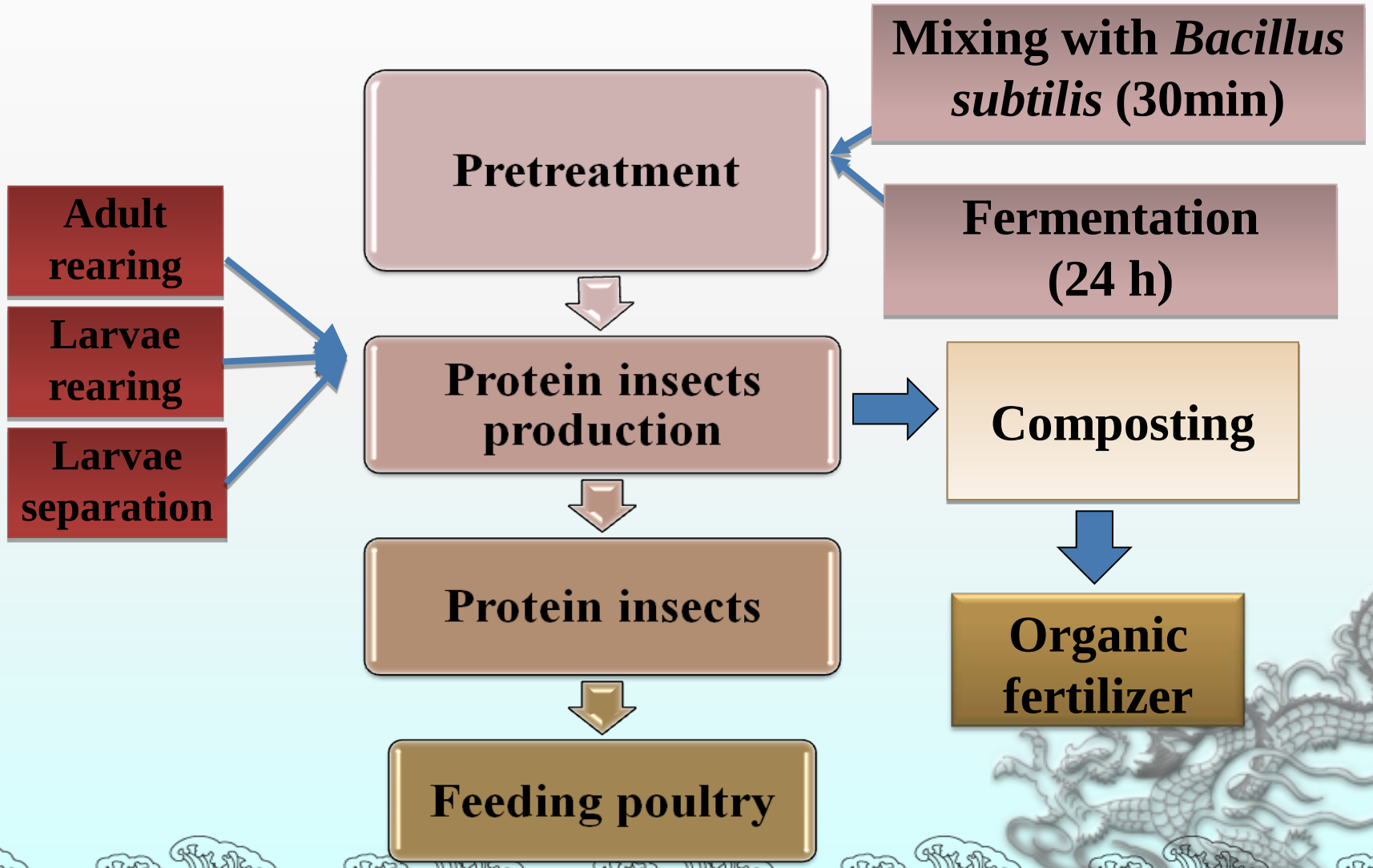
Mass production of housefly

- Large-scale housefly (*Musca domestica*) production system by using chicken manure is established in China to provide fresh maggots or maggot powder for feeding chickens and shrimps.

Life cycle



Process flow diagram



System improvements

Semi-automatic production system

Manure treatment

Culture tray preparation

Larval rearing

Larval seperation

Larval collection

Chicken feeding with maggots

System improvements

1. Adults for increasing egg production

Improvements:

a)Semi-automatic water supply

b)Increasing adult density

c)Enriched medium for adults

System improvements

2. Methods for eggs collection



Improvements:

a) **Clean eggs by using a cloth on the wheat bran**
b) **Quantitative weight for next step**

System improvements

3. Pretreatment of the chicken manure for maggot production

Improvements:

a) **Reduced possible pathogens**

b) **Reduced terrible odor**

c) **Reduction of the time and labor**

System improvements

4. Semi-automatic transportation of the containers

Improvements:

a) **Automatic stacking system**

b) **Semi-automatic transportation**

System improvements

5. Effective larvae rearing

Improvements:

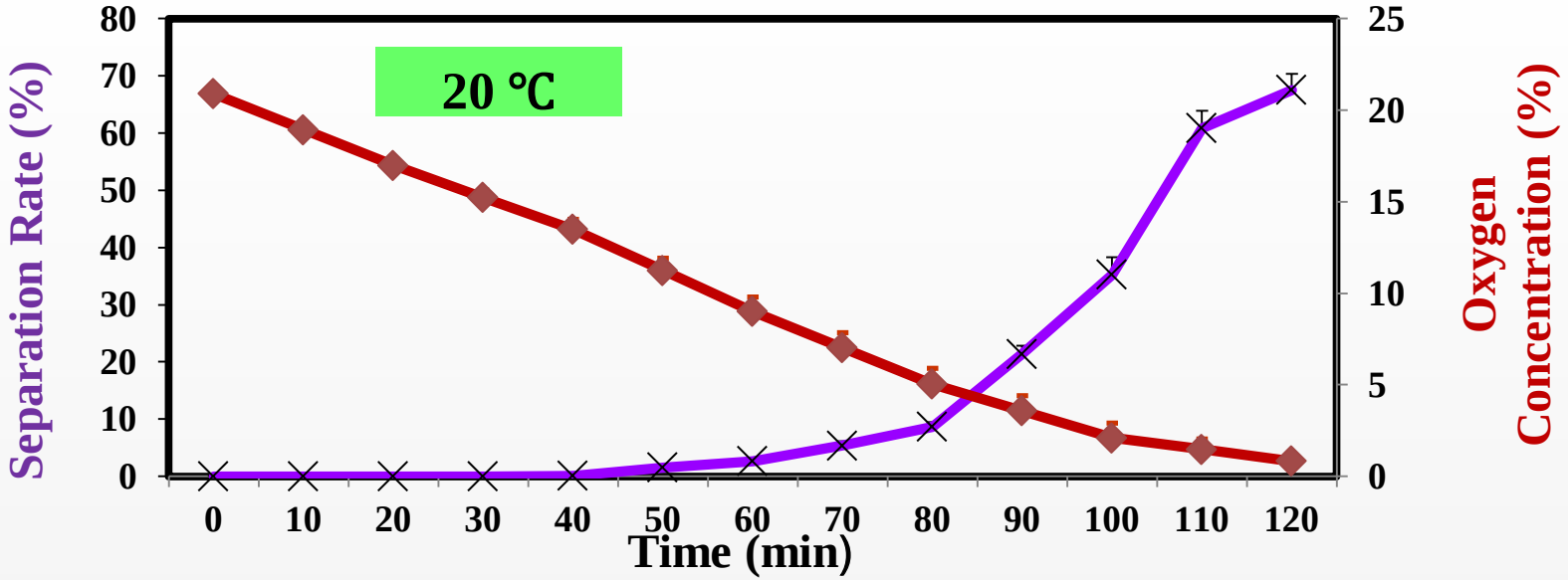
a) **Effective utilization of the rooms**

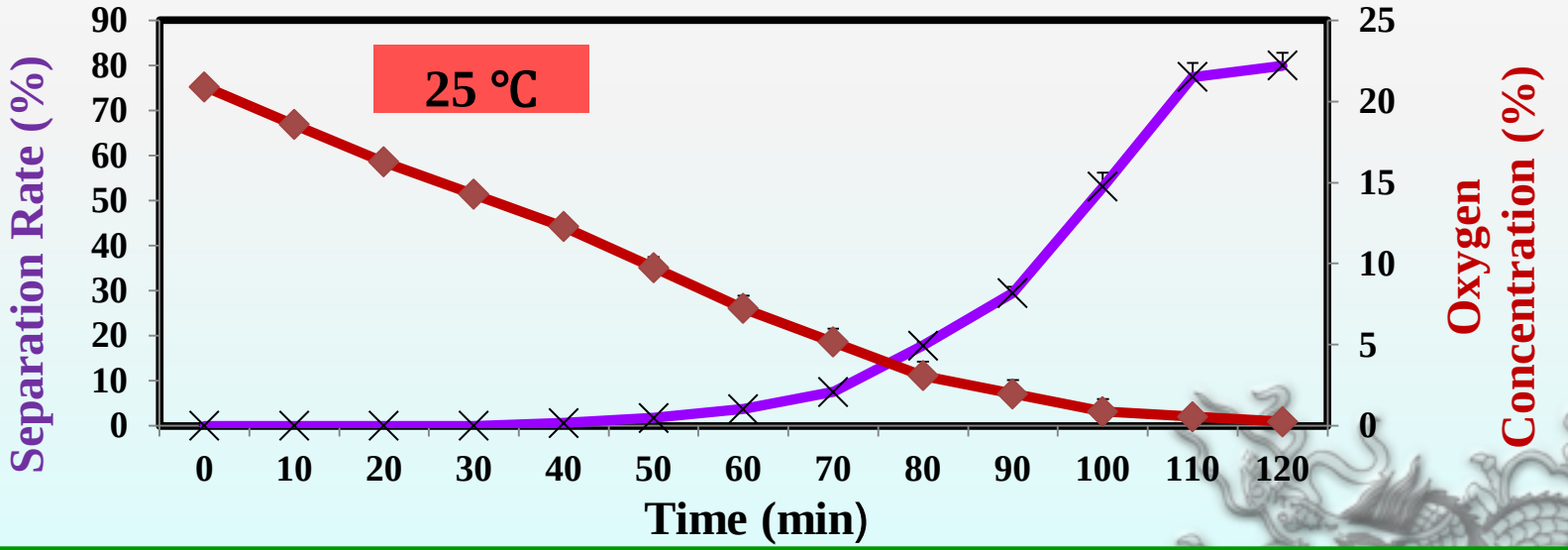
b) **Protected breeding with plastic nets**

System improvements

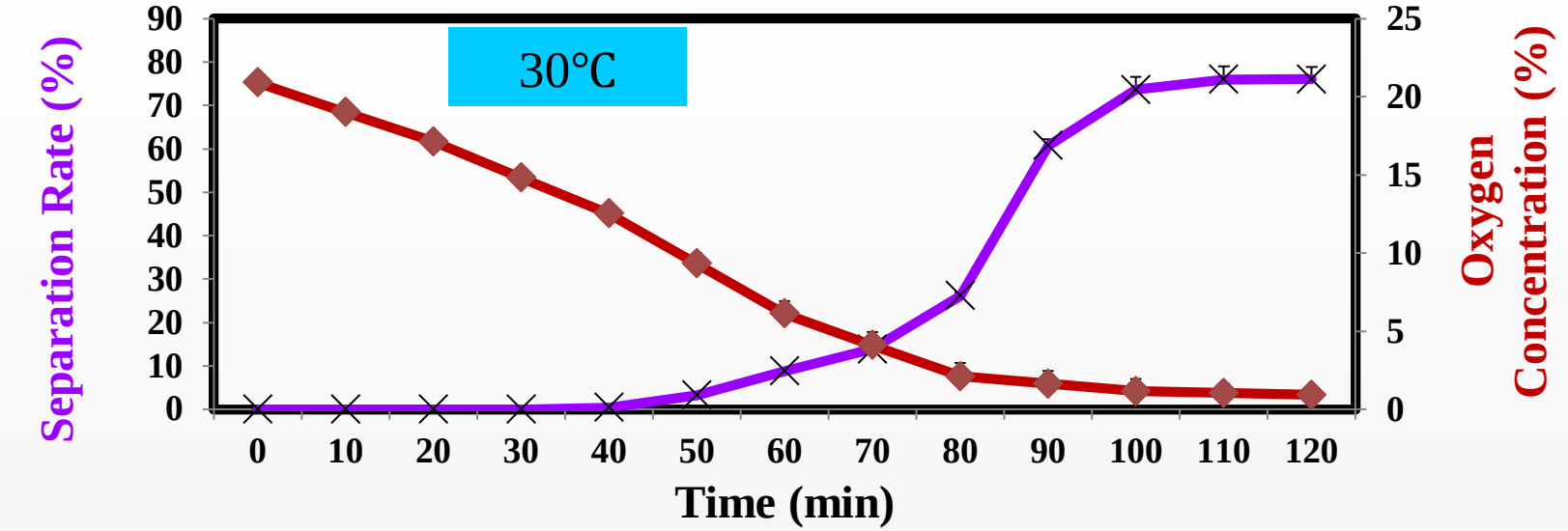
6. Maggot separation

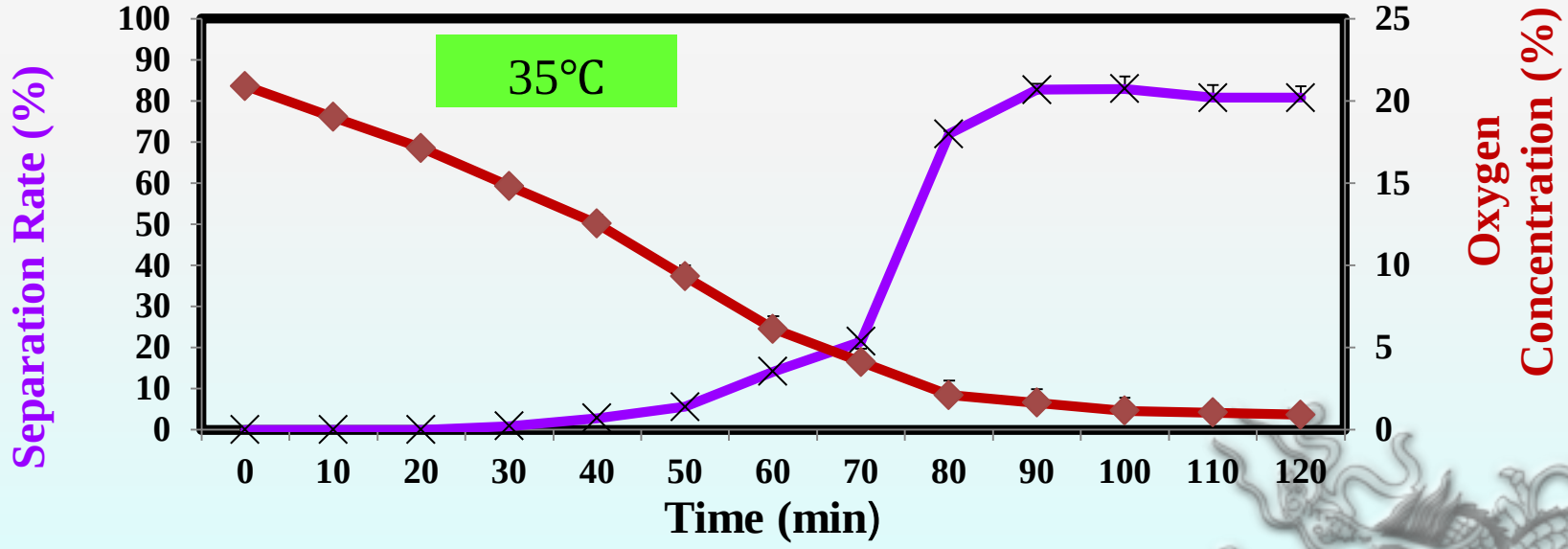
Under low oxygen and high ammonia concentration in the closed rooms, more than 70% larvae escaped from the medium in two hours, depending on the air temperature in the containers.



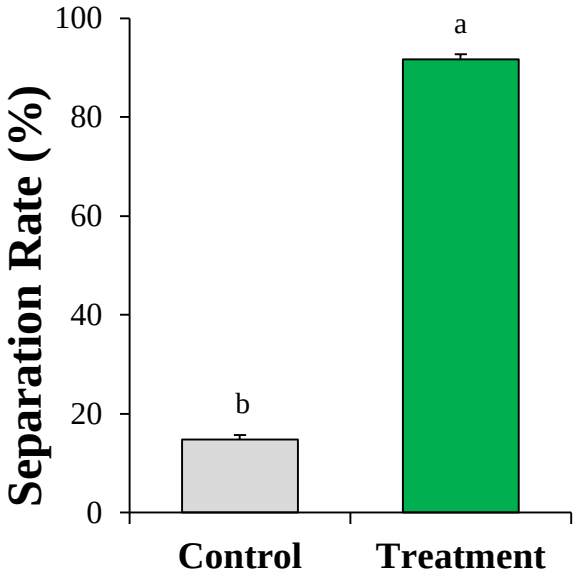


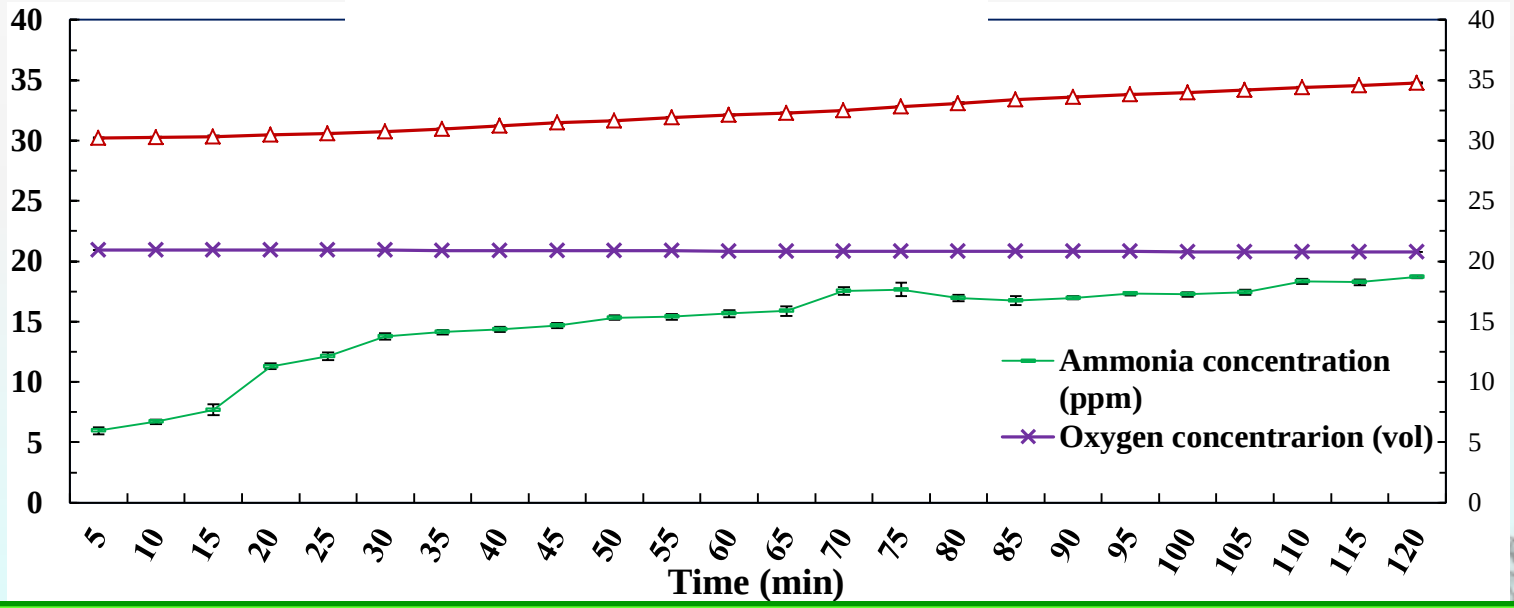
Effect of oxygen concentrations on the separation rates (%) of housefly larvae at different temperatures





Effect of oxygen concentrations on the separation rates (%) of housefly larvae at different temperatures





Initial temperature is 30℃, Separation rates (%) of housefly larvae in an airtight room and temperatures, oxygen, ammonia concentration for 2 hours.

System improvements

7. Maggot microwave drying

Improvement:

■3 kg fresh maggots can be dried every 6 minutes

Fertilizer quality

- **Residue after maggot rearing as an organic fertilizer**

Test data of residue after rearing housefly			
Number	Item	Result	Indicators of organic fertilizer
1	Organic components	54	≥45%
2	Total nutrient	14.9	≥5.0%
3	Moisture	37	≤30%
4	pH	8.4	5.5-8.5
5	As	0	≤15 mg/kg
6	Hg	0.7	≤2 mg/kg
7	Pb	50	≤50 mg/kg
8	Cr	10	≤150 mg/kg
9	Cd	3	≤3 mg/kg
10	Number of fecal coliforms	<8	≤100 mumbers/g
11	Mortality of roundworm eggs	100	≥95%

The residue meets the standard of organic fertilizer if the water content is decreased by drying.

Maggot powder quality

Quality of the maggot powder

Chemical composition of housefly maggot meal				
Number	Item	Maggot powder	Skim maggot powder	Best fishmeal
1	Crude protein (%)	58.53	66.25	≥60
2	Fat extract (%)	21.8	3.2	≤10
3	Moisture（%）	1.1	7.4	≤10
4	Ash (%)	6.5	9	≤20
5	Mold (cfu/g)	3.7×10^2	3.6×10^2	$\leq3\times10^3$
6	Salmonella (cfu/25g)	0	0	0
7	KOH（mg/g）	3.30	0.6	≤5
8	Cr (mg/kg)	2.46	0.9	≤8

Feeding shrimps with fresh maggots

Experimental design:

1. Shrimp species: *Litopenaeus vannamei*
2. Industrial shrimp diets replaced by 25%, 50%, 75%, 100% fresh maggots.
3. Indoor cultures with containers and aeration system.



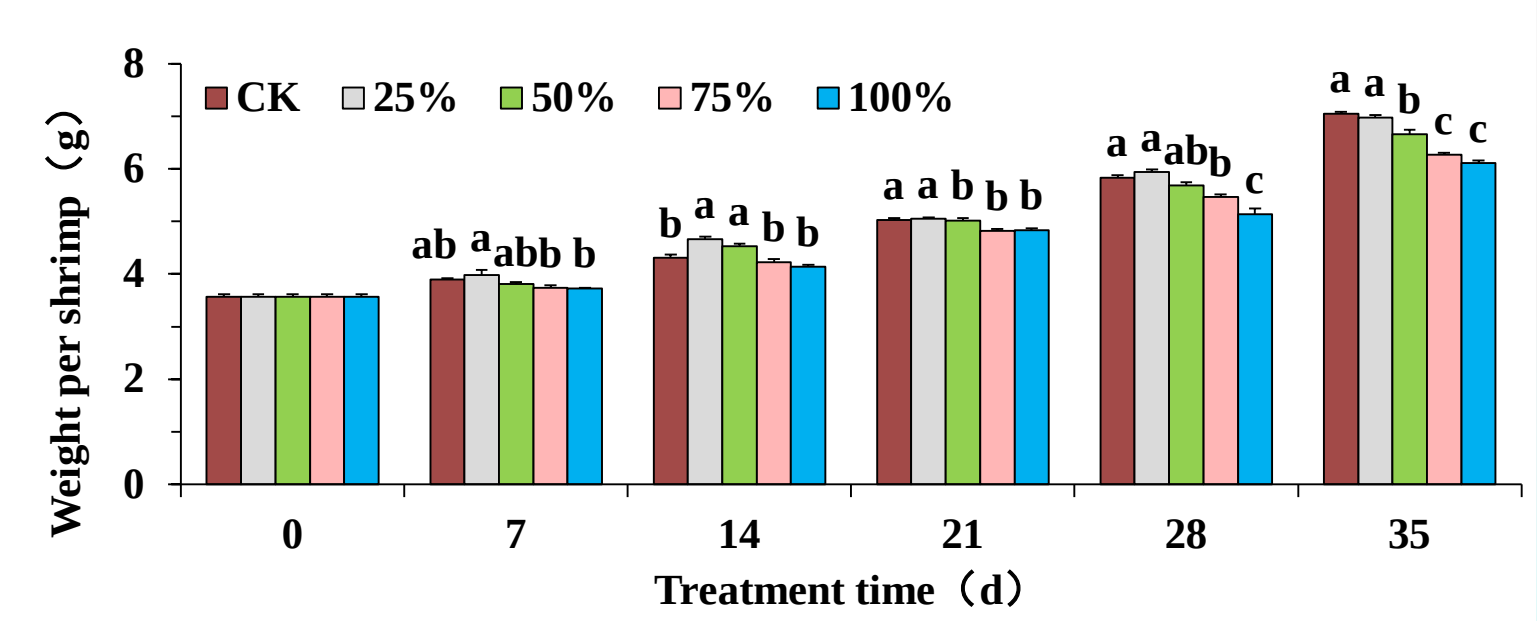

Feeding shrimp with maggots

Methods:

1. Water: T:27±2 ℃; salinity:2.0-3.0; DO > 6.0 mg/L; pH 7.8±0.1
2. Scale of feeding: 3% of shrimp weight.
3. Feeding time: 9:00 and 17:00
4. Experimental period: 35 d

Feeding shrimp with maggots

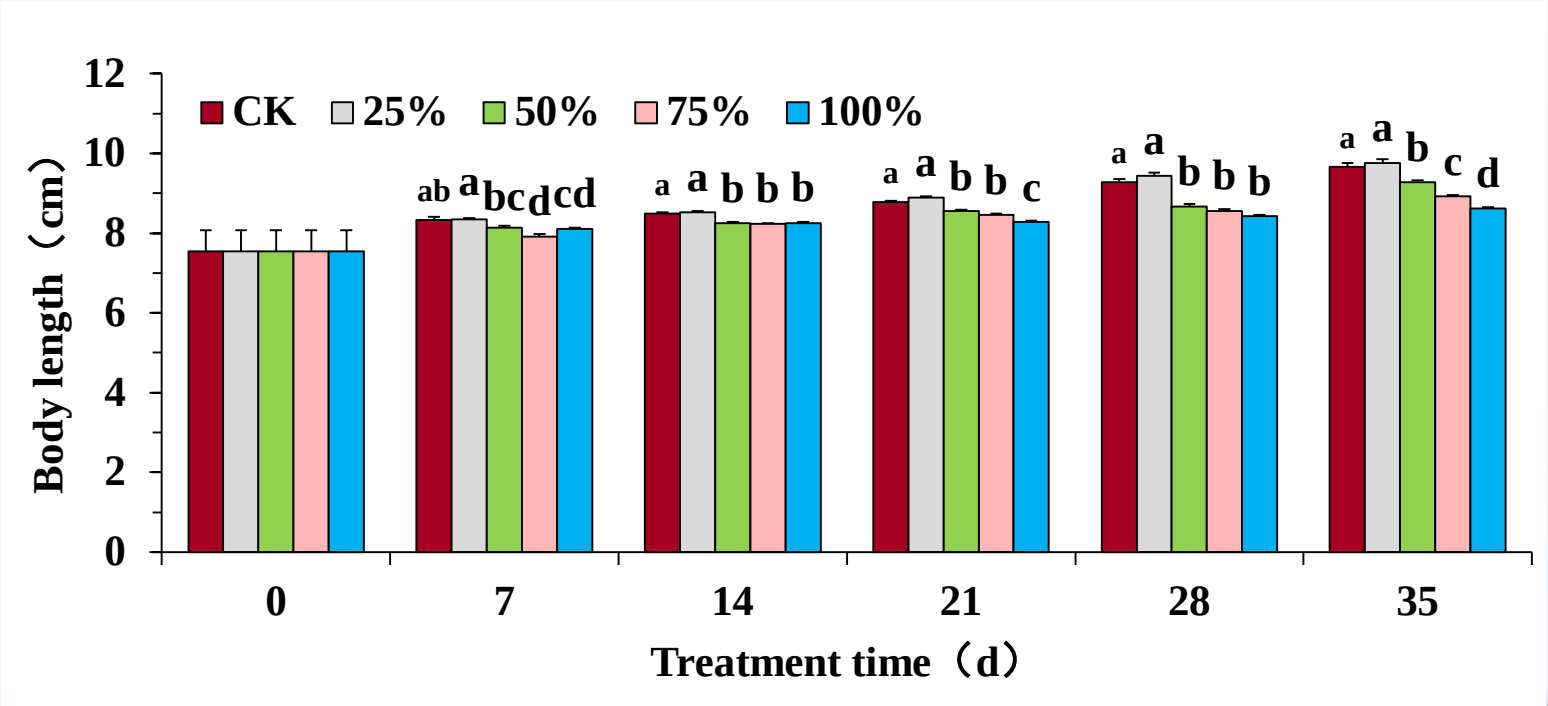
◆Weight of the shrimps



The fresh weights of the shrimps fed with 25% fresh maggots are not significantly different from those with routine shrimp feed.

Feeding shrimp with maggots

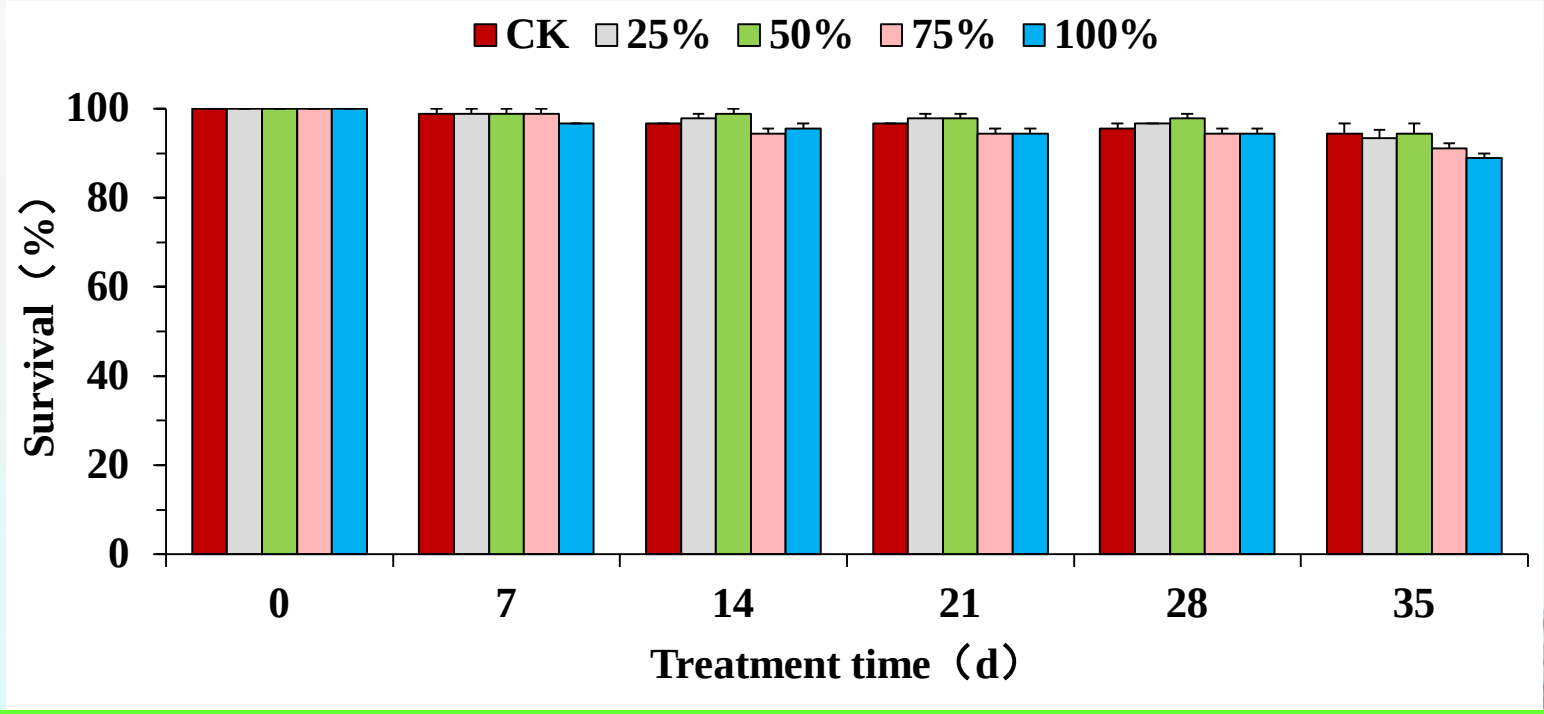
◆Body length of the shrimps



The body length of the shrimps fed with 25% fresh maggots are not significantly different from those with routine shrimp feed.

Feeding shrimp with maggots

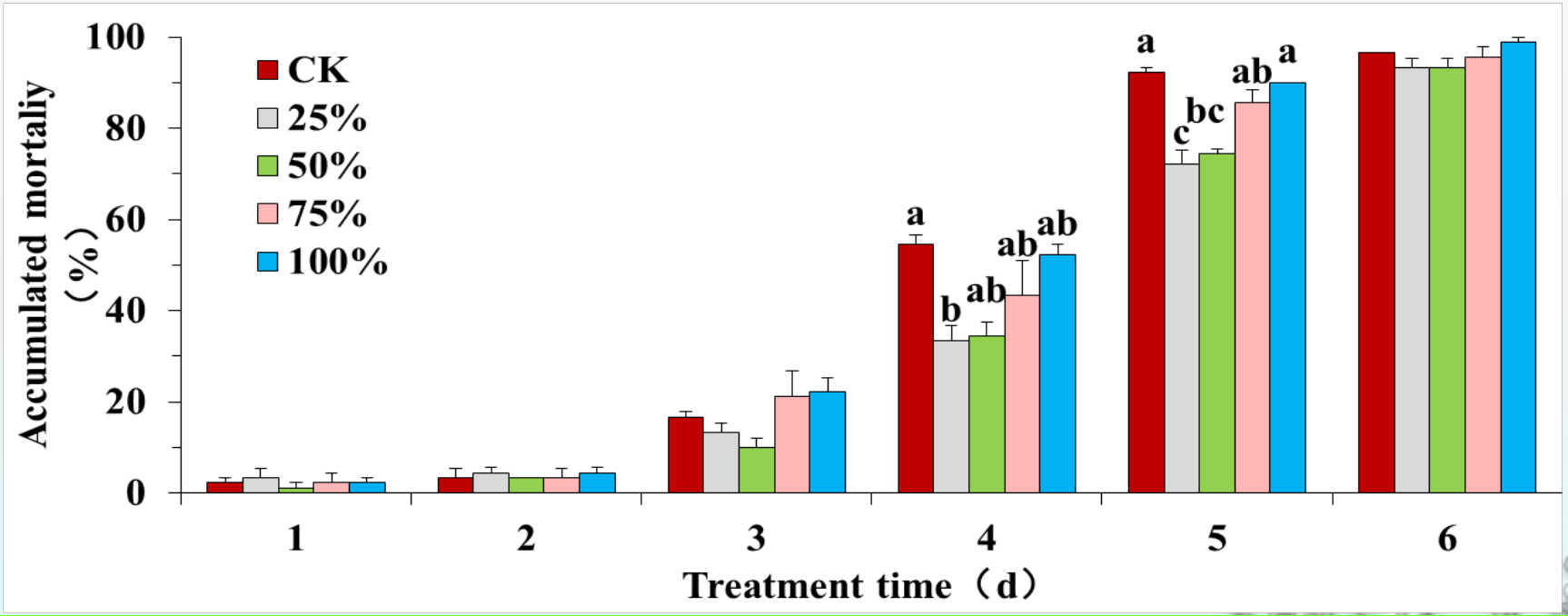
Survival rates of the shrimps



No significant difference was found among treatments and the control.

Feeding shrimp with maggots

- Mortality of the shrimps infected by WSSV (White spot syndrome virus)



25% fresh maggots in the diet significantly decreased the shrimp mortalities at 4 and 5 days when the shrimps were infected by WSSV.

Chickens fed with fresh maggots

Experimental design:

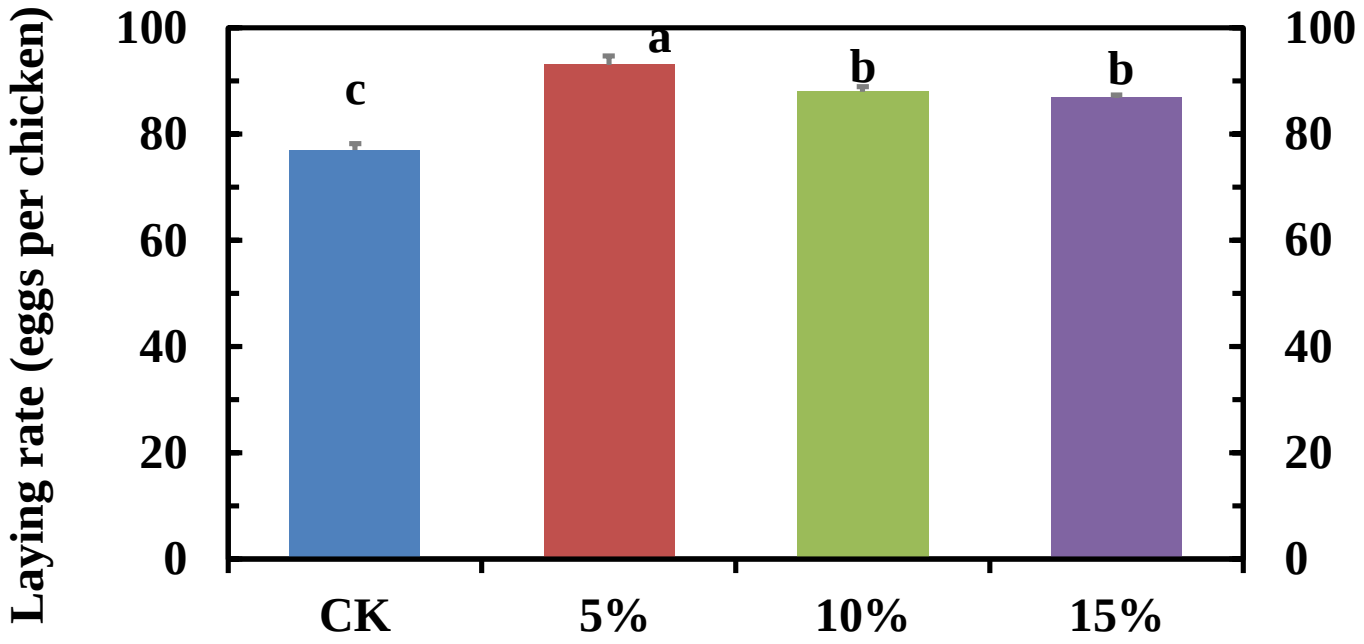
1. Species: Huxu breeders
2. Industrial diets replaced by 5%, 10%, 15% fresh maggots.
3. Indoor cultures.

Methods:

1. Quantity of the feed: 40 g per chicken each time
2. Feeding time: 8:00am and 15:00pm
3. Experimental period: 270 d

Feeding chickens with maggots

- **Laying rate:**

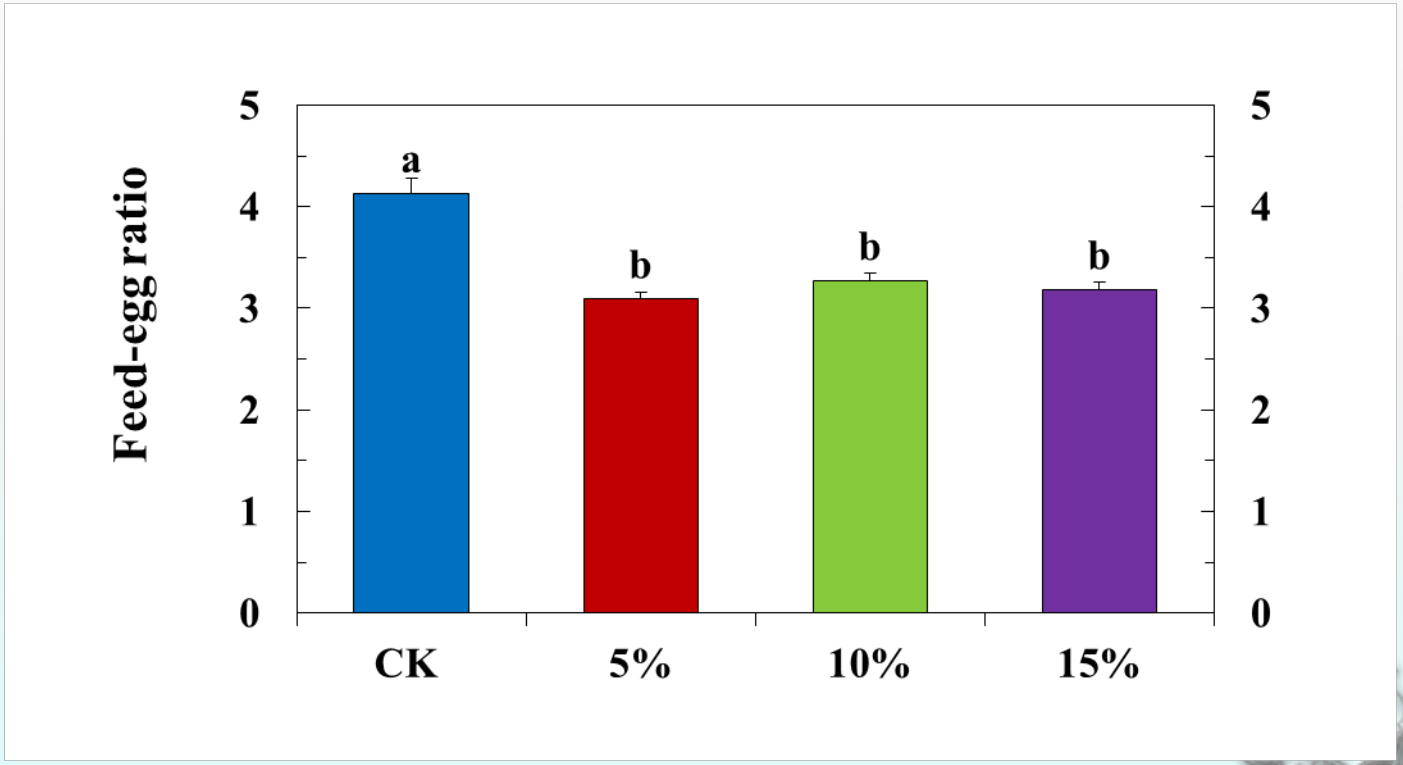


Eggs per chicken from 90 to 270 day-old in different groups

Laying rates were significantly higher in all treatments than in the control and highest laying rate was found in group receiving 5%maggots .

Feeding chickens with maggots

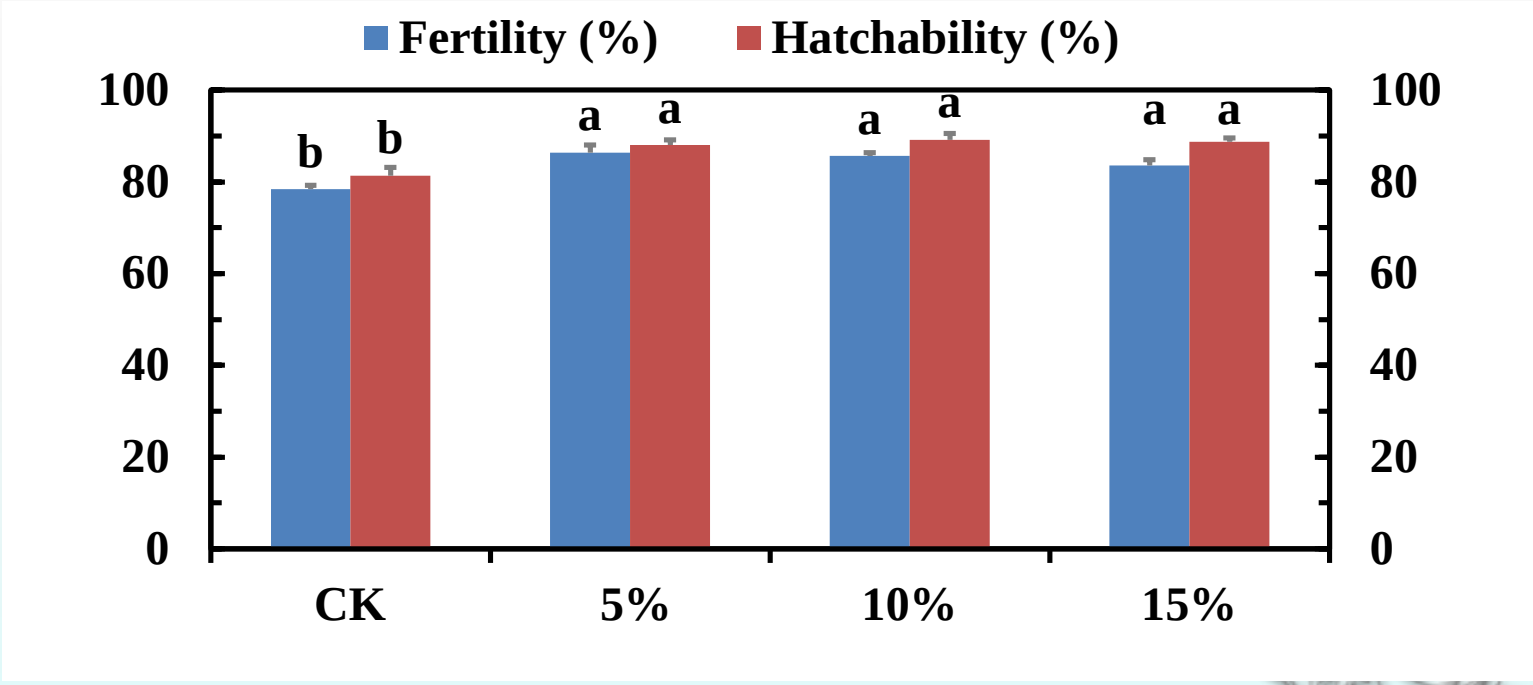
- **Feed-egg ratio**



Diets containing 5%, 10% and 15% fresh maggots reduced feed-egg ratio.

Feeding chickens with maggots

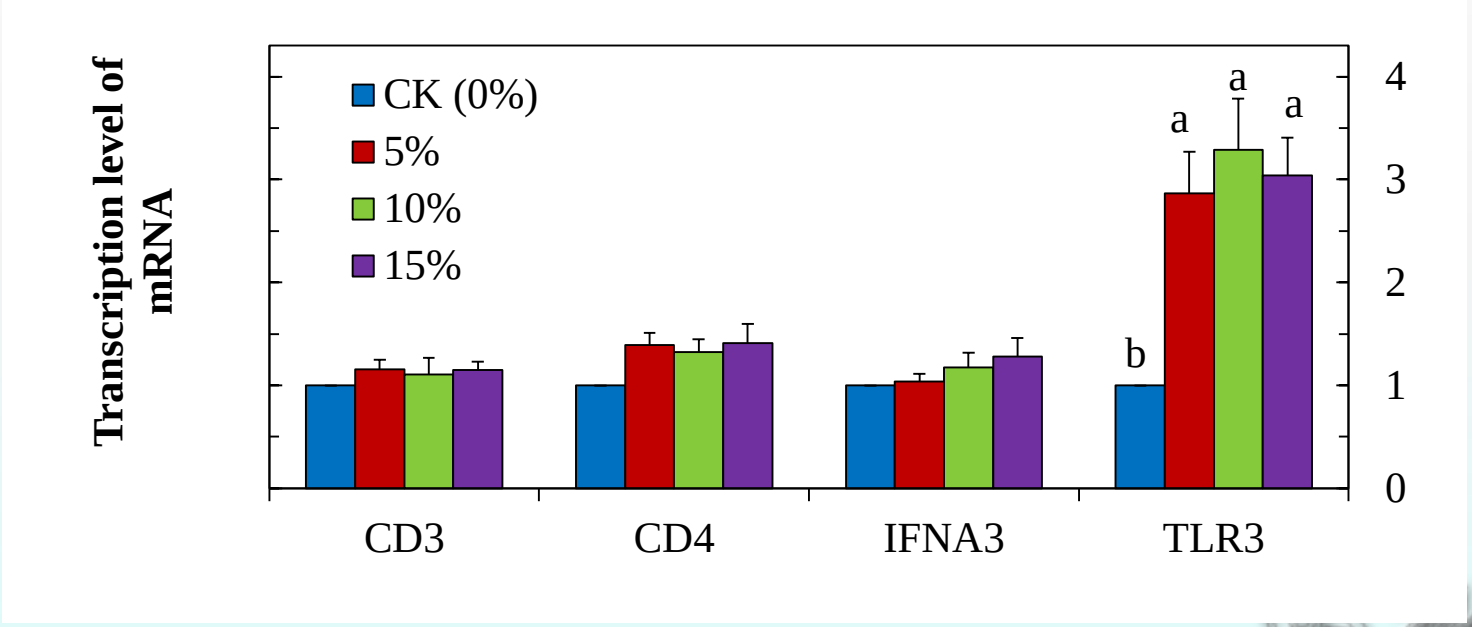
- **Fertility and hatchability**



Fresh maggot additions significantly increased egg fertility and hatchability.

Feeding chickens with maggots

- **mRNA transcription of immune-related genes in bursa**



Higher expression level of *TLR3* was observed in the chickens receiving fresh maggots.

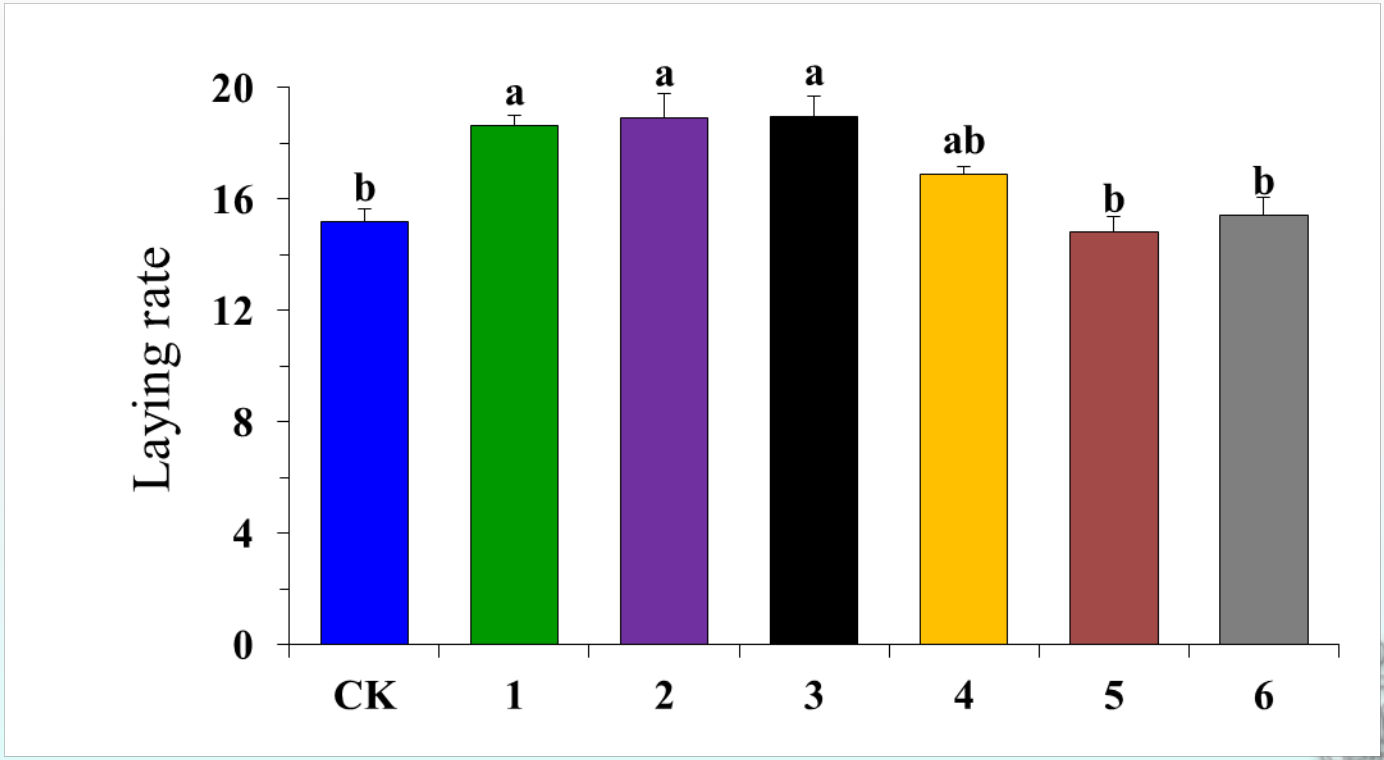
Chickens fed with insect powders

Experimental design:

Treatments	Ratios (%) of maggot, mealworm or fish meal	Protein content
CK	0 (maggot) +0 (mealworm) +100 (fish meal)	17.16%
1	100 (maggot) +0 (mealworm) +0 (fish meal)	17.04%
2	0 (maggot) +100 (mealworm) +0 (fish meal)	15.88%
3	50 (maggot) +50 (mealworm) +0 (fish meal)	17.00%
4	50 (maggot) +0 (mealworm) +50 (fish meal)	17.07%
5	0 (maggot) +50 (mealworm) +50 (fish meal)	17.05%
6	33.3 (maggot) +33.3 (mealworm) +33.3 (fish meal)	16.99%

Chickens fed with insect powders

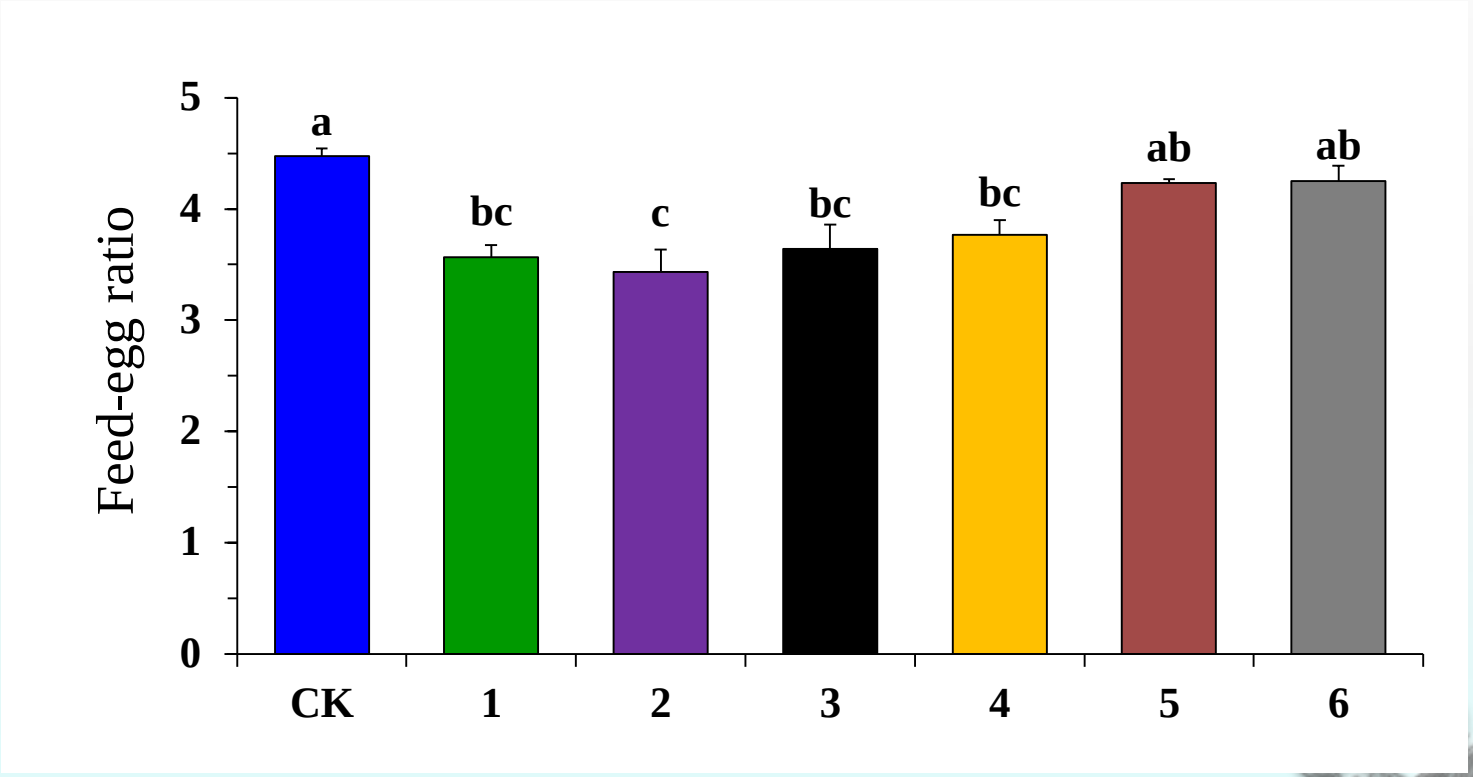
- Laying rate (eggs per chicken)



Laying rates were significantly higher in treatment 1, 2 and 3 than that in the control, indicating that insect powders improved the chicken performance.

Chickens fed with insect powders

- **Feed-egg ratios**



Treatments 1, 2, 3 and 4 can reduce feed-egg ratios.

Manuscripts

1. Zhao G.Y., Chen J.H., Su H.Y., Bruggeman G., Fitches E., Kenis M. and Han R.C. Influence of house fly *Musca domestica* larvae as a feed supplement on the performance and immune activation of Huxu breeders. **In preparation**.
2. Zhao G.Y., Chen J.H., Su H.Y., Fitches E., Kenis M. and Han R.C. Improved rearing system of house fly *Musca domestica* larvae. **In preparation**.

Conclusion

1. **The improved rearing system can be used for large scale production of house fly *Musca domestica*.**
2. **5 % supplement of the routine feed with fresh larvae significantly improves the chicken performance with high laying rates, fertility and hatchability, and lower feed-egg ratios, and activates the immune response.**
3. **Insect powders can replace fishmeal for chicken production, based on the chicken performance.**

Acknowledgement

- **The work is supported by:**

PROteINSECT
INSECTS AS SUSTAINABLE SOURCES OF PROTEIN

- **EU Project "Enabling the Exploitation of Insects as a Sustainable Source of Protein for Animal Feed and Human Nutrition" (PROteINSECT: 312084).**

Thank you!

谢谢！