Edible Insects in China

Xiaoming CHEN

Professor and PhD

Research Institute of Resource Insects (RIRI)
Chinese Academy of Forestry (CAF)
- History
- Common species
- Nutrition analysis
- Cooking ways
- Utilization
1. History of edible insects in China

- In China ancient, edible insect as cate to respect gust.
- Some edible insects are both food and medicine.
- Even today, edible insect is popular in restaurant.
2. Common species of edible insects in China

There are 177 species that are from 96 genera, 54 families, 11 orders recorded in *The Edible Insects of China* (Chen & Feng, 1999).
(1) Ephemerida

- There are 3-4 species as food.
- Common species is *Ephemerella jianghongensis*.
- The nutritious elements of *E.jianghongensis* have been analyzed.
(2) Odonata

- 6 to 7 species dragonfly larvae are recorded as food.
- The nutritious elements of 3 species have been analyzed.
16 species from 3 genus and 2 families are recorded as food.
The nutritious elements of 3 species have been analyzed.
Orthoptera

- 9 species from 8 genus and 3 families are recorded as food.
- Locust and cricket are common edible insects.
- The nutritious elements of 2 species have been analyzed.
Homoptera

- 7 species from 7 Genus and 5 Families are recorded.
- Common edible insect species is *Crytotympana atrata*.
- The nutritious elements of 4 species have been analyzed.

*insect egg*  
(*Ericerus pela*)

*cicada*
Hemiptera

- 7 species from 6 Genus and 3 Families are recorded.
- Common species are stinkbugs: *Tessaratoma papillosa, Eurostus validus*.
- The nutritious elements of 4 species have been analyzed.
Coleoptera

- 30 species from 25 genus and 11 families are recorded.
- Common species: *Stromatium longicone*, *Sphenoptera kozlovi*, *Tomcus piniperda*, *Oryctes rthinoceros*,
- The nutritious elements of 13 species have been analyzed.
Megaloptera

- There is only *Acanthacorydalisis orientalis* being recorded as food.
- The nutritious elements of *A. orientalis* have been analyzed.

**Acanthacorydalisis orientalis**

Adult | *Acanthacorydalisis orientalis* nymph
Lepidoptera

- 70 species from 25 genus and 16 families have been recorded. Larvae & pupae as food.
- Famous edible insects, such as Chinese caterpillar fungus, insect tea, bamboo insect, silkworm and so on.
- The nutritious elements of 14 species have been analyzed.

Bamboo insect  
Chinese caterpillar fungus  
Silkworm pupae
Diptera

- There are 2 species from 2 genus and 2 families being recorded.
- The larva of housefly (*Musca domestica*) is common edible insect. *Acanthacorydalis orientalis*.
- The nutritious elements of *M. domestica* have been analyzed.
- Larvae are traditionally used to make cake.
Hymenoptera

- 32 species from 9 genus and 4 families have been recorded,
- Common species are bees, ants and wasps.
- The nutritious elements of 20 species have been analyzed.
Edible insect in market
3. Nutritive value of edible insects

- Protein and amino acids
- Fat and fatty acids
- Carbohydrate
- Inorganic salts and trace elements
- Vitamins
(1) Protein: average content is higher than 40% (20-70%)

The protein content of edible insects in 10 orders (%)

Ephemeroptera, Odonata, Orthoptera, Homoptera, Hymenoptera, Coleoptera, Magaloptera, Lepidoptera, Diptera, Hymenoptera
(2) Amino acids

- Amino acids: 30-65%
- Necessary amino acids: 10-30%

The amino acids amount of edible insects in 10 orders %
(3) Fat

- Content: 10-50% ,
- Higher in larvae and pupae, low in adults

The fat content of edible insects in 8 orders (%)
The carbohydrate content of edible insects in some orders

<table>
<thead>
<tr>
<th>Insect Order</th>
<th>Carbohydrate Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odonata</td>
<td>1-16%</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Homoptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Diptera</td>
<td>1-16%</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>1-16%</td>
</tr>
</tbody>
</table>

(4) Carbohydrate

Content: 1-16%
Inorganic salts and trace elements

- more than 30 species of insect have done nutritious analysis.
- rich potassium (K), sodium (Na), calcium (Ca), copper (Cu), iron (Fe), zinc (Zn), Manganese (Mn), phosphorus (P), high in calcium, zinc and iron.
- Edible insects can supply necessary nutritive elements for human.
<table>
<thead>
<tr>
<th>种类</th>
<th>K (mg/kg)</th>
<th>Na (mg/kg)</th>
<th>Ca (mg/kg)</th>
<th>Ma (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Zn (mg/kg)</th>
<th>Fe (mg/kg)</th>
<th>Mn (mg/kg)</th>
<th>P (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>角突箭蜓 <em>Gomphus cuneatus</em> Needham</td>
<td>2 620</td>
<td>590</td>
<td>4 180</td>
<td>880</td>
<td>64.3</td>
<td>124.8</td>
<td>728.9</td>
<td>74.8</td>
<td>1 470</td>
</tr>
<tr>
<td>舟尾丝 <em>Lestes paraemorsa</em> Selys</td>
<td>2 930</td>
<td>2 020</td>
<td>2 160</td>
<td>970</td>
<td>64.8</td>
<td>147.7</td>
<td>1 198.0</td>
<td>58.9</td>
<td>2 470</td>
</tr>
<tr>
<td>红蜻 <em>Crocothemis servilia</em> Drury</td>
<td>3 330</td>
<td>2 310</td>
<td>1 510</td>
<td>950</td>
<td>50.6</td>
<td>103.8</td>
<td>461.6</td>
<td>27.2</td>
<td>1 420</td>
</tr>
<tr>
<td>云管尾角蝉 <em>Darthula hardwickii</em> (Gray)</td>
<td>2 120</td>
<td>610</td>
<td>280</td>
<td>4 500</td>
<td>56.9</td>
<td>544.3</td>
<td>100</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>白蜡虫 <em>Ericerus pela</em> Chavanness eggs</td>
<td>6 300</td>
<td>8 9.51</td>
<td>353.7</td>
<td>1 200</td>
<td>23.6</td>
<td>164.2</td>
<td>26.74</td>
<td>6 000</td>
<td></td>
</tr>
<tr>
<td>小纹蝽 <em>Cyclopelta parva</em> Did tant</td>
<td>4 720</td>
<td>1 680</td>
<td>480</td>
<td>1 530</td>
<td>2.4</td>
<td>155.8</td>
<td>119.7</td>
<td>19.9</td>
<td>8 200</td>
</tr>
<tr>
<td>暗绿巨蝽 <em>Eusthenes saevus</em> Stal</td>
<td>610</td>
<td>780</td>
<td>280</td>
<td>260</td>
<td>45.4</td>
<td>78.0</td>
<td>98.3</td>
<td>16.3</td>
<td>1 520</td>
</tr>
<tr>
<td>长足大竹象 <em>Cyrtotrachelus bugueti</em> Guer</td>
<td>2 620</td>
<td>650</td>
<td>270</td>
<td>1 050</td>
<td>38.4</td>
<td>306.1</td>
<td>64.7</td>
<td>21.0</td>
<td>5 190</td>
</tr>
<tr>
<td>长足牡竹象 <em>C. Longimanus</em> Fabricius (Faldermann)</td>
<td>1 740</td>
<td>510</td>
<td>390</td>
<td>480</td>
<td>22.9</td>
<td>127.1</td>
<td>66.3</td>
<td>25.9</td>
<td>2 920</td>
</tr>
<tr>
<td>华北大黑鳃金龟 <em>Holotrichia obliterata</em> (Motschulsky)</td>
<td>397.22</td>
<td>455.78</td>
<td>18.86</td>
<td>101.33</td>
<td>14.65</td>
<td>299.52</td>
<td>61.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>凸星花金龟 <em>Protaetia aerata</em> (Erichson)</td>
<td>187.47</td>
<td>303.65</td>
<td>35.56</td>
<td>97.48</td>
<td>338.54</td>
<td>20.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>桃红颈天牛 <em>Aromia bungii</em> Faldermann</td>
<td>131.56</td>
<td>220.54</td>
<td>23.97</td>
<td>98.76</td>
<td>102.50</td>
<td>15.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>昆斑星天牛 <em>Anoplophora nobilis</em> Ganglbauer</td>
<td>133.56</td>
<td>105.20</td>
<td>10.42</td>
<td>95.42</td>
<td>105.33</td>
<td>9.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>粒肩天牛 <em>Apriona germari</em> (Hope)</td>
<td>150.68</td>
<td>254.36</td>
<td>25.46</td>
<td>102.34</td>
<td>96.56</td>
<td>20.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>麦蛾蛉虫 <em>Pectinophora Gossypella</em> (Saunders)</td>
<td>113.40</td>
<td>163.21</td>
<td>33.40</td>
<td>87.01</td>
<td>36.78</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>亚洲玉米螟 <em>Ostrinia furnacalis</em> Guenee</td>
<td>148.66</td>
<td>156.81</td>
<td>17.13</td>
<td>78.29</td>
<td>264.81</td>
<td>6.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>金凤蝶 <em>Papilio machaon</em> Linnaeus</td>
<td>1 250</td>
<td>90.5</td>
<td>384</td>
<td>279</td>
<td>1.5</td>
<td>3.5</td>
<td>18.0</td>
<td>0.9</td>
<td>457</td>
</tr>
<tr>
<td>竹虫 <em>Chilo fuscidentalis</em> Hampson</td>
<td>2 620 13</td>
<td>740</td>
<td>880</td>
<td>1 060</td>
<td>11.1</td>
<td>109</td>
<td>57.1</td>
<td>41.8</td>
<td>1 690</td>
</tr>
<tr>
<td>桑蚕 <em>Antheraea pernyi</em> Guerin-Meneville</td>
<td>390 15</td>
<td>620</td>
<td>790</td>
<td>3 800</td>
<td>19.01</td>
<td>141.8</td>
<td>8.73</td>
<td></td>
<td>690 17</td>
</tr>
<tr>
<td>家蝇 <em>Musca domestica</em> Linnaeus</td>
<td>600</td>
<td>2 700</td>
<td>1 200</td>
<td>12 300</td>
<td>59</td>
<td>570</td>
<td>406.104.3</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>双齿多刺蚁 <em>Polyrhachis dives</em> Smith female adults</td>
<td>613.34</td>
<td>172.36</td>
<td>32.66</td>
<td>155.42</td>
<td>378.36</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male adults</td>
<td>585.28</td>
<td>163.78</td>
<td>27.08</td>
<td>148.83</td>
<td>391.56</td>
<td>101.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The vitamin amount of edible insects in certain orders

### The larva of *Tenebrio molitor* (mg/100g)

- **VB12**: 0.065
- **VB**: 0.52
- **VE**: 0.44

### The pupa of *Dendrolimus punctatus wenshanensis* (mg/kg)

- **VA**: 9810
- **VB1**: 0.41
- **VB2**: 18.7
- **VC**: 94.5
- **VD**: 25.6
- **VE**: 82.5

### The larva of *Clanis bilineata singtauica* (mg/kg)

- **VB1**: 0.49
- **VB2**: 5.2
- **VB12**: 14.12
- **VE**: 30.65
- **VC**: 9.8
- **VB3**: 25.6

### The larva of *Apis cerana* (mg/100g)

- **VA**: 0.083
- **VB1**: 2.5
- **VB2**: 3.4
- **VC**: 18.8
- **VE**: 0.2
Cooking ways

- Fry, fry after stewing
- Braising, stewing,
- Boil, steaming,
- Roasting
Industrialization of edible insect in China

- Artificial cultivation technique in large sale.
- Research and development health care food for different people, for example, children, old people and other people.
- Change insect original shape (powder, capsule and tablet) and accepted easily.
Some edible insect products in China
Conclusion

- Edible insect is one special type of good protein resource.

- Edible insects are nutritious foods that supplement nutrition for people in developing area.

- By modern technique, edible insects can be made to health care food.

  ( enzymes, hormones, polysaccharide et al.)
Introduction of RIRI

Research Institute of Resource Insects (RIRI), Chinese Academy of Forestry (CAF)
History: RIRI founded in 1955

Six research departments:
- Resource insect;
- Environment insect;
- Forest resource & environment;
- Ecology;
- Molecular biology and biological chemistry;
- Forest chemistry & production;

Four experimental stations:
- Tropic station;
- Subtropic station;
- Dry hot valley station;
- Hungeriness station
What are resources insects?

- Insect as beneficial resource for human being
- with important economic, ecological and scientific value
- Direct and indirect utilization
Resource Entomology

- Insect production as industrial raw materials (e.g. lac, insect wax, insect dye etc.)
- Honey bee
- Insect as medicine resource
- Insect as protein resource
- Ornamental insects (butterfly)

- Pollination insects
- Natural enemy insects
- Insects benefit for environment

Insect structure and function (bionics)

Economic

Ecology

Science

narrow sense (directly utilization)

broad sense (indirectly utilization)
1. Insect secretion as Industrial raw materials

1.1. Lac insect

*Kerria lacca*

- Larvae
- Adult
- Resin

Lac insect → host tree → lac
Lac value

Lac secreted by lac insect is an important chemical raw material, which is widely apply in chemical, food, machine and medical industries.
1.2. Insect wax

- Insect wax secreted by Chinese white wax scale insect (*Ericerus pela*)

- Apply in chemical, food, cosmetic and medical industries
Farmer harvest insect wax
Insect wax processing in factory
1.3. Insect dye

Cochineal Insect \((Dactylopius .coccus )\)

Cochineal is a scale insect that live on cactus, red dye extracted from cochineal body is an important bio-dye which is applied in cosmetic, food, printing and dyeing.
Cultivation of cochineal insect
Dry cochineal insect

Insect red dye

Dry cochineal insect
Chinese gallnut formed by aphids stimulated host tree (Rhus),

Tannin extract from Chinese gallnut applied in chemistry, medicine, food, weave dyeing.
Form process of Chinese gallnut
2. Insect as medicine resource

- There are about 250 species of insects as medicine in Chinese traditional medicine.
- More than 700 species insects can excrete 60 kind of insect toxin.
- There are founded more than 400 kind of antibacterial substances in insect in the world.
Chinese caterpillar fungus

- Immunity
- Anticancer
- Hepatitis

Cordyceps sinensis (Berk)

Hepialus armoricanus Oberthús

fungi

infection

insect
Some common medical insects in China

- Mylabris phalerata (Caantharidin)
- Stinkbug Aspongopus chinensis
- Larvae of chafer
- Dung beetle
- Cricket

Some common medical insects in China
3. Butterfly Cultivation & Industrialization

- Artificial Cultivation in large scale
- Butterfly garden
- Butterfly artware
Life cycle of *Papilio machaon*

- **Egg**
- **Larva**
- **Pupae**
- **Adult**
Life cycle of *Kallima inachus*

- Egg
- Larva
- Pupae
- Adult
Artifical Feeding

Larvae

Pupae
Butterfly artware
4. Pollination insect

Studies on insect pollination of bio-energy sources tree *Jatropha curcas* L

<table>
<thead>
<tr>
<th>Order</th>
<th>species</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hymenoptera</td>
<td>19</td>
<td>54.29%</td>
</tr>
<tr>
<td>Diptera</td>
<td>5</td>
<td>14.29%</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>4</td>
<td>11.43%</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>4</td>
<td>11.43%</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>3</td>
<td>8.57%</td>
</tr>
<tr>
<td><strong>∑</strong></td>
<td><strong>35</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
The pollination system of *Jatropha curcas*
Pigeonpea, a tree pea that live 6-8 years, is a protein resource.
Insect Cell Culture

The in vitro culture of cells taken from living insects, and make the cells grow continuously.
- More than 30 kinds of cell lines from different insect in RIRI.
- Use of cultured cell strains in place of animal experiments
- Propagation using cultured cells of insect virus
- Anti-microorganism substances produced by cultured insect cells

**Insects:**
- *Blaps rhynchoptera*
- *Tenebrio molitor*
- *Bombyx mori*
- *Hepialus gonggaensis*
Welcome to visit RIRI in Kunming, China!