Handling and Processing Seaweed from the farm to the Japanese market place

Seaweed Conference 2014

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Today’s Topics

0. Introduction of RIKEN FOOD Co. Ltd.
1. Utilization of seaweed as the basis of Japanese food.
2. Handling and processing seaweed in Japan
3. Situations of seaweed market in Japan
4. A strategy for developing production and expanding consumption of seaweed.
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Introduction of Riken Food

- Foundation: 1 July, 1964
- Capital: 1 million USD
- Annual sales: 80 millions USD (March 2013)
- Main Product: Wakame (Undaria) and other seaweeds products, seasonings
- Main Process: Air Rolling Drying method for Seaweed (PAT.)
- Production capacity: Dry Wakame 500 t/year, Wakame soup 100 millions pack
- Employee: 271 (1 August 2012)
- Mother company: Riken Vitamin Co., Ltd
- Factories: Miyagi and Iwate prefectures in Japan, Dalian in China
Our products

Cut & Dry Wakame
´FUERU WAKAME CHAN´

Wakame Soup
Wakame for rice
Seaweeds salad
Stipe of Wakame
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Utilization of seaweed as the basis of Japanese food

- Undaria
- Chondracanthus
- Laminaria
- Agar
- Porphyra
- Cladosiphon
- Laminaria (extract)
- Undaria
- Laminaria (extract)
Seaweeds in the Japanese Food

ONIGIRI (rice ball)
Porphyra (Wrap)
Laminaria (Ingredient)

ODEN (Japanese Pot-au-feu)
Laminaria (Ingredient, Extract)

MISO Soup
Undaria (Ingredient)
Laminaria (Extract)

Drying Laminaria
Extraction of UMAMI

Many dishes
Utilization of seaweed in Japan

<table>
<thead>
<tr>
<th>Class</th>
<th>Edible species in Japan</th>
<th>Major Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>28</td>
<td>Ulva, Enteromorpha, Monostroma, Codium, Caulerpa, etc.</td>
</tr>
<tr>
<td>CHLOROPHYTA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>38</td>
<td>Undaria, Laminaria, Analipus, Eisenia, Sargassum, Nemacystus, etc.</td>
</tr>
<tr>
<td>PHAEOPHYTA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>79</td>
<td>Porphyra, Gloiopeltis, Chondrus, Gracilaria, Gelidium, Meristotheca, Solieria, etc.</td>
</tr>
<tr>
<td>PHODOPHYTA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The first mention about seaweeds in AD 700s.
- Many species are edible in Japan.
- Japanese use the most kinds seaweeds for food in the world?
- Seaweeds are basis of Japanese Food!
Nutrient components and health benefit of Seaweeds

Seaweeds are low calorie food and contain a lot of nutrients.

<table>
<thead>
<tr>
<th>Class or Species</th>
<th>Component</th>
<th>Benefit</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phaeophyte</td>
<td>Alginate</td>
<td>The intestine-controlling function</td>
<td>Asaoka (1998)</td>
</tr>
<tr>
<td>Laminariales (Laminaria, Undaria)</td>
<td>Fucoidan</td>
<td>Anti-inflammatory and anticancer effects</td>
<td>Maruyama et al. (2003)</td>
</tr>
<tr>
<td>Phaeophyte</td>
<td>Fucoxanthin</td>
<td>Anti-obesity effect</td>
<td>Miyashita et al. (2011)</td>
</tr>
<tr>
<td>Rhodophyte</td>
<td>Vitamins</td>
<td>Regulatory effects</td>
<td>Lembi and Waaland (1998)</td>
</tr>
</tbody>
</table>
Utilization of seaweed as the basis of Japanese food

• Many species of seaweed are used for Japanese food.
• Seaweeds are low calorie and contained nutrients for health benefit.
• Seaweeds is contributed to low calorie food culture and long life in Japan.
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Handling and processing seaweed in Japan
Annual production amount of Natural harvest and cultivation in 2013:

- Annual production amount of Natural harvest: 4202 unit; 100t
- Annual production amount of cultivation: 3180 unit; 100t

Annual production amount of Natural harvest by species in 2013:

- Laminaria: 569 unit; 100t
- Others: 277 unit; 100t

Annual production amount of cultivation by species in 2013:

- Porphyra: 352 unit; 100t
- Laminaria: 505 unit; 100t
- Undaria: 165 unit; 100t
- Others: 846 unit; 100t

- Production amount of cultivation is 80% over
- Laminaria harvested from natural coast is almost second-year plants for extract of “UMAMI”

Annual report of MAFF 2013, Japan
Annual changing of production amount by cultivation
Porphyra, Laminaria, Wakame

Total amount is decreasing, especially one of wakame is markedly declining.
Cultivation schedule and technics of *U. pinnatifida* in Japan

**Gametophyte**

**Sporophyte**

- *n* (Gametophyte)
- *2n* (Sporophyte)

**Seedling**

- Nursing seedling (depth→Shallow)
- Harvest (Mature plants)
- Trimming for density control

**Spring**

- Harvest (young plants)
- Selection of mother strain

**Summer**

- Young sporophyte
- Harvest (young plants)
- Farm selection
- Setting seedling for main rope
- Trimming
- Setting of seedling

**Autumn**

- Germination
- High light
- Long day period

**Winter**

- Natural coast
- Cultivation
- Natural coast

**Farm selection**

- Sporophyll
- Spore
- Summer
- Spring
- Winter
- Autumn
Cultivation method; 1) Making of seedling

- Selection of mother plant
  - Quality and size of leaf or sporophyll
- Semi-Drying of sporophyll in the shade
  - Stimulus for spores release
Cultivation method; 1) Making of seedling

- Immersing sporophyll in seawater
- Immering strings in seawater released spores
Cultivation method; 1) Making of seedling

Hang down to approx. 10m depth

- Strings are gradually raised to shallow depth from July to October
- Germination from a gametophyte to a sporophyte is caused by illumination development
Cultivation system of *U. pinnatifida* (Wakame) in Japan

Northeastern site, “SANRIKU”

Southern site, “NARUTO”

**Longline type**

- float
- rope
- plants
- Rope for anchor
- bottom
- Anchor (Concrete)

**Raft type**

- float
- Sea surface
- 100m
- Anchor
- Sea surface
Cultivation system *U. pinnatifida* in Korea and China

Raft type (Korea)

- Float
- 100m
- Rope for plant
- 100m

Many long lines type (China)

- Main rope
- 8m
- 0.8~2.0m
- 浮き
Production process of Wakame (Undaria) Row material → boiled and salted → Drying

Hervest → Collection → Boil and Cooling → Salted → Dehydration → Separation: leaf and stipe → Air rolling dry → Cut and Dried Wakame
Production process of Wakame (Undaria)

1. Harvest
2. Collection
3. Boiling and Cooling
4. Salting
5. Dehydration
6. Separation: leaf and stipe
7. Air rolling dry
8. Cut and Dried Wakame
Production method of *U. pinnatifida* and *S. japonica*

**Boil and salt**
- **Purpose:** Keeping quality by inactive enzyme, changing color from brown to green
- **Making place:** fisheries or cooperative association

**Raw material:** quality check
**Boil:** over 90 °C by seawater (or fresh water), 20–60 seconds (depending on size of Raw material)
  * Seawater is better for keeping texture of plants
**Cooling:** immediately after boil, under approx. 20°C of plants
**Salt:** mixing plants and salt, approx. 30% for fresh weight of plants
**Immersing into salt water:** In the tanks, salt degree is saturation, for 1 or 2 days
**Dehydration:** Decreasing moisture by pressing.
Production process of Wakame (Undaria) Row material $\rightarrow$ boiled and salted $\rightarrow$ Drying

1. **Harvest**
   - Collection
2. **Salted**
   - Boil and Cooling
3. **Dehydration**
   - Separation: leaf and stipe
4. **Air rolling dry**
5. **Cut and Dried Wakame**
Morphological characters of Undaria

Undaria is used whole plant without holdfast depending morphology and texture.
Separation leaf and stipe

- It is the only process for U. pinnatifida
- Handiwork

Northern Japan

Dalien, China
Production process of Wakame (Undaria)

Row material → boiled and salted → Drying

Harvest

Collection

Boil and Cooling

Salted

Dehydration

Separation: leaf and stipe

Air rolling dry

Cut and Dried Wakame
Dry method

– Rolling dry method for dry cut wakame, created by RIKEN FOOD in 1970s
– Process: wash, cut, dehydration, dry
– Advantages:
  1) reducing volume of product = **reduction of packaging cost**
  2) higher mobility on the belt conveyor = **stability and speedy for automatic package**
  3) smooth surface of WAKAME = **prevention for breaking a plastic bag of products**
  4) reduction time by eating after putting wakame into water or hot water = **quality**
Producing process after dry

1) 1st Air separator
2) 1st Sieve sorter
3) 2nd Air separator
4) Belt Dryer
5) 2nd Sieve sorter
6) Color sorter
7) Visual sorting
8) X-ray and Metal checker

→ Package

http://www.rikenfood.co.jp/process03.html
Problems during the processing at the factory

Removing of Alien Substances \(\rightarrow\) Manufacturing cost higher

**Present situation**
- 66% Raw Material
- 22% Processing
- 12% Selection

**Ideal situation**
- 9% Raw Material
- 32% Processing
- 59% Selection

Selection cost occupies 50% of total cost.
A lot of machine for selection; color, density, magnet, X-ray).
Seaweed form is complex.
The visible sorting by worker is essential factor.
Production method of *U. pinnatifida* and *S. japonica*

<table>
<thead>
<tr>
<th>Method</th>
<th>Main use</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry by sunlight</td>
<td>UMAMI extract</td>
<td><em>S. japonica</em></td>
</tr>
<tr>
<td>Boil and salt</td>
<td>Product of Boil and salt</td>
<td><em>S. japonica</em></td>
</tr>
<tr>
<td></td>
<td>Dry product (cut wakame)</td>
<td><em>U. pinnatifida</em></td>
</tr>
</tbody>
</table>
Harvest of natural plants of S. japonica in Hokkaido, northern Japan
Tool for harvest of *S. japonica*
Drying by solar drying on the ground
Drying by wind in the warehouse
Dry product for UMAMI extract, ‘DASHI KOMBU’
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# Market scale of seaweed in Japan

<table>
<thead>
<tr>
<th>Species</th>
<th>Price (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porphyra (NORI)</td>
<td>2,000 million</td>
</tr>
<tr>
<td>Laminaria (KOMBU)</td>
<td>3,000 million</td>
</tr>
<tr>
<td>Undaria (WAKAME)</td>
<td>630 million</td>
</tr>
<tr>
<td>Sargassum fusiforme (HIZIKI)</td>
<td>250 million</td>
</tr>
<tr>
<td>Salada of Seaweeds</td>
<td>125 million</td>
</tr>
</tbody>
</table>

Datas by SHOKURYO TIMES
Sales channels of seaweed products in Japan

Government of Prefectures → Demarcated Fishery Right

Fisheries: Cultivation or Harvest

Fishing cooperative

Processing company

Wholesale for domestic
(e.g. Supermarket)

Wholesale for business use
(e.g. Restaurant, Food company)

Market for domestic

Market for business use

Consumer

e.g. Internet
Order Service

Direct sale
Annual changing of production amount and price of Undaria in Northern Japan

- Increasing of Seawater temperature during long term, → production amount decreasing and nutrient depletion → variable quality of row material
- Decreasing the number of fisheries → unstable price
Market size of Undaria in Japan

Boiled-Salted product → Increasing market by Drying product → the decrease trend

15% since 1993
Annual purchase situation of seaweed in Japanese household

Annual purchase amount of Undaria in one household

Annual purchase price of Porphyra in one household

Annual purchase amount of Laminaria in one household

Annual purchase amount of cooked Laminaria in one household

Annual report on the family income and expenditure survey, MIC, JAPAN

Purchase amount of seaweeds in Japan has continued to decline recently.
Seaweed production and the changing market in Japan

- Production amount of seaweeds in Japan is tending to decrease.
- Especially, decreasing level of Undaria production is markedly.
- Several factors (Environment, decreasing number of fisheries, eating habits and so on) led to reduction of production amount and market.
- Every fields of seaweed industry is under the downward spiral
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A strategy for Developing production and expanding consumption

• Researcher’s supports need to developing raw material production by Fisheries.

• Company’s promotions need to expanding consumption on customers.

Both factors need to growth the seaweed industry.
A strategy for production and expanding consumption

The reduction of labor for production is essential factor!!
- Wide temperature tolerance cultivar by selection breeding. 
  effect: arrangement culture plan → avoid the working concentration
- Earlier growth cultivar by selection breeding. 
  effect: some times farming
  higher productivity  → profit improvement of fishermen
Development of new culture system for selection breeding

This system enable to study selection breeding more effective (approx. 300 ind./2000L).

*Incubator scale* (Gametophyte ~ 5mm Sporophyte)

1*st* tank (7L) (5mm ~ 30mm Sporophyte)

2*nd* tank (30 L) (30mm ~ 100mm Sporophyte)

3*rd* tank (500 L) (10cm ~ 50cm Sporophyte)

4*th* tank (2,000 L) (50cm over Sporophyte)

International seaweed symposium (2013)
Strategy for expanding consumption
-Development of new production-
Strategy for expanding consumption
-Food education activity-
Conclusion

- Seaweeds play an important part of Japanese food.
- Producing methods of seaweed are developed every species in Japan.
- Rolling dry method is most available process for cut and dry wakame.
- Production amount and market scale of seaweeds in Japan are tending to decrease, it is caused by many factors.
- Mutual development of both researcher and company is important for keeping and advancing seaweeds production and Japanese food culture.