Current Topics on the Microbiological Safety of Packaged Foods in Japan

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Current and Future Safety Issue for Food Packaging in Japan -- focusing on microbiological safety

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The Society of Packaging Science & Technology, Japan

The Society of Packaging Science & Technology Japan was established as a professional society to promote progress in all of the scientific and technological fields related to packaging.

Since its establishment on April I, 1992, the Society has convened annual meetings and International Packaging Seminars to promote domestic and international exchanges.

In September1996, the Japan Science Council officially recognized the society as a registered scientific organization.

Major Activities

The Society works in close cooperation with the Japan Packaging institute and cooperates with universities, government and private research organizations and other professional organizations to conduct the following activities:

1) Annual Meeting, International Packaging Seminars
In addition to the Annual Meeting, International Packaging Seminars (IPS '96, IPS '97, IPS '99) are convened which provide venues for exchanges with overseas researchers.

Banquet during Annual meeting

Current President
Dr. M. Ishikawa

2) Journal of Packaging Science & Technology, Japan

Is the only professional journal covering science and technology related to packaging in Japan that publishes academic reports in English and Japanese.

In academic reports, special editions focusing on hot topics and fundamental topics are published.

The journal is published 6 times a year.

3)Symposiums

The society convenes symposiums covering hot topics related to packaging or on research and technology trends in interdisciplinary areas related to packaging where several specialist covered related Subjects.

4) Domestic and International Packaging Research Exchange

Co-Operation with IAPRI (International Association of Packaging Research Institutes), Korean Packaging Society and the Packaging institute in the convening of international meetings through participation in scientific panels, providing keynote speakers, etc. .

My topics today

1)Basic information on microbiological safety in packaged foods

2)Current safety issues in packaged foods in Japan

1)Basic information on microbiological safety in packaged foods

Food preservation techniques

1)Disinfection

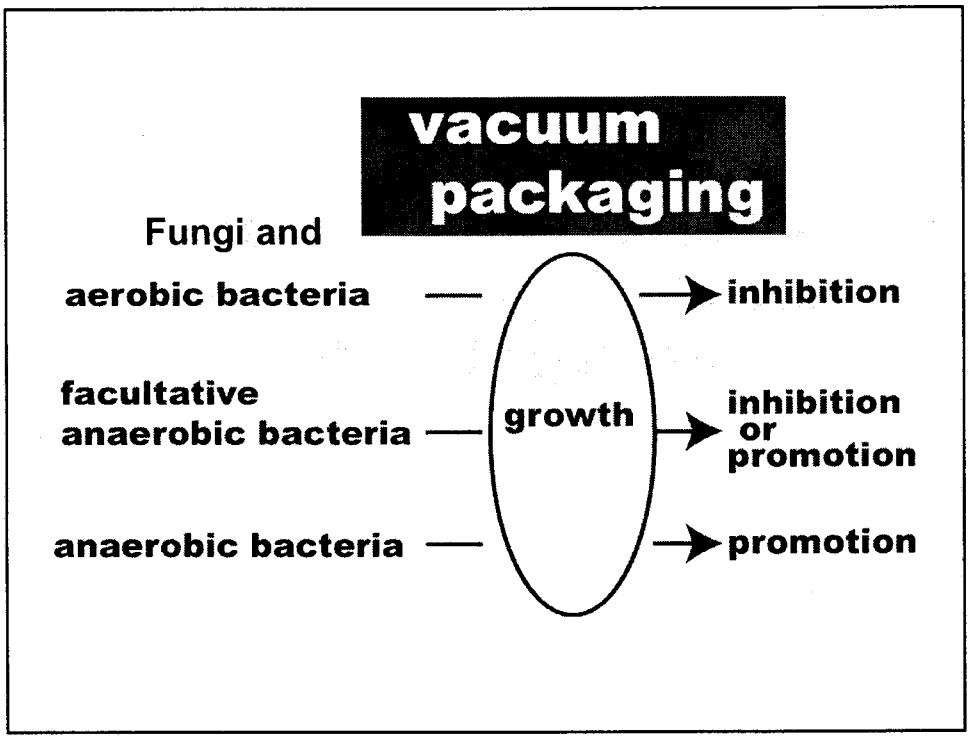
- **Thermal Death**
  - **Sterilization**
    - **Retorted Food**
    - **aseptically-packaged food**
  - **Pasteurization**

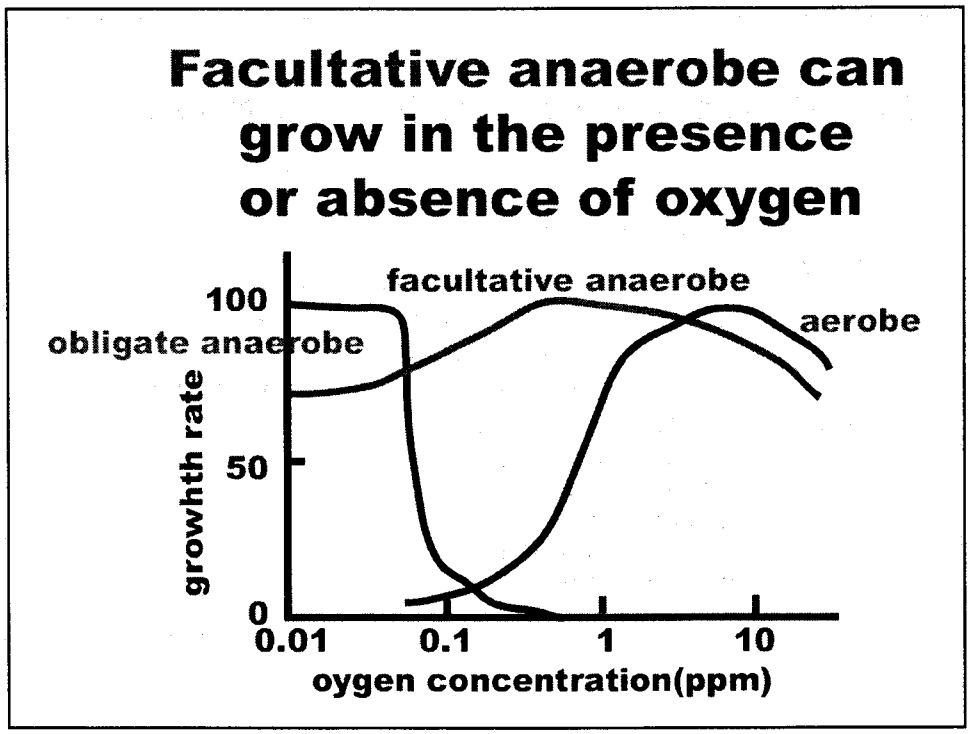
- **prevention of secondary contamination**

2)growth inhibition

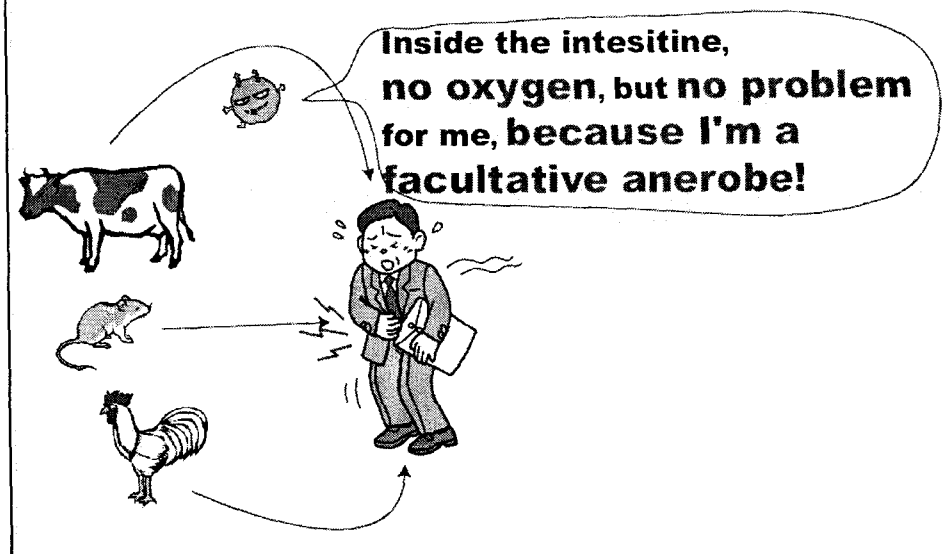
methods of food preservation

- **low temperature**
- **acidification**
- **low water activity**
- **preservatives**
- **packaging**


vacuum packaging
Fungi and
aerobic bacteria
facultative anaerobic bacteria
anaerobic bacteria
growth
inhibition
inhibition or promotion
promotion

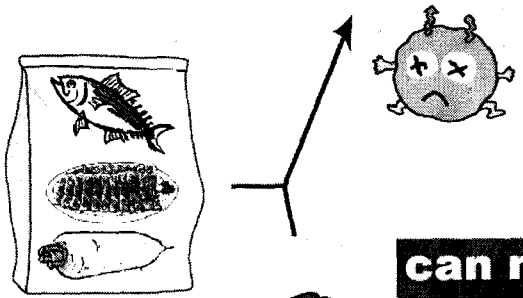

Facultative anaerobe can grow in the presence or absence of oxygen
facultative anaerobe
aerobe
obligate anaerobe
100
50
0
growhth rate
0.01
0.1
1
10
oygen concentration(ppm)

intestinal pathogens

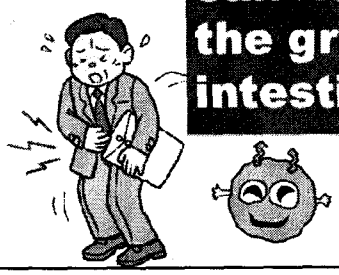


Vacuum package

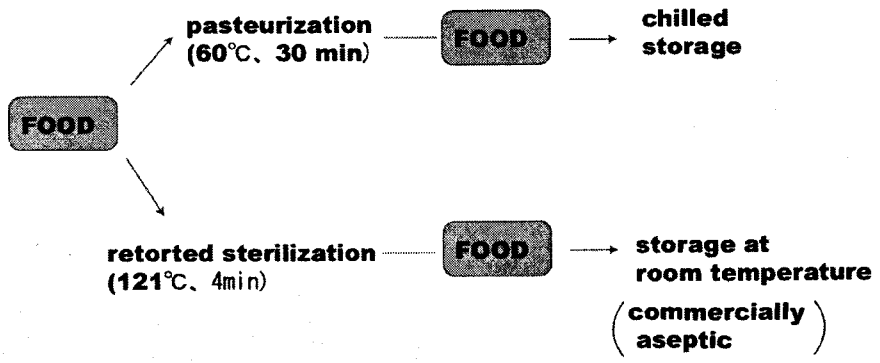
can make longer shelf life



can not prevent the growth of intestinal pathogen

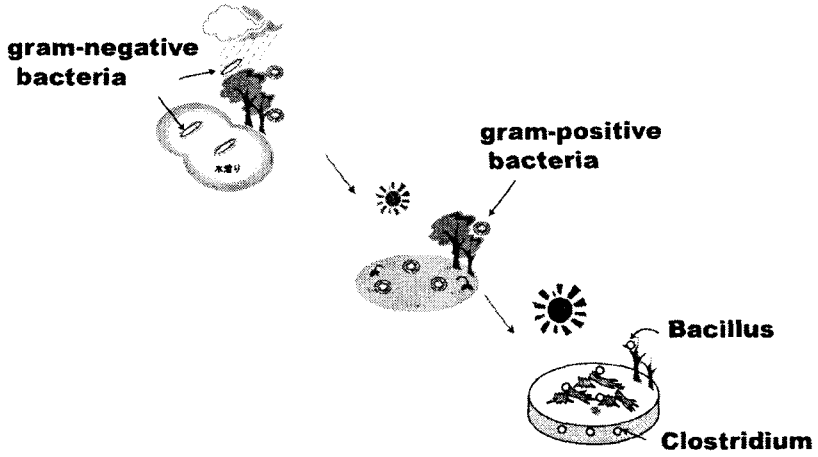


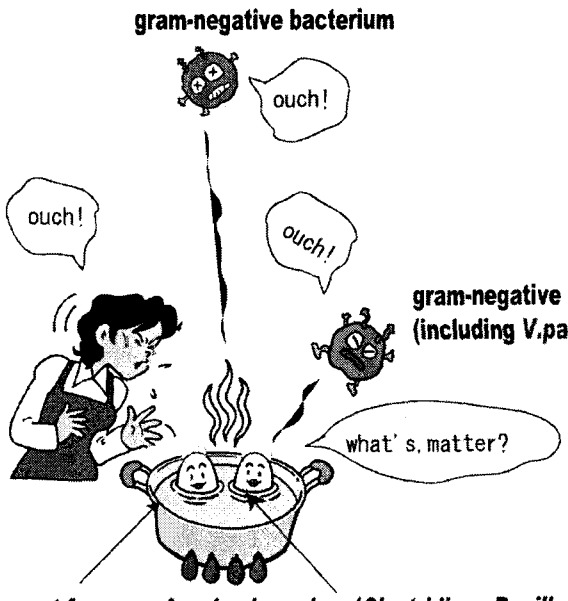
Prevention of risk —Heat sterilization



Spore-forming bacteria

most efficiently adaped to be able to survive in terrestrial environment.

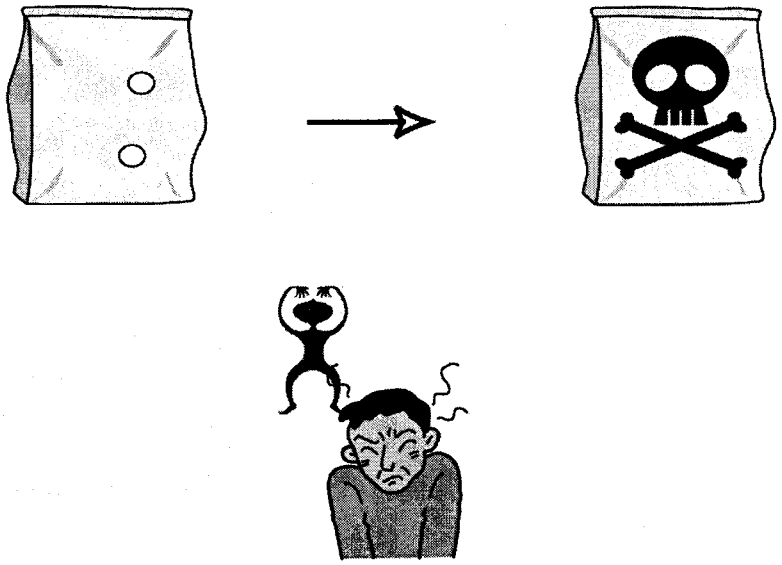




except for spore-forming bacerium (*Clostridium, Bacillus*)

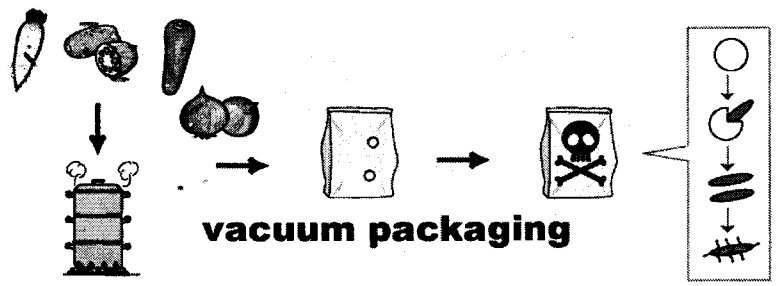
Can be prevented by thoroughly cooking seafood

Packaged food (*C.botulinum*)



Foodborne botulism

Vegetables that are in contact with the soil



Clostridium botulinum

produce [**a potent neurotoxin**
heat-resistant spore

121℃, 4min(F-value 4)

equivalent to or more than what is required for a 12D reduction of. Clostridium botulinum (typeA)

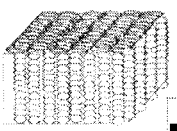
||

retorted sterilization

12D sterilization

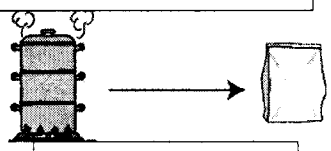
120 ℃、
4 minitues
(F=4)

Clostridium botulinum type A



$10^{12} \rightarrow 10^{0}$

Guideline in Japan for Product processed in the **package**



without F4 sterilization

C.botulinum (Group I) will not grow if...

- Below pH 4.6
- Below Aw 0.93
- Below 10 ℃

Acidification

High vs. Low Acid Foods

Foods can be classified on the basisof **pH**

- > **pH 4.6** are low acid foods
- < **pH 4.6** are acid foods

Marinated fish

p**H 3.6**

resistant to food poisoning

- Low acid (< **pH 4.6)canned foods**

  such as canned corn, peppers, green beans, soups, asparagus, mushrooms, tuna fish, chicken and chicken livers and and meats, ham, sausage, and smoked and salted fish.

Heat sterilization at temperature **121° C for 4 min**

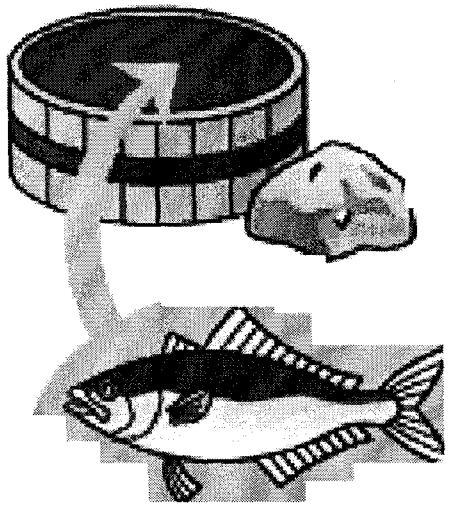
Is necessary

- High acid (< **pH 4.6)canned foods**

  such as canned fruits, fruit juices, jams, and tomatoes with added **acid**, pickles, and vinegars.

Is not necessary

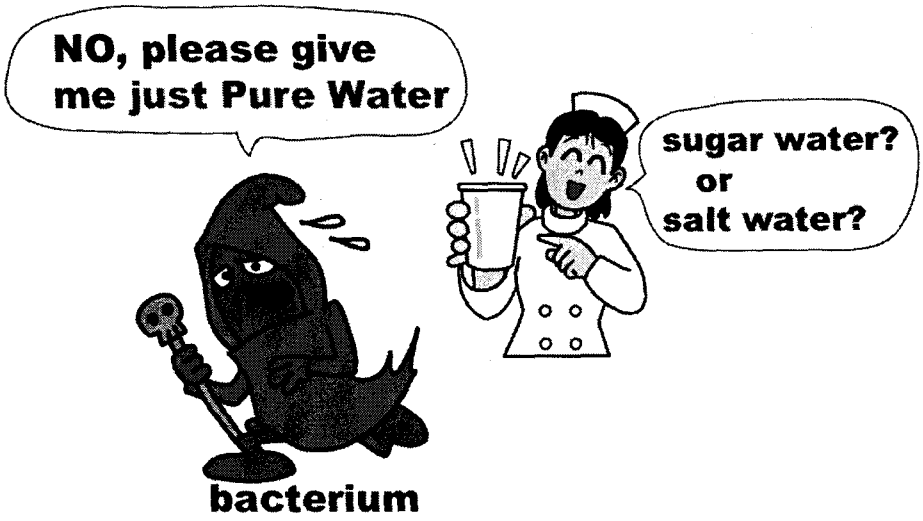
Water activity



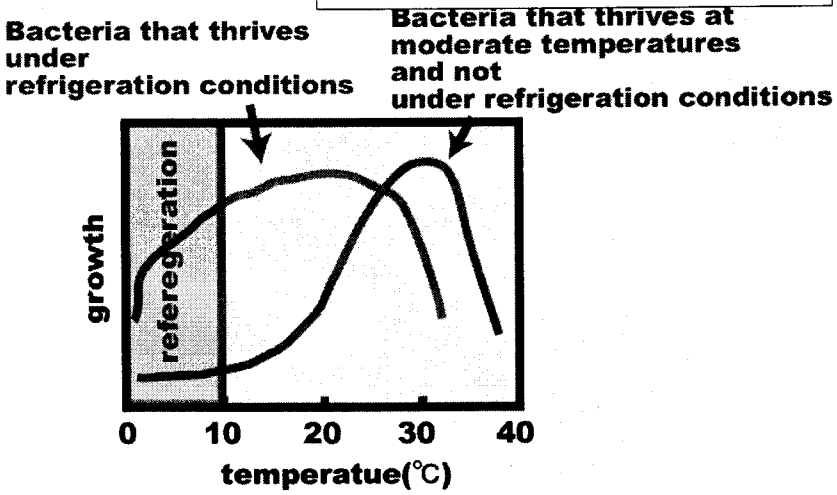
Salt

Water activity(Aw)

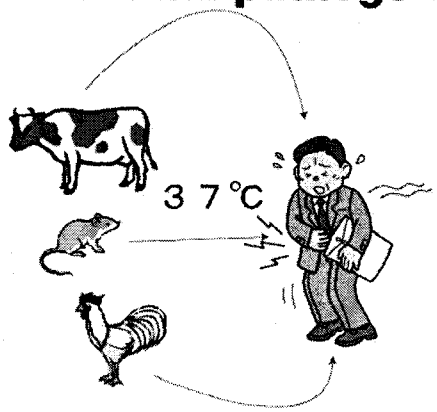
Salt and sugar deprive microorganisms of water



Temperature



intestinal pathogens

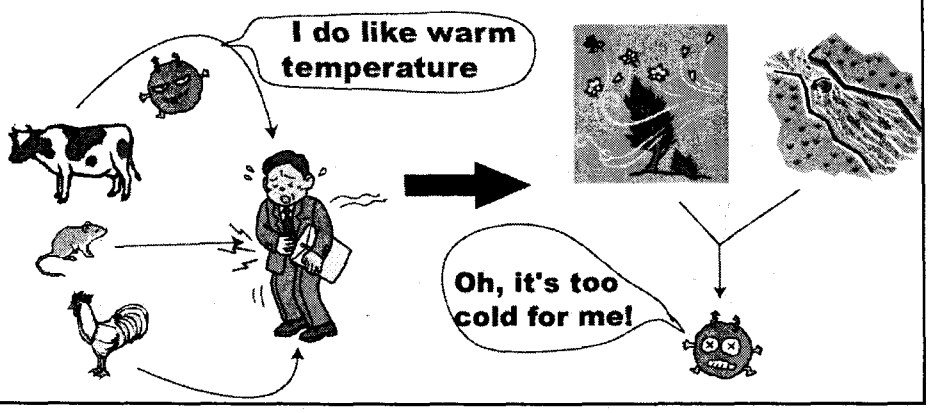


Many of the pathogens which cause gastrointestinal disease are closely associated with humans and other warm-blooded animals.

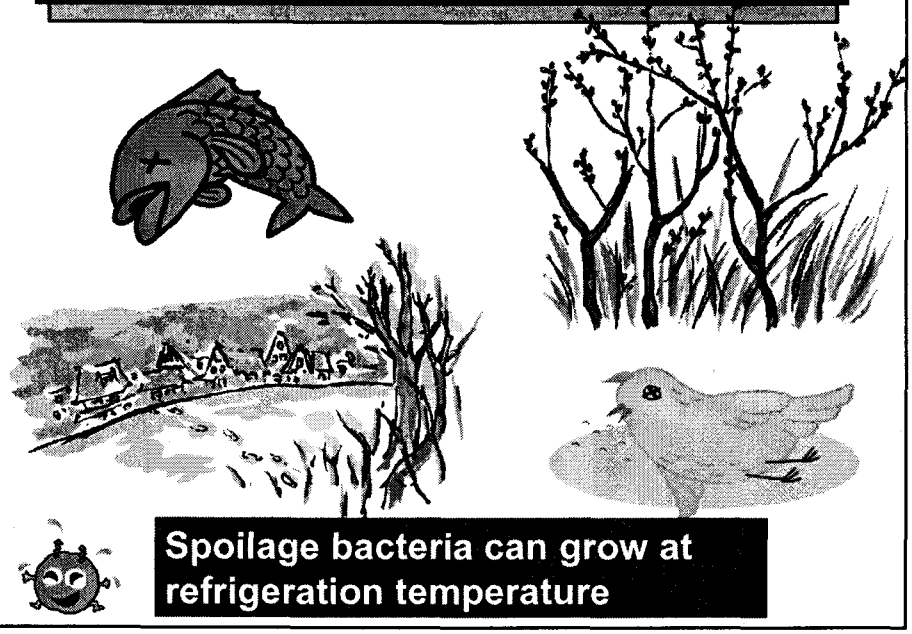
These pathogens are transmitted from one organism to another by contamination of food or water.

Many of the pathogens which cause gastrointestinal disease are closely associated with humans and other warm-blooded animals.

intestinal pathogens



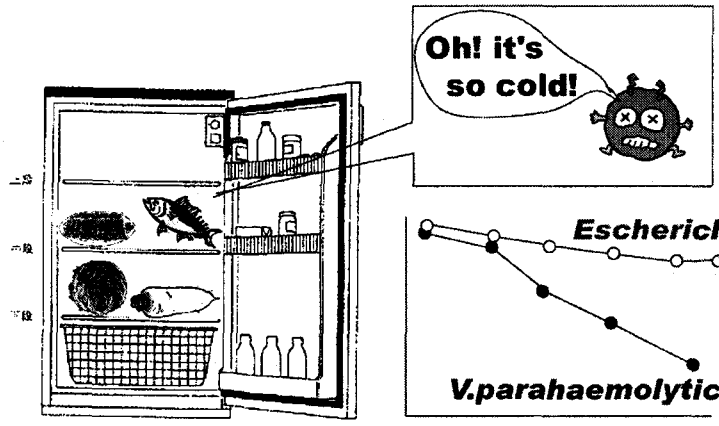
Spoilage can occur in winter

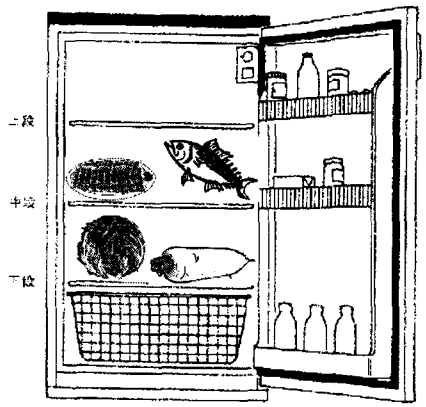


Spoilage bacteria can grow at refrigeration temperature

Sensitive to cold!

Proper refrigeration of seafoods will not allow *V.parahaemolyticus* proliferation





Improper refrigeration of foods contaminated with food pathogens will allow their proliferation

2)Current safety issues in packaged foods

Current safety issues in packaged foods in Japan

1) Lightly Cooked Food (reduction of thermal damage)
→Chilled Food

2) **Retort → Aseptic packaging**

3) T**rends in frozen food** consumption

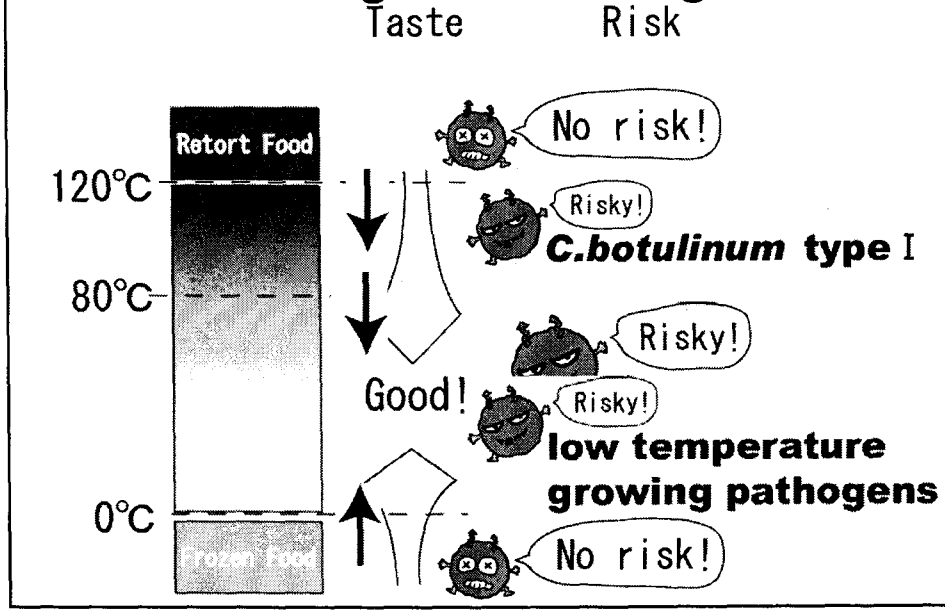
4) Increasing focus on healthy eating
→reduced amount of **preservative**

Increasing microbiological risk

1) Lightly Cooked Food (reduction of thermal damage)

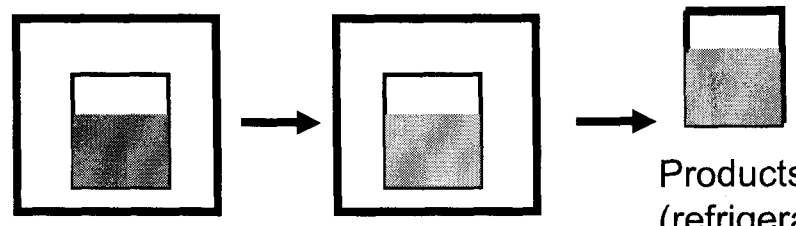
- Raw, unprocessed foods
- Processed foods
  - Ready to eat (RTE) consumer products
  - Not ready to eat food products (require furtherpre paration by consumer)

Trends in thermal food processing and increasing microbiological risk



Experiment 1

Pasta source (refrigerated)



Low temperature heating

C. botulinum type I spores survived

Cool down

Products (refrigerated)

Temperature abuse during transportation or handling of products by consumer

Spores germinate, and produce toxin.

Pasta source (refrigerated)

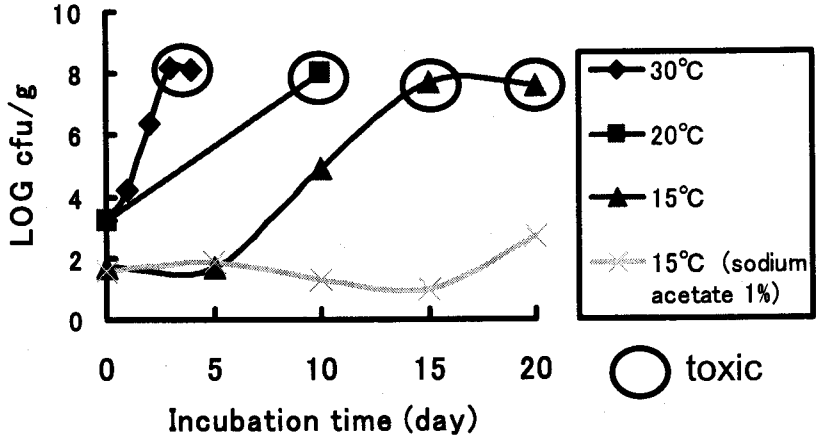
Analysis of pasta source samples inoculated with *C. botulinum* type I at refrigeration temperature.

①15℃, 20℃, and 30℃ incubation
- Carbonara source (pH 6.2)

②10℃ incubation
- Carbonara source (pH 6.2)
- Japanese style source (pH 5.2)
- Cod roe source (pH 6.2)
- Napolitan source (pH 4.3)
- Bolognese source (pH 5.0)

Result Viable cell counts of *C.botulinum*

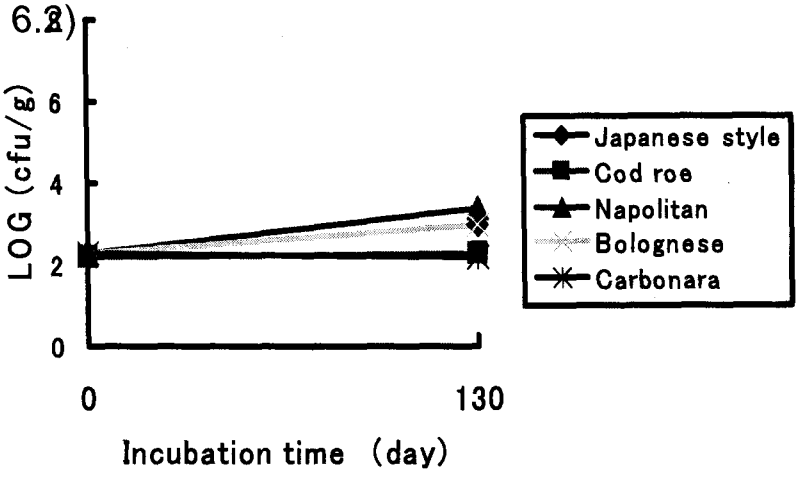
Carbonara source samples (pH 6.2)



The higher the incubation temperature was, the earlier the neurotoxin production started.

Result Viable cell counts of *C.botulinum* at 10°C

5 type of pasta source samples(pH 4.3 – 6.2)



No toxin was detected in all samples at 10°C

Experimental Summary

When *C. botulinum* spores was inoculated into the pasta source samples, toxin was detected in samples of incubation temperature 15°C or above.

No *botulinum* toxin was detected at 10°C.

Refrigerated pasta source products should be stored at 10°C or below to avoid the risk of botulism.

Packaged Food with Reduced thermal process

- Must be labeled "**Keep Refrigerated**"

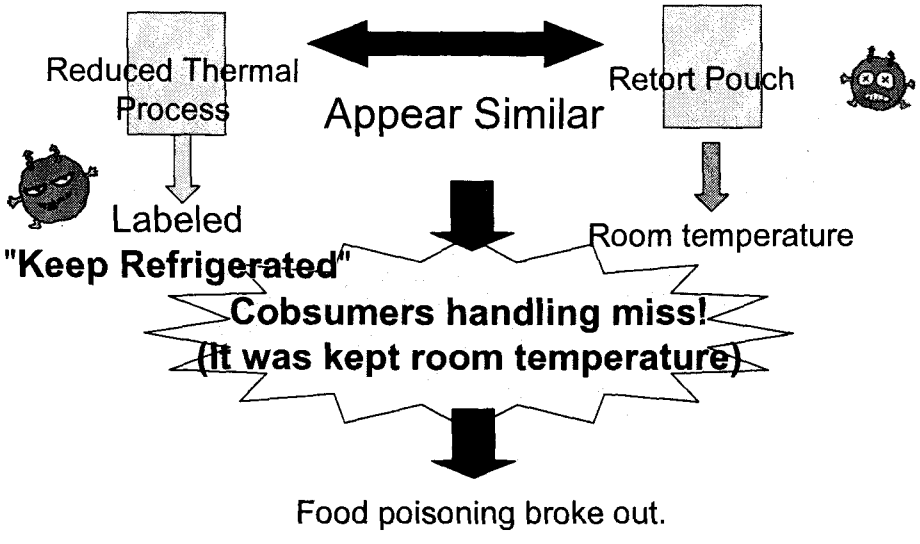
Food poisoning by *C. botulinum* past 10 years in Japan

Year	The number of cases	The number of patients	The number of patients each incident	Fatality	Toxin type	Cause of food poisoning
1996	1	1	1	0	A	Unknown
1997	2	4	3	0	E	Izushi
			1	0	E	Izuahi
1998	1	18	18	0	B	Green olives
1999	3	3	1	0	A	Unknown
			1	0	A	Ingredient of hashed rice
			1	0	A	Unknown
2000	0	0	0	0		
2001	0	0	0	0		
2002	0	0				
2003	0	0				
2004	0	0				
2005	0	0				
2006	1	1				

Food poisoning by *C. botulinum* inHashed Meat And Rice

Increasing of food poisoning by type A, B

The case of botulism Ingredient of hashed rice(1999)



Packaged Food with Reduced thermal process

- Must be labeled "**Keep Refrigerated**"

After the **Botulism incident** in 1999,

Guideline announced by the Ministry of Health, Labour and Welfare, Japan,

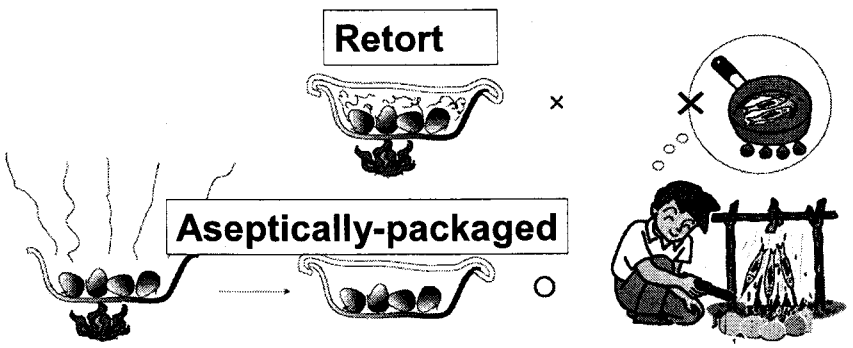
"Font size bigger than about 14 point" is required to get attention of consumer.

2) Retort vs. Aseptic packaging

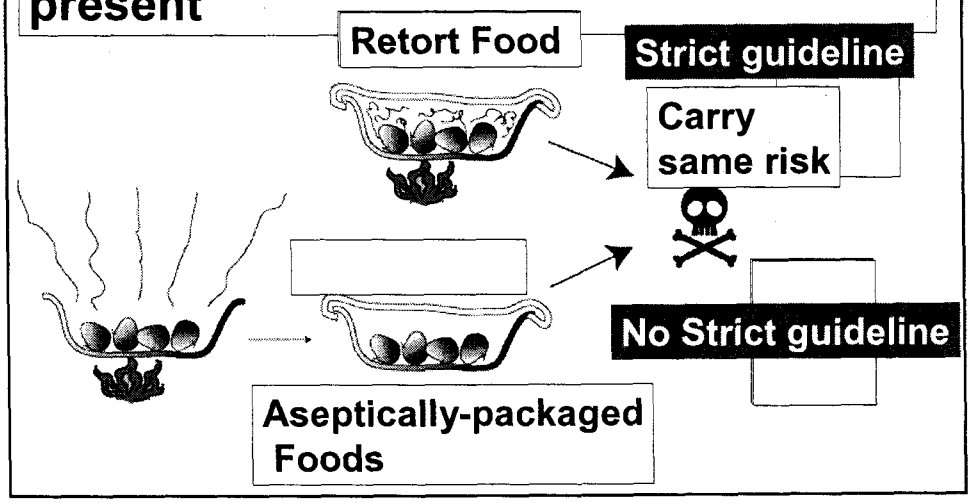
- ● Both produce a shelf-stable product that retains shelf-life for months to years
- ● Cost and expertise
- ● Product quality

Aseptically-packaged foods

- ● Product processed outside of **package**, then packaged under aseptic (sterile) conditions into a sterile **package**



Current problem on
Aseptically-packaged Foods in Janan
→ **At present, no strict guideline is present**

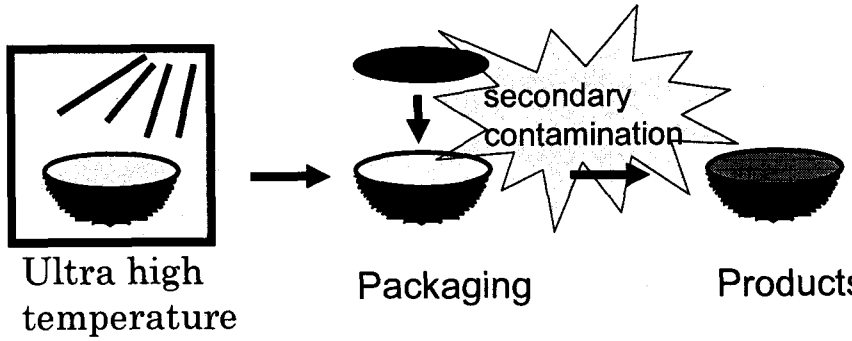


Arising Concerns of the Ministry of Health, Labour and Welfare, Japan (2005～)

Botulinum risk assessments for
Aseptically-packaged Foods

- Examples :
- cases of *botulinum* risk assessments
- ・Steamed pack rice
- ・Pasta sauce

Aseptically-packaged steamed rice



Still carry a slight risk of secondary contamination of *C. botulinum* spores.

Experiment 2

aseptic steamed rice products (pH control)

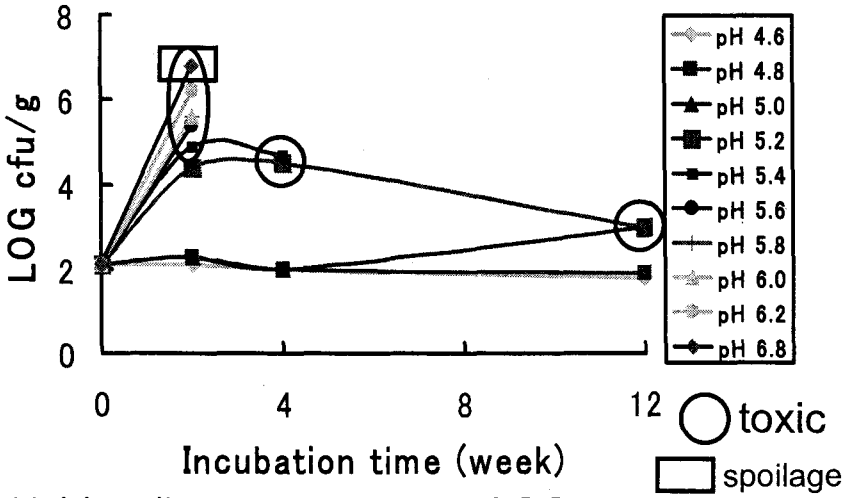
The rice was steam-sterilized using an ultra high temperature process of flash heatings.

pH was adjusted to 4.6 – 6.8

and

Modified atmosphere **containing 0% oxygen and a deoxidant pack**

Viable cell counts of *C.botulinum*



Initial *botulinum* count was 2.1 LOG.
C.botulinum significantly grows in sample pH 5.0 or above.

Experimental Summary

When *C. botulinum* spores alone was inoculated into the rice sample, botulinum toxin was detected in samples of initial pH 5.0 or above.

Aseptic steamed rice products must be adjusted to pH 4.9 or below to avoid the risk of botulism in the package where oxygen was eliminated completely.

Experiment 3

aseptic steamed rice products (pH 6.5)
(Oxygen concentration control)

The rice was steam-sterilized using an ultra high temperature process of flash heating.

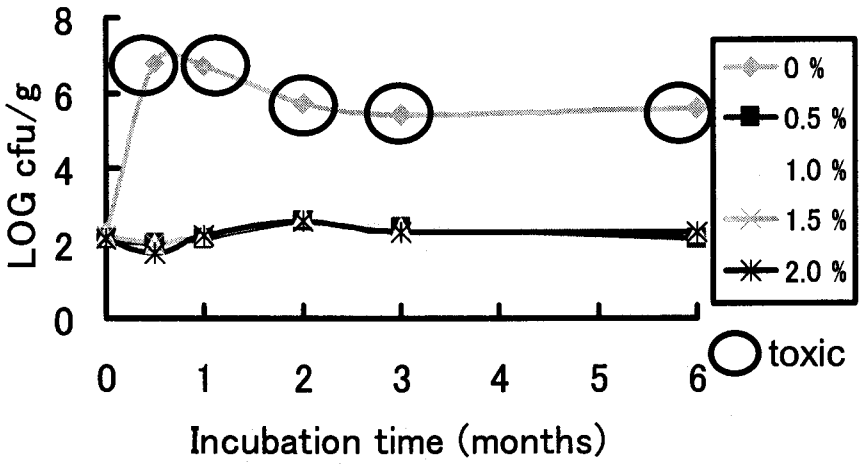
①*C. botulinum* alone was inoculated

O_2 con. 0, 0.5, 1.0, 1.5, 2.0%

②*Bacillus subtilis* was mixed

O_2 con. 2, 4, 6, 8, 10%

Viable cell counts of *C.botulinum*



C.botulinum counts increased in samples adjusted to initial oxygen con. 0%.

Experimental Summary

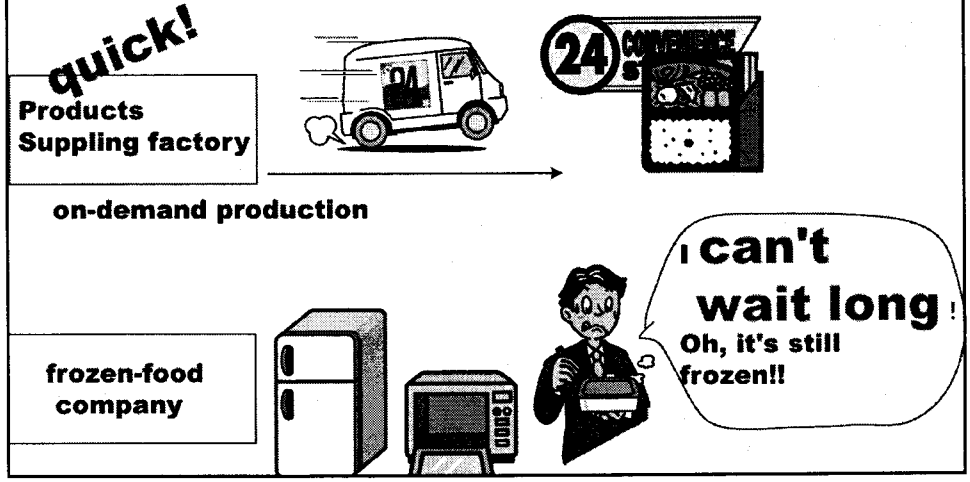
When *C. botulinum* spores were inoculated into the rice sample (pH 6.5) , *botulinum* toxin was detected in samples of initial oxygen concentration 0%. However, when package contains more than 0.5% oxygen, *C.botulimum* did not grow and produce toxin.

We conclude that aseptic steamed rice products must be adjusted to oxygen concentration 0.5% or above to avoid the risk of botulism.

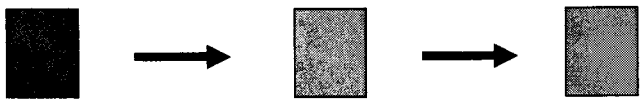
Caution!→With the contamination of other bacteria consuming oxygen, the minimum oxygen concentratio to ensure safety would be higher.

3) T**rends in frozen food** consumption

Chilled processed food is replacing frozen processed food as the favourite processed food of the Japanese consumer



Frozen foods

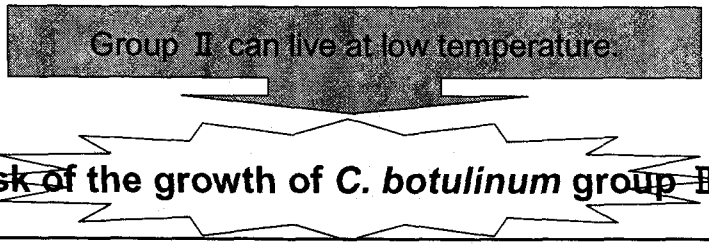


Store	consumer	toxic
Freezer storage	Refrigeration	In a few days of storage
Non-ploteolytic *C. botulinum* spores exist →	Germination and growth →	They produce toxin under refrigeration

Non-proteolytic *C. botulinum* may grow and produce toxin as low as 3℃.

Clostridium botulinum group Ⅱ

- Non-proteolytic
- Grow and **produced toxin at temperatures as low as 3.3 to 4℃**
- Produce type B, E and F toxins.
- Group II spores are less heat-resistant than group I spores.



Experiment 4

Frozen foods

Analysis of frozen foods inoculated with non-proteolysis *C. botulinum* at refrigeration temperature.

①5℃, 10℃, and 15℃ incubation

Hamburg steak (pH 5.5)
Shrimp chili source (pH 6.0)
Chinese bowl source (pH 6.8)

②Growth curve of non-proteolytic *C. botulinum* at 10℃

Hamburg steak (pH 5.5)

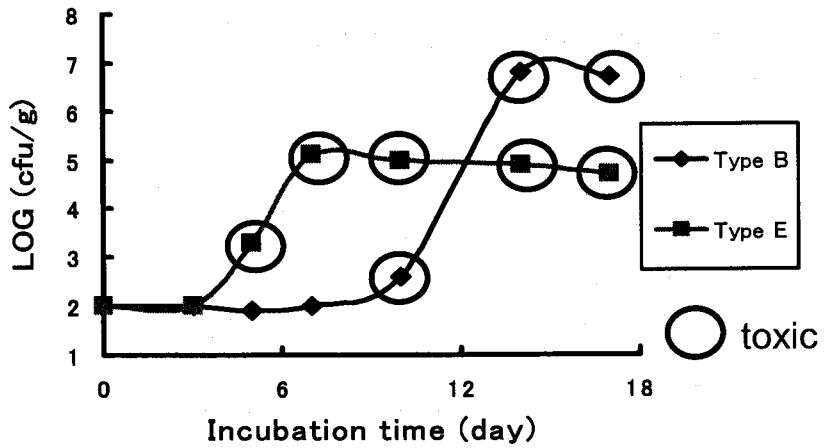
Result ①5℃, 10℃, and 15℃ incubation

Sample type	Incubation time [℃]	First toxin detection times [days]
Chinese bowl	5	7<
	10	5
	15	3
Shrimp chili sourc	5	7<
	10	7
	15	3
Hamburg steak	5	7
	10	5
	15	3

Initial *C. botulinum counts* 2.0 LOG cfu/g.
Samples were incubated for 7 days.

Toxin was detected in a few days of Incubation at low temperatures.

Viable cell counts of *C.botulinum* at 10℃
Hamburg samples at 10℃ (pH 5.5)



Type E toxin was detected after 5 days of Incubation at 10℃.

Experimental Summary

When non-proteolytic *C. botulinum* was inoculated Into frozen foods, toxin was detected after 3 days of incubation at 15℃.

At 5℃, frozen hamburg steak samples was toxic after 7 days of incubation.

When consumer keeps frozen food at refrigeration temperature, it must be cosumed within 2 days of storage.

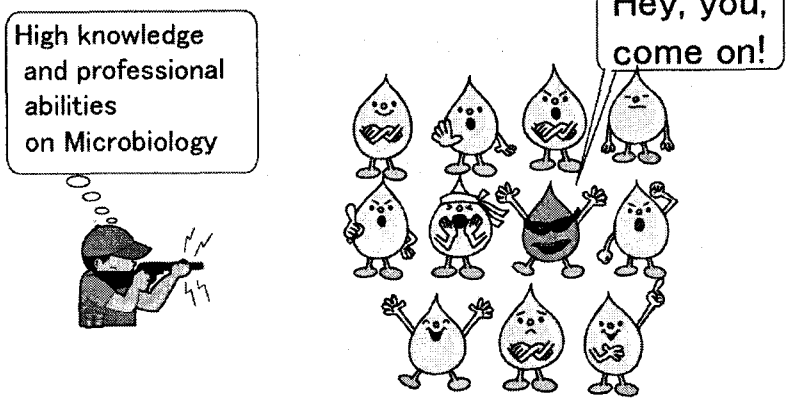
4) **Reduced amount of antimicrobial additive :consumer benefits**

vs

discarding packaged meals whose shelf life has expired

Futrure Prospect: Packaged Food and Food Safety....

- Must be ensured with **a combination of reduced barriers**



Increasing Microbiological Risk