

北九州小倉・糠床糠炊き研究会

The Research society for beds of rice-bran (Nuka-Doko, 400 year history), fermented by lactic acid bacteria and yeast fungus, used for pickling vegetables (Nuka-Zuke) and flavoring boiled blue-backed fish (sardine, mackerel : Nuka-Daki) as healthy traditional dishes in Kokura, Kitakyushu-City, Japan



糠漬け (upper : Nuka-Zuke)

糠炊き (lower : Nuka-Daki)



糠床

(Nuka-Doko)

Nuka-Doko and Nuka-Zuke

Pickling vegetables in Nuka-Doko
One of the Japanese traditional food culture

Kitakyushu-Kokura Nuka-Doko, Nuka-Daki Kenkyukai
Hiroshi Kimura



Nuka-Doko



Nuka-Zuke

What is Nuka-Doko ?

A Nuka-Doko, a bed of rice-bran, is composed of rice-bran as a main starting material, mixed with appropriate amount of water and salt, and preferably with a high-quality starter which is fully fermented and aged rice-bran by the combination of lactic acid bacteria and yeast fungus, used for pickling vegetables. By repeated pickling of various vegetables in a Nuka-Doko at an appropriate temperature (20-25 C) and by taking out pickled ones, lactic acid bacteria and yeast fungus in addition to enzymes in vegetables ferment sugar (glucose), oils (rice-bran oil) and amino acids to produce special flavor which is absorbed in pickled vegetables to be Nuka-Zuke. This is rare fermented food in the world.

Nuka-Dokos



Nuka-Zuke



Nuka-Daki



Macherel



Sardine

Roots of a Nuka-Doko in Japan

There is a historical description (as letters) in history books edited by Tokyo Univ on the Hosokawa family in Kokura castle. Tadaoki Hosokawa was a ruler of the northern area of Kyushu. In the old letters between Tadaoki and his son, Tadatoshi (in 1626 and 1628), there is a description that a Nuka-Zuke of eggplant was sent to Tadaoki in a different place by his son, and his father satisfied with the Nuka-Zuke very much. Therefore, it was demonstrated that Nuka-Doko was already existed early in the 17th century in Japan.

Nuka-Zuke & Pickles

Nuka-Zuke once may be taken as preserved vegetable food like pickles in US. But at present, it's not. Because it is eaten up in one or two days after taking them out of a Nuka-Doko. In Kitakyushu-City, especially in Kokura district, comparatively many family own their Nuka-Doko, and they pickle seasonal vegetables with Nuka-Doko. Nuka-Zuke is eaten as a side dish for breakfast and supper.

Nuka-Doko at present time

However, at present, Nuka-Doko is not so popular among younger generations, 20s and 30s. One of the Japanese traditional fermented food is getting forgotten. This is the same phenomenon as in other traditional food in Japan.

This is why we, the research group, have been handing down the expertise and skills on Nuka-Doko by setting public lectures and training sessions for adults and children.



Kokura Castle



Kitakyushu City Hall

**In order to overcome the present stagnant situation,
new approaches and challenges were presented
by Kitakyushu City itself
to reactivate the traditional food culture of Nuka-Doko and
to propose modern and new fashion for the foodculture.**

**Challenges, “HAKKO JAPAN in KYUSHU 2015”
(fermentation)**



目指せ、
発酵美人。



ぬか小町
北九州のぬか文化を全国へ!

Hiroshi

郷土料理研究家に教わるなどして
ぬか炊き料理を学んでいる



ぬかまたはぬか炊きを使った、
オリジナルレシピ大募集
2015年8月18日~10月9日

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Teaching how to make Nuka-Daki in TV

Promotion girls for the Nuka-Doko culture



Hiroshi

Opening tape-cut for the big event



**A competitive show
for new proposals using
Nuka-Doko & Nuka-Daki**



**A variety of new cooking was
proposed by students, general
citizens and professional cooks
for the competition.**

Judges for the new cuisine using Nuka-Doko & Nuka-Daki



Bagna Cauda as Grand Prix by a restaurantowner



Visit the related site

<http://hakkou-japan.com/>



**New ways
of taking
Nuka-Doko
&
Nuka-Daki**

Hiroshi



Health checkup of Nuka-Dokos of the visitors in the event.

pH, NaCl% 、 odor, taste, and moisture of their Nuka-Dokos were checked by specialists.



Training session for Nuka-Doko by Hiroshi's wife

Pickling processes using Nuka-Doko in Japan

Pickling of various vegetables using a Nuka-Doko is performed batch-wise in every home as well as in Nuka-Zuke shops in Kitakyushu-city Japan. A continuous pickling process is not applicable because a Nuka-Doko is a mud-like composition and because several kinds of vegetables are pickled all at once. A Nuka-Zuke taken out of a Nuka-Doko is adhered by Nuka-Doko (or called Nuka-Miso) Therefore, it is removed by washing before eating. These processes are different from those for “Pickles” in US.

Recently, a Nuka-Doko in a liquid phase has been developed and commercialized. However, the flavor typical to fermented Nuka-Doko has not been fully reproduced. Therefore, Nuka-Zuke produced by using a conventional Nuka-Doko is preferred by consumers who know the real taste and flavor of Nuka-Doko and Nuka-Zuke.

Nuka-Dokos to prepare Nuka-Zuke

I have seven Nuka-Dos below for experiment, three rice-bran based and four not rice-bran based. My wife's are larger rice-bran based ones.



**Hiroshi's Nuka-Dokos
(for experiment)**

Net content :

1Kg, 1kg (left), 3Kg(right)

1Kg(left), 3Kg(right)

**2Kg(left), 2Kg(right)
(not rice-bran based)**

My wife's Nuka-Doko

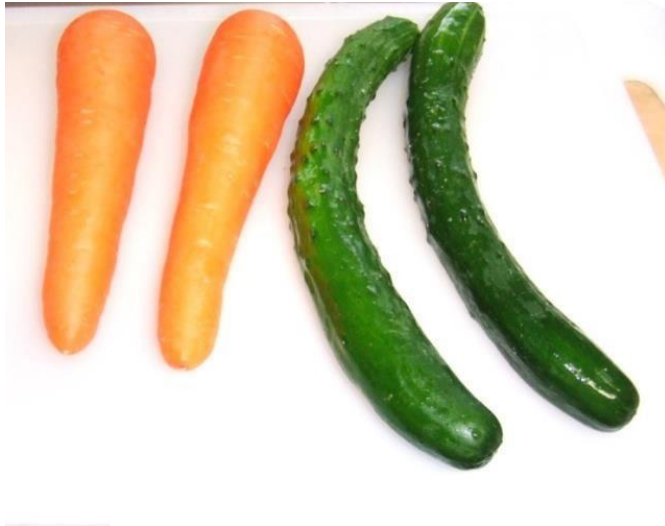
Net content :

12Kg(left), 6Kg(right)

My wife's Nuka-Dokos
Hiroshi's Nuka-Dokos

In Hiroshi's

Preparation of vegetables before pickling (in case of root vegetables)



Cucumber and carrot are washed and adhered water is removed with paper towel. Carrots are peeled totally, and cucumbers peeled as shown in the right figure (two lines). Rub very small amount of salt on the peeled surface of the vegetables to promote pickling.

If vegetables are weighed before and after pickling, water flown out from vegetables divided by the original weight can be an index of pickling degree. But it depends on the kinds of vegetables.



Pickling vegetables (cucumber and carrot)



Push vegetables completely inside the Nuka-Dokos

Pickling time of vegetables at 20-25°C

Cucumbers 8hrs

Carrots 10hrs

(depends on preference of people)

Vegetables used for Nuka-Zuke

Spring bamboo shoots, bracken, broccoli, cabbage,
asparagus

Summer eggplant, cucumber, Japanese ginger, okra,
green soybeans, paprika, Konjac, celery,
tomato, spaghetti squash,. pumpkin

Autumn/Winter Japanese white radish, turnip,
carrot, lotus root, yam, chayote,
Italy (peel)

Delicacy avocado, banana

Degree of pickling

**Quick pickled
(Asa-Zuke*)**

**Well-pickled
(Furu-Zuke**)**

Sour	slight	very sour
pickling time, hr	5-6	10-24
Temp, °C	20-25	20-25
weight loss, %	≈8	>10
taste	taste bland	dark taste
	like vegetable salad	

***vegetables lightly preserved in salt**

****stir fry cut Nuka-Zuke with little oil, and red pepper is added to be **a very nice dish when drinking.****



Asa-Zuke



Stir fry of Nuka-Zuke

Nuka-Zuke cuisine by the Japanese restaurant, “Ajidokoro-Yano”, owned by “Sumico”, a popular jazz singer

(She is one of the advisers for our research group, and her sensory taste and smell are extremely sensitive)

Preparation of a Nuka-Doko by Kimura

Materials

① rice-bran (raw and fresh)	1000g
② salt (natural)	140g
③ water (natural)	1400-1600g
④ starter (high quality fermented rice-bran)	150g 200g
⑤ cucumber (grated)	5g
⑥ kelp (chopped)	2.5g
⑦ red pepper (chopped)	

Into a plastic container (5ℓ), 1600g of water and 140g of salt are charged, and agitate the mixture to make a homogeneous solution.

Then, 1000g of rice-bran is charged and mix the content to make a rice-bran suspension. Then, a starter, grated cucumber, chopped kelp and red pepper are charged, and mix the content homogeneously.

Then, the final mixture is filled in a transparent tapperware (5-ℓ).

The reason why a transparent container is used is to observe the initiation of the fermentation and aging processes. Dramatic change in state of a Nuka-Doko is observed during the initial fermentation and aging processes.

The function of each material for a Nuka-Doko

- ① Rice-
bran** a resource of glucose and related sugars, and initial lactic acid bacteria source.
- ④ a
starter** fermented and aged Nuka-Doko to promote the fermentation of a newly prepared Nuka-Doko.
- ⑤
cucumber** a supply source for glucose and lipoxxygenase a supply source for sodium glutamate as a
- ⑥ kelp** starting material for propionic acid as a major fermented odor of a Nuka-Doko. It is also a supply source for taste. In Japan, Rausu kelp has the highest content of gultamate. Its price is twice or three times higher than general kelps.
- ⑦ red
pepper** capsaicin is antibacterial and promotes lactic acid fermentation
- ⑧
Sansho** fruit of Japanese pepper, sanshol also functions as red pepper
- ⑨** citron pericarp is often used as additional flavor

(1) Observation of fermentation of a newly prepared Nuka-Doko without using a starter

About 2-3 months are required for the completion of the fermentation as shown in Fig 1.

(2) Observation of fermentation of a newly prepared Nuka-Doko with using a starter.

Only two weeks are required for the completion of the fermentation followed by the primary aging, as shown in Fig 2. A significant decrease in pH by promoted fermentation due to the addition of a starter was clearly observed.

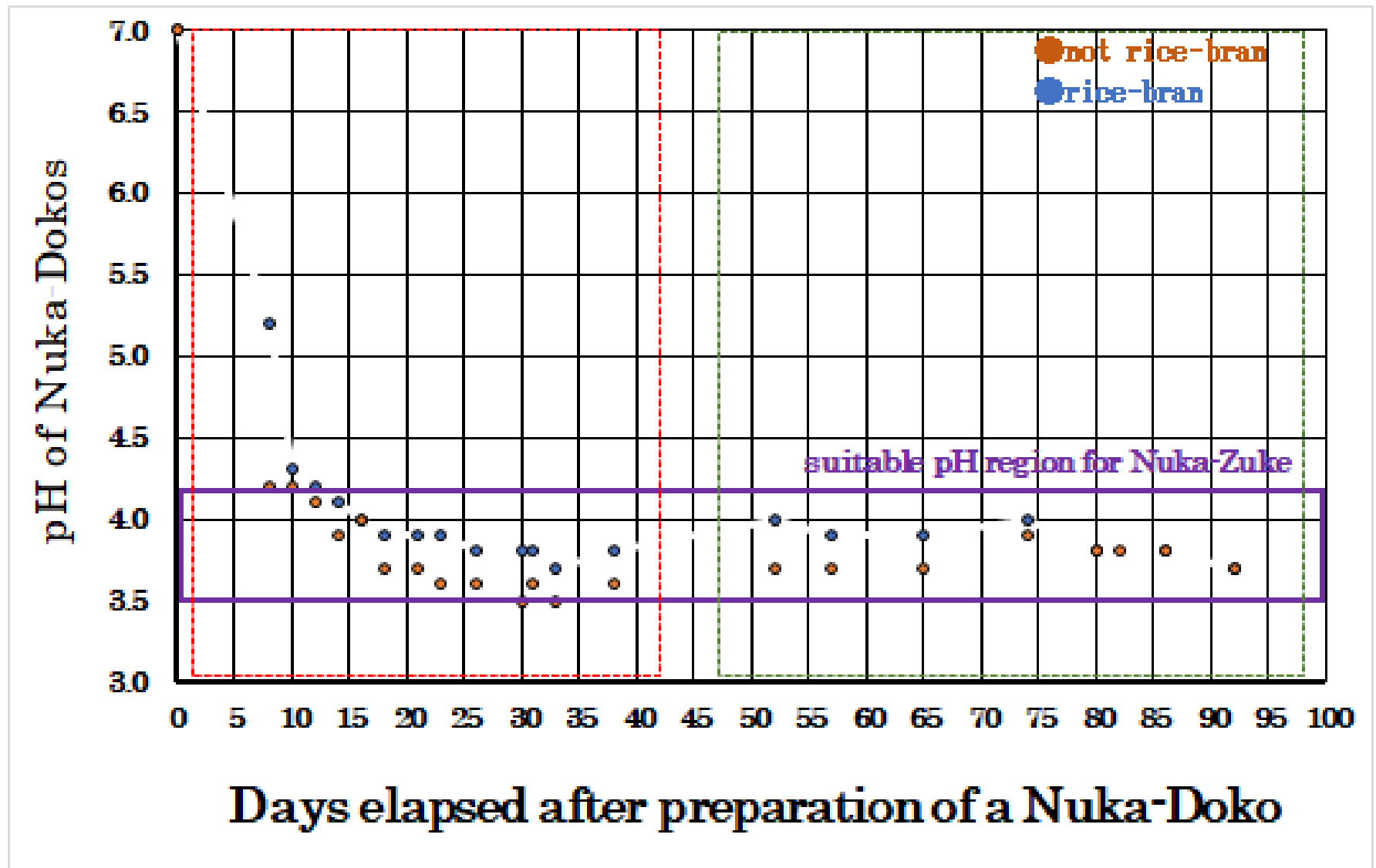


Fig 1 Fermentation of a Nuka-Doko without using a promoter

A starter is “a fermented and aged Nuka-Doko with high quality” maintained by continued careful daily care of a Nuka-Doko.

It is mixed with raw rice-bran when preparing a new Nuka-Doko to promote fermentation and to attain the same flora of a starter for a newly prepared one.

suitable pH region for Nuka-Zuke

After the initial two weeks, pickling of favorite vegetables can be performed to prepare Nuka-Zuke. And red pepper, Sansho (Japanese pepper), pericarp, and kelp are added further depending on preference of a owner of Nuka-Dokos.

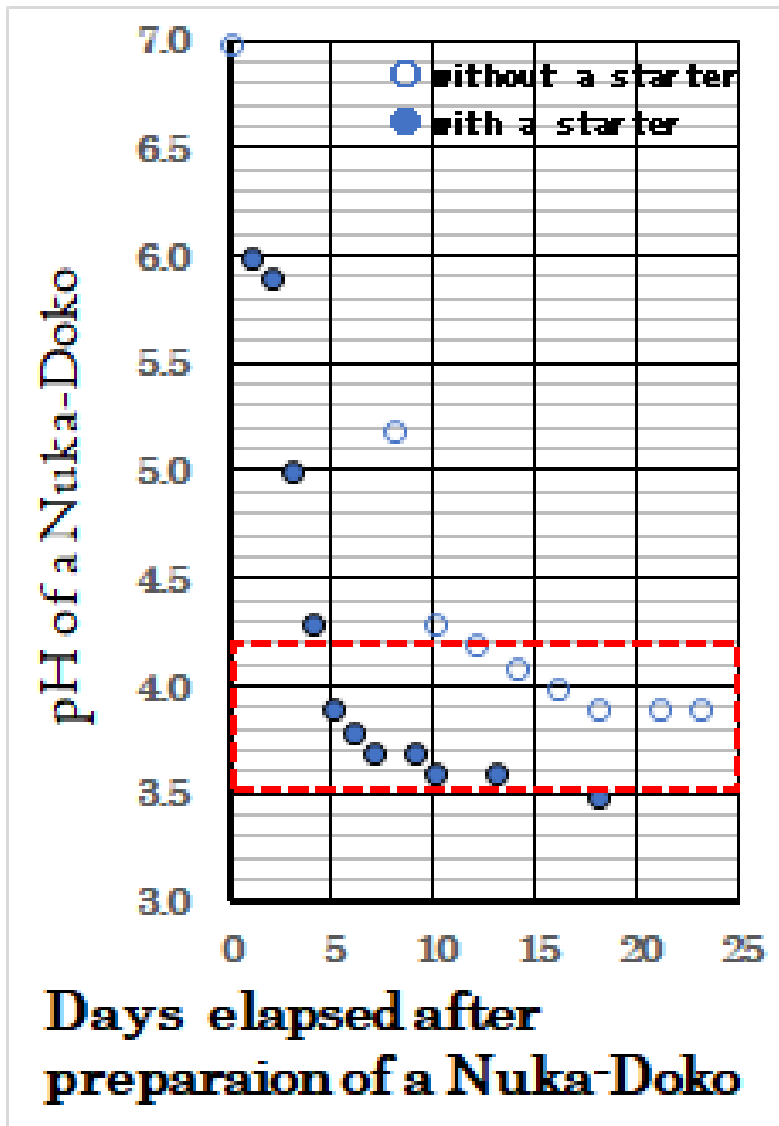
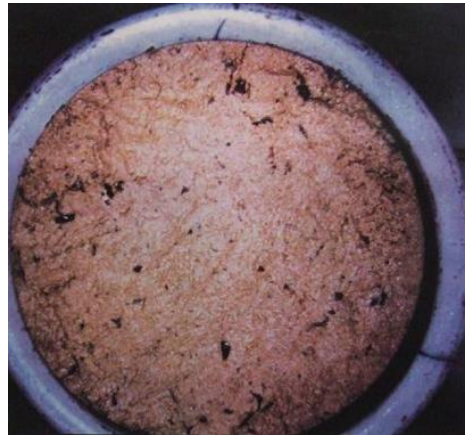


Fig 2 Effects of a promoter on the fermentation of a newly prepared Nuka-Doko

(3) Comparison of starters

Comparison of fermentation processes of newly prepared Nuka-Dokos promoted by three different starters from Dr. Iai's and two advisers, Ms. Hatano and Ms. Yano for our research group was performed as shown in Fig 3 and following pictures of Nuka-Dokos. Dr. Imai, who was the top adviser for our research group, revealed the versatility of the fermentation process of Nuka-Dokos for the first time in 1980s by detailed experiments. He was a pioneering top scientist in the science of Nuka-Doko fermentation.



Dr. Imai's Nuka-Doko, 150 years old then, highly aged with high quality.



Dr. Imai, Hiroshi and Ms. Yano After his lecture in the university.

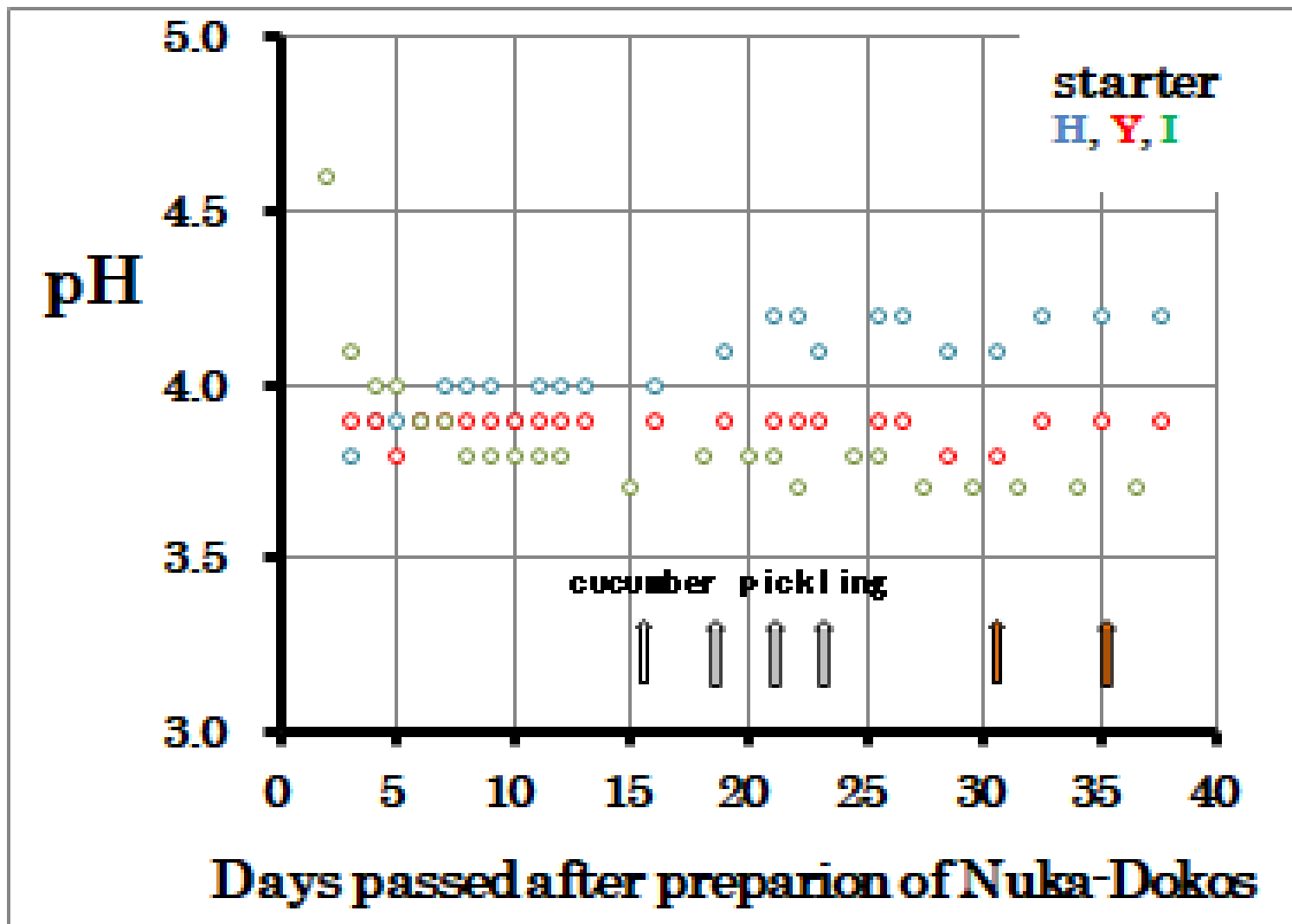


Fig. 1 pH change after the preparation of Nuka-Dokos using three persons' different starters

(I indicates Dr. Imai's, Nuka-Doko, 150 years at 1995)



2015.9.15 5:31:52 (8164)

2015.9.15 5:32:04 (8165)

2015.9.15 5:32:12 (8166)



2015.9.15 5:33:02 (8167)

2015.9.15 5:33:12 (8168)

2015.9.15 5:33:26 (8169)



2015.9.15 17:42:16 (8179)

2015.9.15 17:43:00 (8181)

2015.9.15 17:43:36 (8183)



2015.9.15 17:42:30 (8180)

2015.9.15 17:43:10 (8182)

2015.9.16 04:10:50 (8184)

Expansion of Nuka-Dokos by the generation of CO₂ proceeded greatly, and a water phase (depth: 15-20mm) is observed at the bottom of Nuka-Dokos.



Day 2.5

2015.9.16 04:12:32 (8186)



Day 2.5

2015.9.16 04:13:06 (8187)



Day 1.5

2015.9.16 04:11:50 (8185)



Day 2.5

2015.9.16 04:33:42 (8191)

Growth of white film yeast is observed at the upper edge of the container.

The expansion almost completed at Day 2.5, and then contraction proceeded.



2015.9.16 04:14:20 (8188)



Day 3.0

Day 3.0

Day 2.0

1015.9.17 04:37:30 8194

1015.9.17 04:38:18 8195

1015.9.17 04:38:54 8196



1015.9.17 04:39:36 8197

1015.9.17 04:39:48 8198

1015.9.17 04:40:02 8199

The growth of white film yeast over the upper surface of Nuka-Dokos proceeded greatly first for the left Nuka-Doko started by Hatano-Doko. Hatano-Doko generates excellent fermentation odor. produced by yeast. Within four days after the preparation of Nuka-Dokos, a pH of a Nuka-Doko decreased to less than 4.



1015.9.18 04:47:20 8205

1015.9.18 04:48:26 8207

1015.9.18 04:49:22 8209



1015.9.18 04:47:40 8206

1015.9.18 04:48:40 8208

1015.9.18 04:49:36 8210

Dramatic expansion of a Nuka-Doko due to CO₂ generation, followed , by the growth of white film yeast, was completed within 4-5 days after the preparation of a Nuka-Doko. But it depends on temperatures . Foam sound by the generation of CO₂ was also listened.

Influence of accumulated water by repeated pickling of vegetables on the fermentation of Nuka-Dokos, and corresponding treatments

Addition of salt as well as rice-bran should be performed in the daily use of a Nuka-Doko. Because water liberated by repeated pickling accumulates in a Nuka-Doko, resulting in a decrease in a concentration of salt of a Nuka-Doko and an increase in moisture of Nuka-Dokos .

These additional treatment, especially addition of salt is very important to keep the health of a Nuka-Doko.

If the additional treatment is ignored, an acid % of a Nuka-Doko rapidly decreases (●) to deteriorate a Nuka-Doko resulting in unpleasant odor and taste. This is because unnecessary microorganisms (●) producing unpleasant odor and taste increase rapidly from Day 7 as shown in Fig 4.

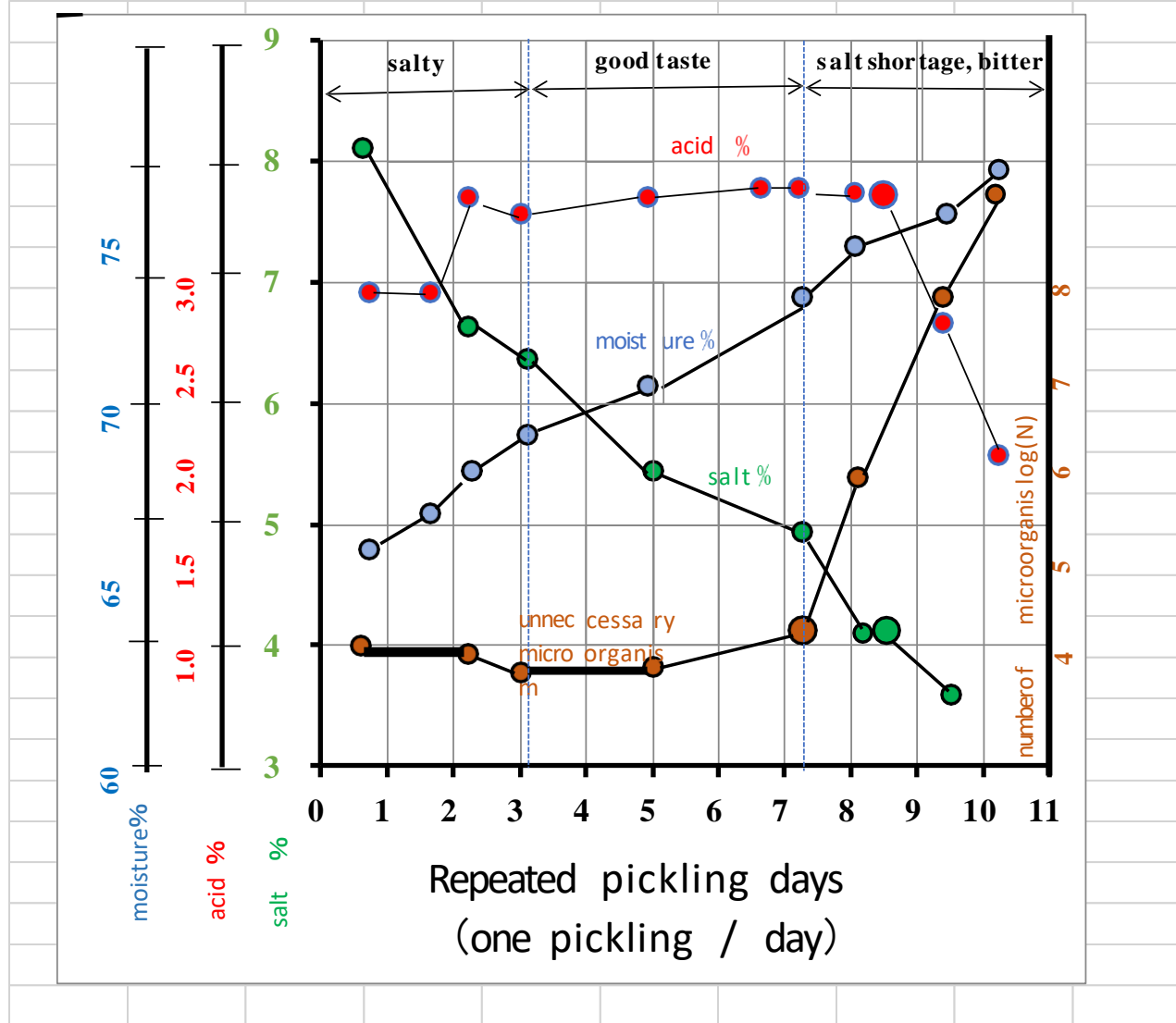
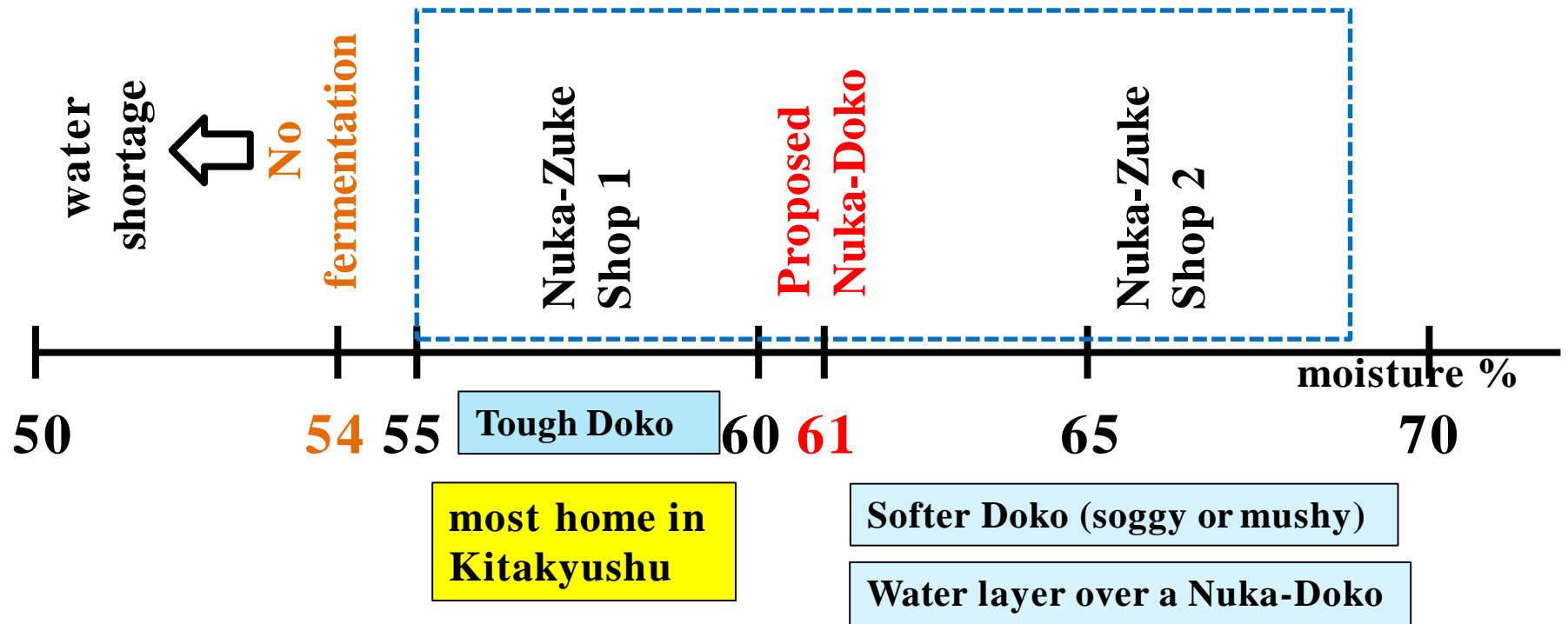


Fig. 4 Influence of repeated pickling on a Nuka-Doko

M. Imai, *Nippon Nougai Kagaku Kaishi*, 57 (11), 1105-1112 (1983).
 The original figure was remade as Fig 4.

Effect of moisture % of a Nuka-Doko on the fermentation of Nuka-Dokos



**Softer Doko : easy fermentation and pickling;
deteriorate at higher temperatures than 35°C**

Aroma is different between the two types of Nuka-Dokos.

Flavor produced in a Nuka-Doko

Flavor typical of fermented Nuka-Doko is produced by the series of enzyme reactions based on yeast starting from sodium glutamate. Kelp is a major resource for the amino acid. Details about the flavor produced in a Nuka-Doko was reported by Dr. Imai in 1980s. He revealed the universality of the fermentation of a Nuka-Doko for the first time in 1980s.

M. Imai, Nippon Nougai Kagaku Kaishi, 57 (11), 1105-1112 (1983).

The content of flavor compounds in a fermented and aged Nuka-Doko is less than 100 ppm. Most of them are oil-soluble and are existed with rice-bran containing rice-bran oil which is also a source for γ -lactones (mainly C₉, peach like odor) as an important aroma in aged Nuka-Doko.

Therefore, separation of fermented rice-bran from a Nuka-Doko for increased productivity for Nuka-Zuke degrades the quality of it significantly. Nuka-Zuke greatly. Because oil-soluble flavor are lost. The higher the productivity for Nuka-Zuke is, the lower the quality of Nuka-Zuke is.

Volatile lower carboxylic acids constitute 75% of the flavor of a Nuka-Doko, among which a content of propionic acid ($\text{CH}_3\text{CH}_2\text{COOH}$) is 54 ppm as shown in Fig 5.

Aroma produced in a fermented Nuka-Doko

		ppm	(%)
①	volatile carboxylic acids	70.4	74.2
②	esters	6.5	6.8
③	alcohols	6.0	6.3
④	phenols	3.9	4.1
⑤	S, N-containing compds	3.9	4.1
⑥	S, N-containing compds	2.2	2.3
⑦	carbonyl compds	1.5	1.6
⑧	hydrocarbons	0.5	0.5
	Total	94.9	100

Imai, J. Japan Association of Food Preservation Science, 21 (3), 161-178(1995)..
Imai, Shokuno Senmon Zasshi, 107(1), 41-45(2013).

Pro pionic acid 54.5 ppm, acetic acid 3,2 ppm, Butyric acid 1.1 ppm
C9 γ -lactone 1.7 ppm

Sensory test & Principal Component Analysis for Nuka-Zuke

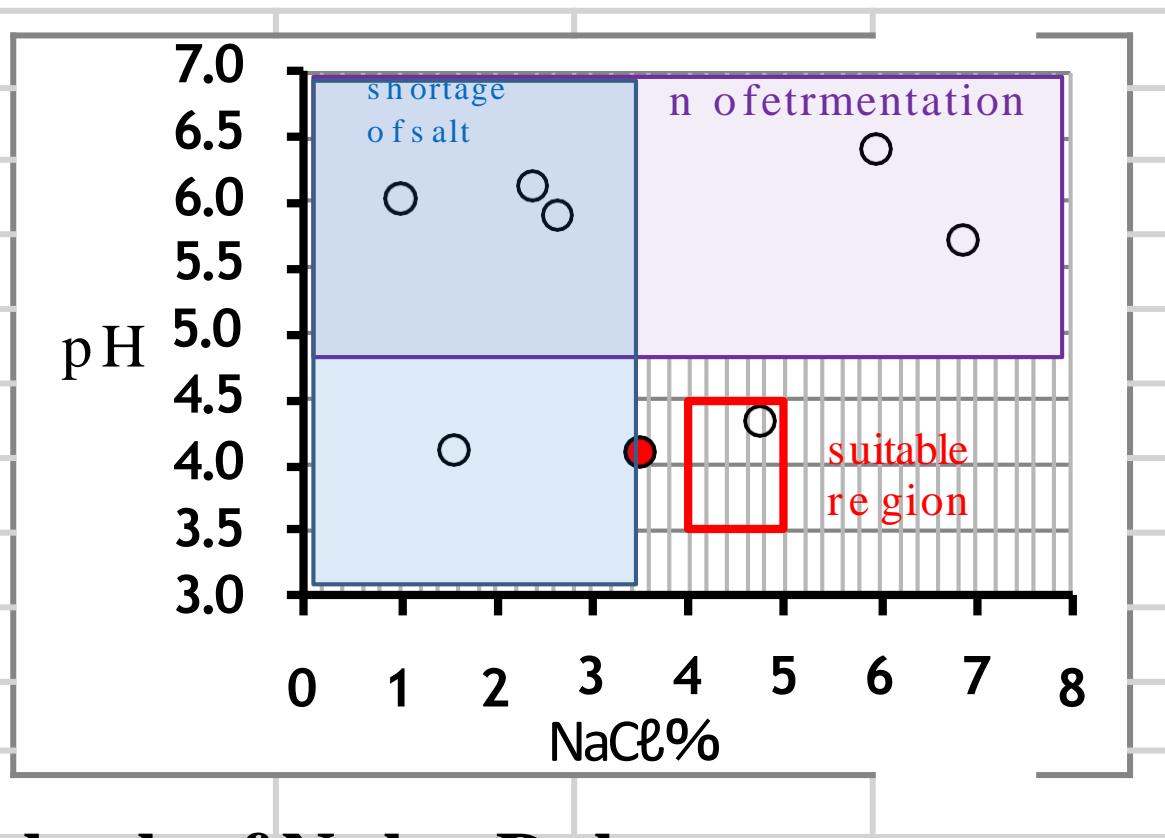
Estimation items

- 1. fermentation and aged flavor of Nuka-Dokos**
- 2. sour taste**
- 3. flavor of vegetables (freshness)**
- 4. sweetness**
- 5. bitterness**
- 6. irritation**
- 7. good to eat or no good**
- 8. requested preference for the Nuka-Zuke samples**



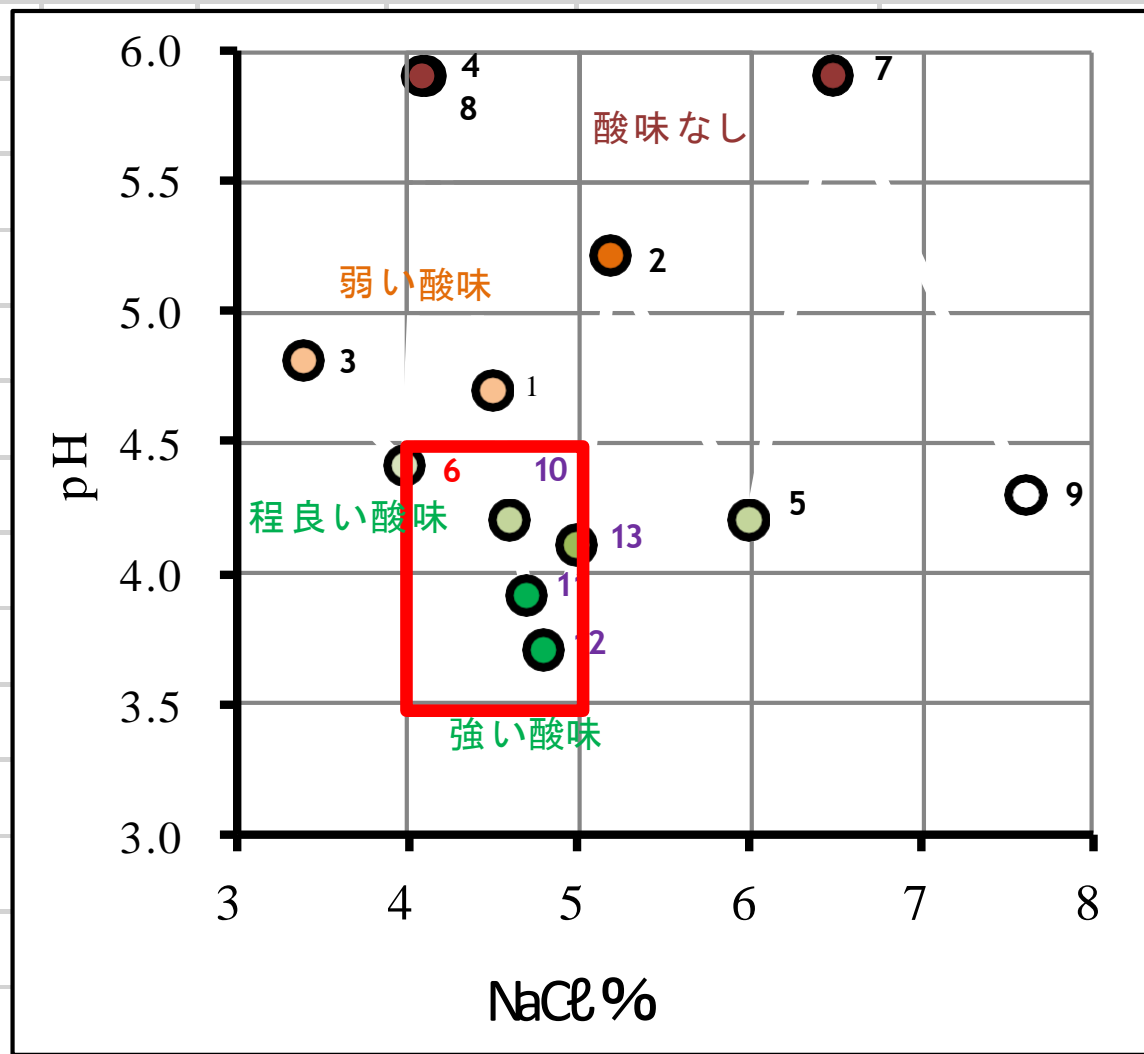
**Pickling of sliced cucumber and its sensory test
(pickling time, 20 mins at 25 °C)**

	NaCl%	pH
1	3.5	4.1
2	4.8	4.3
3	6.0	6.4
4	6.9	5.7
5	2.4	6.1
6	2.7	5.9
7	1.1	6.0
8	1.6	4.1
9	0	0



Health check of Nuka-Dokos of the visitors to HAKKO Japan 2015

- in the square is no good because excess Shansho was added resulting in deterioration of her Nuka-Doko (no fermentation odor)
- is the best Nuka-Doko. She was a housewife of a large family. She picked large amount of vegetables resulting in a significant decrease in NaCl%. I told her to add salt and rice-bran as fast as possible.



	塩分	pH
1	4.5	4.7
2	5.2	5.2
3	3.4	4.8
4	4.1	5.9
5	6.0	4.2
6	4.0	4.4
7	6.5	5.9
8	4.1	5.9
9	7.6	4.3
10	4.6	4.2
11	4.7	3.9
12	4.8	3.7
13	5.0	4.1

Health check of Nuka-Dokos of the members of our research group including the two advisers, Ms Hatano and Ms Yano (Nuka-Zuke shop owners)

Training session for Nuka-Dokos

Kitakyushu Kokura Nuka-Doko, Nuka-Daki Kenkyukai

<http://www.nukaken.jp>

*What's
Nuka-
Doko*

Materials of Nuka-
Doko and their
function

Bodily sensation
of fermentation of
a Nuka-Doko



Pickle seasonal
vegetables

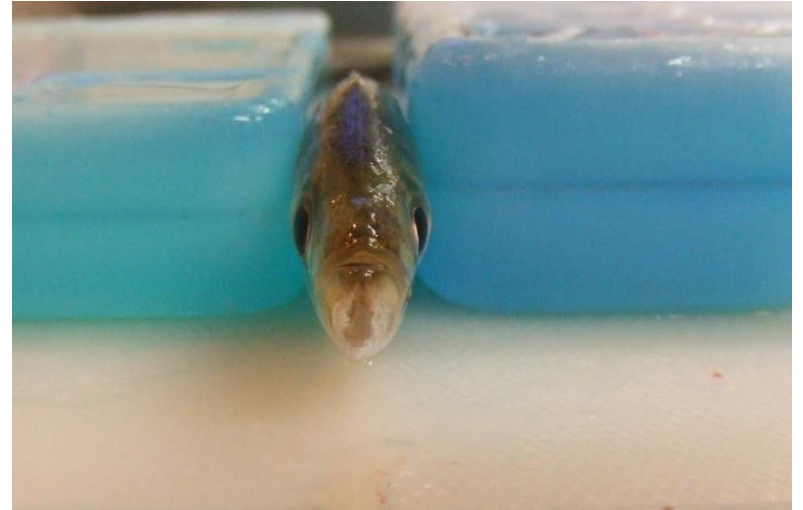
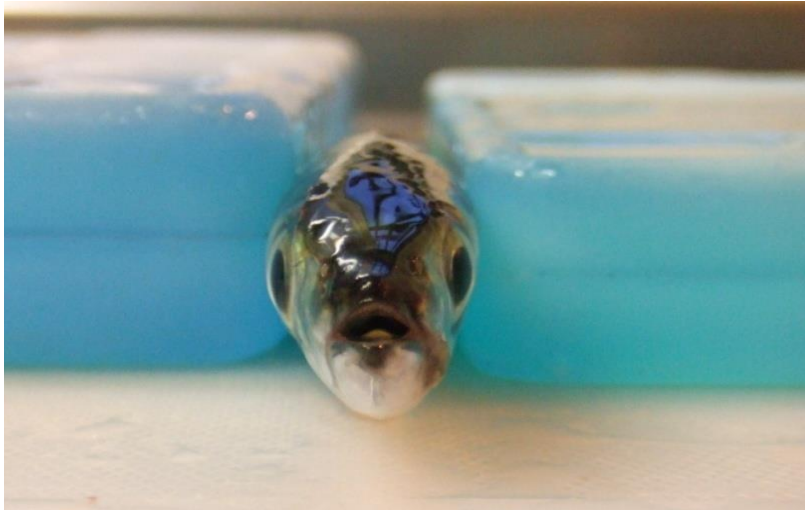


*What's aroma
of Nuka-Doko*



**White film yeast
Don't throw away**

**For maintenance
for health
of a Nuka-Doko**



Hi !

Which is mackerel used for Nukla-Daki ?



meckerel



Sardine

**Nuka-Dokos are basis
for Nuka-Zuke and Nuka-Daki**

My research targets

- 1. To reproduce the taste of the Nuka-Daki which my aunt used to prepare for us (more than 60 years ago) . She has a large Nuka-Doko then. Recently, taste of Nuka-Daki drastically degraded due to shortage of fermented Nuka-Doko and use of excess amount of seasoning such as Shoyu, Mirin, sugar and Japanese Sake. Traditional real taste of Nuka-Daki was already lost in the related markets. Recent younger generation do not know the taste of Nuka-Daki**
- 2. To develop high quality Nuka-Dokos with highest productivity by fastest fermentation.**
- 3. To improve texture or mouth-feel of Nuka-Daki of mackerel**
- 4. To commercialize non-rice bran based Nuka-Doko**



1951

1968



My aunt and me



Dr. Imai, Hiroshi and Ms. Yano after the second lecture by Dr. Imai at the University of Kitakyushu in 2014.



Hiroshi

Ms Yano

Ms Hatano