Buckwheat: its utilization in Japan and our buckwheat research

K. IKEDA\textsuperscript{1}, I. KREFT\textsuperscript{2}, Y.ASAM\textsuperscript{3} and S. IKEDA\textsuperscript{1}

1 Kobe Gakuin University, Kobe, Japan
2 Slovenian Forestry Institute, Ljubljana, Slovenia
3 Ryukoku University, Otsu, Japan
Buckwheat is a traditional food in Japan. There is the oldest description on buckwheat on 8th Century. Some information suggests that cultivation of buckwheat originated from 5th Century.
Re-attention to traditional foods such as buckwheat is currently growing.

Title: Analysis of the Power of Buckwheat (2013)
There are many TV programs about buckwheat in Japan.

Buckwheat noodle-making contests are often held. There are their grade examination systems.
This is Wanko Soba (North region of Japan). I had 60 cups.
Izushi Soba near Kobe.  

Izumo Soba near Kyusyu
There are many buckwheat noodle shops even on Shinkansen-line. !
Zaru (bamboo basket) soba

Funny-woman noodles (okame soba)

Tempura-soba

Ten-Zaru soba

Noodles with herring

Soba-Sushi
Buckwheat noodles with fish dumplings
Buckwheat noodles with soybean curd
Noodles with grated radish

Noodles with fried wheat dumplings
Buckwheat sprout as a vegetable
Ita (board) Soba
Yamagata region

Soba with seaweed
Niigata region
Buckwheat kome (groats)

Tokushima prf.

Yamagata prf.
Buckwheat flour dish like polenta in Italy
Buckwheat confectionaries
This cake is made from Owariya. This shop was build on 15\textsuperscript{th} Century.

We went to this shop with Prof. Kreft, Mr. Zewen and Dr. Wieslander.
Ikeda has proposed “Molecular Cookery Science” (1997).
Current interest in food functionality is growing.

Primary function: *Nutritional function*

Secondary function: *Function concerning palatability*

Tertiary function: *Health-promoting function*
Mechanical characteristics is an important quality attribute which affect palatability.
Ikeda and Kreft have analyzed texture characteristics and chemical composition with many buckwheat varieties. We show a close relationship between both factors.

Fig. 2. Correlation relationship between the total protein content and starch (total starch, amylopectin and amylose) content in buckwheat flours. (A) correlation coefficient ($r = -0.731 \, (p < 0.001)$); (B) $r = -0.499 \, (p < 0.01)$; (C) $r = -0.474 \, (p < 0.01)$; (D) $r = 0.443 \, (p < 0.01)$; (E) $r = 0.455 \, (p < 0.01)$.
We also showed high adhesiveness of buckwheat. This is TV program about adhesiveness.

NHK SUIENSAR (2012.4.10)

Fig. 5. Effects of incorporating isolated buckwheat albumin (I) and globulin (II) into buckwheat flour on the texture characteristics of heated dough. Buckwheat albumin or globulin was added to buckwheat flour at 4% (ADD4%) and 8% (ADD8%) concentrations. (A) hardness; (B) cohesiveness; (C) adhesiveness; (D) springiness; and (E) chewiness. Values are means (n=3). *Significantly different from the value without protein (ADD0%) (p<0.01).
There are many protein components in buckwheat flour.

There are many protein components affecting mechanical characteristics.
There is a difference in mechanical characteristics between common and Tartary buckwheat.

PC 1 (45.22%, Breaking energy etc)

Here is a difference in mechanical characteristics between common and Tartary buckwheat.
Tartary buckwheat shows high hardness with low cohesiveness.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Hardness / Cohesiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>1.00</td>
</tr>
<tr>
<td>Tartary</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Each analysis value was expressed as a relative textural value as the observed textural value of a common buckwheat (Kitawase-soba cv.) as a standard value was taken as 10.00.
Cohesiveness negatively correlated to the rutin content of Tartary buckwheat.

Relationship to the rutin content and cohesiveness of Tartary buckwheat

\[ r = -0.999 \] (P<0.01)

**C1**: Aki-soba, **C2**: Botansoba, **C3**: Dewakaori, **C4**: local var. Fukui-zairai, **C5**: Hashikami-wase, **C6**: Hitachi-aki-soba, **C7**: Iwate-wase, **C8**: local var. Kagoshima-zaiwai, **C9**: Kitawase-soba, **C10**: Mogami-wase, **C11**: Shinano No.1, **C12**: Shinshu-oosoba, **T1**: Hokkai T8, **T2**: Japan, **T3**: Chaina
Addition of rutin increased hardness and decreased cohesiveness in Tartary buckwheat.
These is soybean curd, tofu in Japan. In Japan, alkaline reagents such as ammonia (NH₃) are used to soften tofu, especially freeze-dried Tofu.
Alkaline additives such as ammonia improves low cohesiveness. High cohesiveness leads to easily-preparation into products.

Fig. 2. Changes in cohesiveness of Tartary buckwheat dough as a function of ammonia concentration used as the pretreatment. The cohesiveness was measured with the pretreatment of Tartary buckwheat flour with gaseous ammonia ranging from 0M to 6M.
Alkaline additive maybe leads to the release of rutin from its binding to protein.

- Binding of rutin to Proteins
- Low cohesiveness
  - Not easy to make products
- Release of rutin from protein
  - Improvement of cohesiveness
  - Easy to make products
Buckwheat noodles are prepared as shown in these figures. We tried to clarify the scientific basis of the traditional method.
We are analyzing with buckwheat noodle-making experts..
These are analyzing scenes.

←This is chrysanthemum dough.
There is various buckwheat noodles in Japan

(1) Classif. from flour-type
   Sarashina-Soba made from inner layer four
   Inaka-Soba made from whole flour

(2) Classif. from noodles-binders
   Various foods, e.g., Ground tea, Yam tuber flour, Sea weed etc. are used.

(3) Classif. from noodles preparation
   Hand-made type,
   Commercial dried type,
   Commercial precooked type,
We showed classification of various buckwheat noodles by mechanical analysis.

PC 1 (48.99%, Breaking stress etc)

PC 2 (82.12%, Brittleness stress etc)
We also showed classification of buckwheat and other cereals by mechanical analysis.
We shows that buckwheat is similar to maize in view of mechanical analysis.
We showed classification of various dough-binders used to buckwheat noodles.
Common Buckwheat – Kitawase-soba var.

Buckwheat noodles alone without any dough-binder was taken as zero point (x=y=0).
There is a common proverbial saying concerning the palatability of buckwheat noodles, i.e., noodles prepared with the following flour conditions are believed to be best palatable:

(1) Just-harvested seed
(2) Just-ground flour
(3) Just-prepared noodles
(4) Just-cooked noodles
We showed mechanical decrease arisen by long storage period, high humidity and high temperature. Therefore, just-harvested seed is palatable.

* Significant (P<0.05) difference from the original grain
** Significant (P<0.01) difference from the original grain
*** Significant (P<0.001) difference from the original grain
Buckwheat protein is precipitated by some metal salts. We are developing new products used with such salts.
Stone-milled flour is different from roller milled flour. Stone-milled flour is believed to be palatable. Our analysis suggests that stone-milled flour has bigger flour with more flavor and smaller flour with high cohesiveness.

Distribution of the particle size of buckwheat flours:

Stone mill

Roller mill
We showed that buckwheat noodles with cassava starch is palatable and is suitable for mass-serving meals such as big hospitals.

Control noodles (Cont.)

With cassava starch noodles (CS)

Cont. : Buckwheat 6 : Wheat 4
CS : Buckwheat 6 : Wheat 2 : Cassava starch 2

Boiling→Keeping in the ice water (60min)

Noodles preparation:
Takehiko KONISHI
(Professional on preparation of buckwheat noodles)
Nutritional analysis is important. We are analyzing.

Physiological factors
Food factors (amino acid score, digestibility)

<table>
<thead>
<tr>
<th>(1)</th>
<th>Chemical composition</th>
<th>Amino acid score</th>
<th>Chemical composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2007 WHO/FAO/UNU Pattern</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(2)</th>
<th>Digestibility</th>
<th>Digestibility</th>
<th>Digestibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resistant proteins</td>
<td>Resistant starch</td>
<td></td>
</tr>
</tbody>
</table>

Classification of protein by solubility

<table>
<thead>
<tr>
<th>Species</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alubumin</td>
<td>Water-soluble</td>
</tr>
<tr>
<td>Globulin</td>
<td>Salt-soluble</td>
</tr>
<tr>
<td>Glutelin</td>
<td>Acid-soluble</td>
</tr>
<tr>
<td>Prolamin</td>
<td>Alcohol-soluble</td>
</tr>
</tbody>
</table>

Need of classification by new concept e.g., digestibility
We showed that buckwheat protein belongs to resistant protein.

Fig 1: Susceptibility of various proteins to pepsin action. H denotes hemoglobin; O, ovalbumin; G, buckwheat globulin; and A, buckwheat albumin.
We showed that buckwheat flour contains some anti-digestive factors.

Fig. 1. Trypsin inhibitory activity and tannin content in various buckwheat, wheat, and soybean products.
From comparison to other foods, we showed that buckwheat belongs to be resistant proteins (RP). Now, there is high interest in RP.
There is a famous buckwheat dish, i.e., Cha-soba, prepared with matcha (ground green tea).
Our analysis shows that Cha-soba exhibits low cohesiveness. This shows that Cha-soba shows high crunchy mouth sense with delight.
Japan belongs to countries with high Mean Life Expectancy (MLE).

Female  86.83 years old
Male      80.50 years old

WHO 2015 Report
Sum (F+M)

1) Japan     84
2) Andorra  83
2) Australia 83
2) Italy     83
2) San Marino 83
2) Singapore 83
2) Spain      83
2) Switzerland 83
9) Luxemburg 83
9) Sweden    83
Washoku, i.e., Japanese diets including buckwheat dishes was registered in “Intangible Cultural (IC) Heritage in UNESCO on 2013. Therefore, there is a possibility that Washoku may be associated with high MLE (mean life expectancy) in Japanese people.
Apart from MLE (Mean Life Expectancy), Shizuoka prf. showed the highest Healthy Life Expectancy (HLE) in Japan.

<Female>
Mean life expectancy 86.61 y.o.
Healthy Life Expectancy 74.21 y.o.

<Male>
Mean life expectancy 80.21 y.o.
Healthy Life Expectancy 71.19 y.o.

<Female Ranking by HLE>  <Male Ranking by HLE>
No.1 Shizuoka prf.  No.1 Aichi prf.
No.2 Gunma prf.  No.2 Shizuoka prf.
No.3 Aichi prf.  No.3 Chiba prf.
Shizuoka prf. shows the highest consumption of green tea and tuna-fish in Japan. Therefore, green tea and fishes may be associated with high HLE (healthy life expectancy) of Shizuoka people.
Apart from HLE (Healthy Life Expectancy), Nagano pref. showed the highest Mean Life Expectancy (MLE) in Japan.

**<Female>**
Mean life expectancy 86.61 y.o.
Healthy Life Expectancy 74.21 y.o.

**<Male>**
Mean life expectancy 80.21 y.o.
Healthy Life Expectancy 71.19 y.o.

**<Female Ranking by MLE>**
No.1 Nagano pref.
No.2 Shimane pref.
No.3 Okunawa pref.

**<Male Ranking by MLE>**
No.1 Nagano pref.
No.2 Shiga pref.
No.3 Fukui pref.
Buckwheat is very famous in Nagano. Although there are various factors responsible for high MLE (mean life Expectancy), there is a possibility that buckwheat consumption may be, at least in part, one of the factor involved.
CONCLUSION
Japanese people like buckwheat dishes including cha-soba. We hope that buckwheat will be a food which maintains healthy life of many people in the world.