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Wheat quality for the Japanese flour milling and noodle industries

By Graham Crosbie, Division of Plant Industries, Western Australian Department of Agriculture, South Perth; Diane Miskelly, Bread Research Institute of Australia, North Ryde, New South Wales; and Tim Dewan, Australian Wheat Board, Melbourne, Victoria

About one-third of Australia's wheat production is used in the manufacture of Asian noodles.

Japan is one of our most important noodle wheat markets. In that country much of the 900,000 to 1,000,000 tonnes of Australian wheat bought each year is used for noodle production. About 70 per cent of this wheat is Australian Standard White (ASW) from Western Australia. ASW is highly regarded for its suitability for the production of white, Japanese-style noodles.

The remainder comprises mainly Australian Prime Hard (APH) which is valued for the production of yellow, Chinese-style noodles and for various breads.

This article discusses quality aspects associated with flour and noodle production in Japan.

Sources of wheat supplies

Japan imports about 18 per cent of its wheat from Australia. The United States (58 per cent) and Canada (24 per cent) are the other main suppliers (Table 1).

Boiled Japanese noodles which are packaged with a sachet of powdered soup base.

In the 1989 fiscal year, for example, the Japanese Food Agency bought 936,000 tonnes of Australian wheat, of which 638,000 tonnes was ASW from Western Australia and 269,000 tonnes was Australian Prime Hard.

Domestic wheat production in Japan has risen substantially over the past 15 years, from 269,000 tonnes in 1975 and stabilising at about 900,000 to 1,000,000 tonnes per year in recent years. This increase has been in response to a Japanese Government decision to eliminate excessive production of rice and to diversify and encourage expanded production of grains such as wheat and barley.

The 600,000 to 700,000 tonnes of Western Australian ASW wheat that Japan imports each year is recognised as the best wheat available for the traditional white, salted Japanese-style noodle. Generally it is blended with domestic wheat before milling, but some premium noodle flour is made totally from ASW.

Table 1. Average yearly wheat imports into Japan (1984 to 1988 fiscal years)

<table>
<thead>
<tr>
<th>Country of origin</th>
<th>Thousand tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A</td>
<td>2,987</td>
</tr>
<tr>
<td>Canada</td>
<td>1,268</td>
</tr>
<tr>
<td>Australia</td>
<td>933</td>
</tr>
<tr>
<td>Total imports</td>
<td>5,190</td>
</tr>
</tbody>
</table>


ABOVE: Various types of dried Japanese noodles. From left, in order of increasing width, are: somen, hiyamugi, udon and kishimen.
A packet of fresh Japanese noodles. Figure 1. End uses of locally produced flour in Japan.

Table 2. Classification of Japanese-style noodles according to width

<table>
<thead>
<tr>
<th>Classification</th>
<th>Width (mm)</th>
<th>Cutting roll size (no. strands/30 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somen (very thin)</td>
<td>0.7 - 1.1</td>
<td>42 - 26</td>
</tr>
<tr>
<td>Hiyamugi (thin)</td>
<td>1.4 - 1.7</td>
<td>22 - 18</td>
</tr>
<tr>
<td>Udon (standard)</td>
<td>2.3 - 3.0</td>
<td>13 - 10</td>
</tr>
<tr>
<td>Kishimen (flat)</td>
<td>5.0 - 7.5</td>
<td>6 - 4</td>
</tr>
</tbody>
</table>

Australian Prime Hard is valued as a source of high quality flour for the manufacture of yellow, alkaline Chinese-style noodles; it is also used for the baking of certain types of bread. APH is milled mainly under the feed milling programme at a low extraction rate. The extraction rate is the percentage yield of flour from wheat. (See Milling of flour for noodles later in this article.)

End uses of wheat flour

Japan produces about 4.5 million tonnes of flour a year for domestic use, with noodles accounting for about 34 per cent of the end use (Figure 1). Per capita consumption of wheat flour is 32 kg per year, which is high among Asian countries. Noodles form a regular part of the Japanese diet, with the average person eating noodles at least once each day, usually for lunch.

Classification of noodles

Noodles may be classified according to the nature of the raw materials used in their manufacture, by the size of the noodle strands, and by the method of manufacture. They can be made by hand or machine, and are sold as fresh, dried, boiled or instant types.

Classification by raw material

Japanese noodle

The Japanese noodle is white (or preferably creamy-coloured) and is made from a mixture of flour (100 parts), water (32 to 35 parts), and salt (2 to 3 parts). The flour used is made from predominantly soft-grained wheat of medium protein level.

Chinese noodle (Ramen)

Ramen is a yellow noodle made from a mixture of flour (100 parts), water (32 to 35 parts), kansui (a mixture of alkaline salts - about 1 part), and salt (1 part). The flour is made mainly from hard-grained wheat of higher protein content than that used for Japanese noodles. The yellow colour develops by the action of the alkaline salts on the natural flavonoid compounds in the flour.

Soba (buckwheat noodle)

Soba is a grey-green noodle made from a mixture of buckwheat flour and wheat flour, water and salt. The wheaten flour component varies according to the type of soba produced, with a typical level being about 40 per cent in a better quality type. The wheaten flour is
generally higher in protein (12 per cent minim­
mum) and ash content (0.5 per cent and above) than that used for Chinese noodles. The higher protein content compensates for the lack of gluten-forming protein in buckwheat flour.

**Macaroni and spaghetti**

Macaroni, spaghetti and other pasta products, although often referred to as noodles, differ from Asian noodles in several ways. Pasta products are generally extruded under pressure rather than being cut from a dough sheet, and are made from semolina rather than flour. (Semolina has a coarser particle size than flour.) Semolina is generally milled from high protein durum wheat which has much harder grain than that used for the production of noodle flours.

**Classification by size**

Noodles normally have a rectangular cross-section, but it may be square or round depending on the thickness of the dough sheet from which the noodles are cut, and the shape of the groove and size of the cutting rolls used.

Chinese-style noodles manufactured in Japan are thin, rarely more than 1.5 mm wide.

Japanese-style noodles cover a much wider range of sizes. The main types are classified according to width (Table 2).

Seasonal conditions greatly influence the consumption patterns of the various noodle types. The thinner types, somen and hiyamugi, which tend to retain heat better than the thinner types, are preferred eaten hot in winter. Close monitoring of consumer demands is an important aspect of the highly efficient Japanese noodle industry.

Cooking time varies according to noodle width, ranging from about 6 to 8 minutes for the thin somen to about 20 minutes for udon and kishimen.

**Classification by method of manufacture**

A small percentage of noodles are hand-made or semi hand-made and are valued for their fine texture, considered to be associated with gluten development. Most noodles are made by machine, with similar methods of dough mixing, sheeting and cutting of noodles being used in most noodle plants. However, subsequent treatment varies considerably, and noodles may be produced in various forms, the most popular of which are:

*Raw or fresh noodles*, known as nama-men, are sold to retail shops and restaurants, but have a limited shelf life. Only about 2 per cent of Japanese-style noodles are sold fresh, although this is the most popular form of Chinese-style noodle in Japan (Table 3).

*Dried noodles* also known as kan-men, are the most popular form of Japanese-style noodles. These noodles are produced by the controlled drying of raw noodles. The thinner noodle types, somen and hiyamugi, are produced only in the dried form. Few Chinese-style noodles are produced in this way.

Table 3. Production of various forms of noodles in Japan in 1988 fiscal year (April 1 to March 31) as a percentage of total flour (1,379,000 tonnes) used for noodles

<table>
<thead>
<tr>
<th>Form of Noodle</th>
<th>Japanese</th>
<th>Chinese</th>
<th>Soba</th>
<th>Macaroni/Spaghetti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>2.58</td>
<td>15.55</td>
<td>1.86</td>
<td>-</td>
</tr>
<tr>
<td>Dried</td>
<td>16.69</td>
<td>0.50</td>
<td>2.32</td>
<td>-</td>
</tr>
<tr>
<td>Boiled</td>
<td>14.97</td>
<td>3.95</td>
<td>2.74</td>
<td>-</td>
</tr>
<tr>
<td>Steamed</td>
<td>5.81</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wrappers (as for spring rolls)</td>
<td>1.59</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Instant Fried</td>
<td>0.22</td>
<td>10.82</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-fried</td>
<td>0.08</td>
<td>2.31</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cup noodle</td>
<td>-</td>
<td>8.72</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>34.54†</td>
<td>40.53†</td>
<td>6.92</td>
<td>9.23</td>
</tr>
</tbody>
</table>

† Excludes a share of the 8.72% of flour used for cup noodles.

Source: Japanese Food Agency
Boiled noodles are the most popular form of udon. Yude-udon (yude means boiled) needs only a few minutes of reboiling before eating and is therefore a popular convenience food.

Instant noodles, made mainly by steaming and frying, are a popular form of Chinese-style noodles. About 17 per cent of instant Chinese-style noodles are made by the traditional method of steaming and drying raw noodles.

Cup or snack noodles, either Japanese or Chinese types, which are packaged in a plastic cup with additives such as dried soup, vegetables and meat, are an emerging form of instant noodle; the contents of the cup are prepared for eating simply by the addition of hot water.

Frozen noodles, mainly preboiled, but also fresh, are also made. Frozen boiled noodles are made by rapidly freezing the noodle immediately after boiling. This type of noodle is sold mainly to restaurants rather than for home use.

Basic wheat quality requirements

Inherent starch properties

For many years, Western Australian ASW wheat has been highly regarded for the production of Japanese-style noodles. Various studies have associated this reputation with certain pasting characteristics of the starch component of the flour milled from this wheat. This reputation can be linked largely to the soft-grained Gamenya, a variety noted for its high starch paste viscosity (a measure of starch quality which can indicate eating quality).

Sowings of Gamenya have declined in recent years, but they have been partly offset by the emergence of Eradu, a Western Australian bred variety of similar quality. Shipments of high quality wheat to Japan have been maintained by selecting grain from silos with the highest proportions of these two varieties. The Australian Wheat Board started a special segregation of deliveries of Eradu and Gamenya in Western Australia in 1989-90 to ensure continuing supplies of high quality noodle wheat. About 390,000 tonnes of noodle wheat were segregated that season.

Protein level

Western Australian ASW wheat at a protein level of about 10.5 to 10.7 per cent is considered ideal for the production of high quality flour for Japanese noodles. Higher protein levels are required for Chinese noodles and Australian Prime Hard (above 13.0 per cent protein) is considered very suitable.

Freedom from weather damage

Freedom from weather damage is an important wheat quality requirement for both Japanese and Chinese noodles. The presence of undesirable enzyme activity may adversely affect eating quality and noodle colour.

Ideal grain hardness

Flour for the production of Japanese noodles has traditionally been milled from softer grain types, particularly domestic soft red winter wheat and more recently from essentially soft-grained ASW wheat from Western Australia. The use of soft-grained wheat, giving flour with finer particle size and less damaged starch, is considered to be associated with a desirable surface smoothness in the boiled noodle.
Importance of flour colour

In Japan, both Japanese and Chinese noodles are made from low extraction flour (see Milling of flour for noodles below). Low flour ash and good colour grade in the flour are essential for the production of noodles which retain a clean, bright appearance after cooking. These requirements can only be met from wheat of high milling quality.

Australian wheat is white-grained, which means that bran specks in the flour are not as dark as those from red-grained North American wheat. This is one of the big advantages of Australian wheat over other wheats.

Another aspect of flour colour, unrelated to flour ash and colour grade, is the level of yellow pigment, which is determined largely by variety, although somewhat modified by environment. Previously, low levels of yellow pigment in the flour had been a breeding aim to produce a very white Japanese noodle. However, it is now understood that a creamy-coloured noodle is preferred, requiring a moderate level of yellow pigment. A level slightly less than that of the variety Gamenya is thought to be close to the ideal. Yellow pigment level is not critical for Chinese noodles because the yellow colour of these noodles develops by the mixture of alkaline salts (kansui) used in their manufacture.

Milling of flour for noodles

Wheat is milled in Japan for the staple food programme and the feed programme. Milling carried out under the staple food programme is conventional milling to high extraction rates (high yields of flour), say 78 to 80 per cent. Wheat milled under the feed programme, representing about 20 per cent of all wheat milled in Japan, is milled to an extraction rate determined by the Japanese Government, presently at 50 per cent. This low extraction milling system was started in the late 1950s as a means of producing high quality bran for feed.

Most of the APH and about one-half of the ASW bought by the Japanese Food Agency is milled at low extraction levels under the feed programme to produce high grade, low ash flour for noodle manufacture. The rest of the ASW is milled to higher extraction levels, but only the cleanest flour streams of low ash content are used for noodles; the remaining streams are blended with other flour for other purposes, including export.

Production of noodles

There are more than 8,000 noodle manufacturers in Japan. The large manufacturers have automated plants, but some noodles are still made by hand.

The ingredients - flour (100 parts), water (32 to 35 parts), salt (common or alkaline, 1 to 3 parts, can be higher) - are combined in a mixer to form a dry, crumbly dough. The crumbly dough is often rested for a time to improve the smoothness and elasticity of the noodles.

In the next stage, the dough is passed through a series of sheeting or combining rolls to press the dough into a sheet. Initially, two sheets are produced and these are combined into a single sheet. The dough sheet is rested for a short time and then passed through a series of reduction rollers which differ in the size of the gap between them so that the dough sheet becomes progressively thinner; the final thickness of the dough sheet depending on the type of noodle. The dough sheet is then cut into strands by passing through a cutting roll.

Raw or fresh noodles are now cut to length, packaged and sold. Fresh noodles have a limited shelf life and are frequently sold on the day of manufacture. Other types need further processing.
Noodles to be dried are suspended in lengths from rods and allowed to dry under carefully controlled conditions of temperature and humidity. This type of noodle has a long shelf life.

Noodles to be boiled leave the cutters and are steeped in large boiling water baths, cooled in chilled water, drained, packaged and transported to supermarkets in refrigerated transport. Boiled noodle factories often have sophisticated waste water treatment plants and need a high standard of hygiene in the factory, as well as microbiological quality control testing.

Instant noodles are steamed and dried or steamed and fried after the cutting stage and usually packaged with a soup or soy sachet. Together with cup noodles, they are often used as a snack food. Both types are common in Australian supermarkets.

Quality assessment of noodles

The Japanese Ministry of Agriculture, Forestry and Fisheries has established standard testing methods for both Japanese and Chinese noodles.

Japanese noodles

For Japanese noodles, the emphasis is on various characteristics of the cooked noodle, because raw noodles represent only a small fraction of total sales.

The cooked noodles are assessed for colour, appearance, texture and taste. Three components of texture are considered: softness/hardness, elasticity and smoothness. High quality Japanese noodles have a bright, clean lustre, are creamy-coloured, and have a soft but elastic texture and a smooth surface.

Chinese noodles

For Chinese noodles, equal emphasis is given to both raw and cooked types.

Raw Chinese noodles are assessed for colour on the day of manufacture and one day later. Immediately after boiling, the noodles are assessed for texture and taste, with texture again being assessed seven minutes after boiling. Desired characteristics of Chinese noodles are a bright even yellow appearance, a firm elastic texture, and a normal taste.

Noodle quality research in Japan

The importance of the starch component of wheat to the quality of Japanese noodles was first indicated by Nagao et al. (1977). Compared with flour from domestic wheat and various other wheat classes imported into Japan, flour from Western Australian ASW wheat was found to have the lowest gelatinization temperature. It was suggested that this may be linked to the superior quality of ASW for Japanese noodles.

Later studies by Oda et al. (1980) established high correlations between various starch gelatinization characteristics and eating quality of the noodle. This work indicated an association between low amylose or high amyllopectin content of starch and noodle eating quality.

These studies have been complemented by research at the Bread Research Institute of Australia which has identified the peak viscosity of a starch paste as a useful indicator of noodle eating quality (Moss, 1980).

Recent research by Endo et al. (1988) has implicated components extracted from starch, such as proteins and lipids, as factors which influence starch gelatinization properties.

Wheat breeding in Japan

The substantial increase in wheat production in Japan over the past 15 years has been associated with a decline in quality. Domestic wheat is considered lower in quality than Western Australian ASW for Japanese noodles.

About seven years ago, the Japanese Government renewed the emphasis on wheat breeding in Japan in an effort to improve quality. Japanese wheat breeders have set the starch quality of ASW from Western Australia as an important quality objective. This means that Western Australia must strive hard to maintain the quality advantage of its wheat for this highly valued market.

Acknowledgements

We thank Dr S. Nagao of the Nisshin Flour Milling Company Limited, Japan, for his helpful suggestions during the preparation of this article. We are also grateful to Miss K. Tanaka of the Western Australian Department of Agriculture for the translation of technical information from Japan.

References


