23.2 Asian Wheat Noodles

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23.2.1 Introduction

The Arabs claim to have been the first to use dried pasta, as a means of preserving flour during their forays across the desert.

Nevertheless, it is believed that noodles originated in the north of China as early as 5,000 BC. Their modern-day form has developed over the last 2,000 years; present-day noodles (*mian*) were a unique contribution by the Han Dynasty (206 BC to 220 AD), and then spread to other Asian countries. The relationship between noodles and pasta also goes back more than 700 years. It is believed that in the late 13th century, Marco Polo travelled to China and brought noodles back to Italy to add to his country's repertoire of pasta.

Noodles are strips or strands cut from a sheet of dough made from flour, water, and either common salt or a mixture of alkaline salts. They are one of the main staple foods consumed in East and Southeast Asian countries, representing up to 40% of total flour consumption. Though some Asian-style noodles are wheat-based, many others are made from ingredients such as rice flour, potato flour, buckwheat [39] flour, corn flour and bean, yam or soybean flour. Among the more popular varieties are China's cellophane noodles (made from mung-bean flour), egg noodles (usually wheat-based) and rice flour noodles, and Japan's *harusame* (made with soybean, rice or potato flour), *ramen* (wheat-based egg noodles) and *soba* (which contain buckwheat flour). Other Asian countries, including Korea, Indonesia, Thailand, Vietnam and the Philippines, have their own versions of the venerable noodle (Herbst, 1995). In recent years, Asian noodles have also become popular in many countries outside Asia.

This text will focus on Asian wheat noodles (rather than buckwheat noodles or starch noodles made from purified starch, generally from other plant sources such as rice, mung bean, or sweet potato).

23.2.2 Scientific Name for Asian Noodles

Until recently, the U.S. government required a noodle to contain flour, water, and eggs in order to be rightly called a noodle. Since most Asian noodles are not made with eggs, this left

[39] *See footnote [25], chapter 16.3.3, page 194.*

them without much of an identity. The FDA permitted names like "alimentary paste" and "imitation noodles", but Asian noodle producers – from the birthplace of the noodle, no less – could not use the n-word. The government finally relented, and now the name "Asian noodles" can be used (Alden, 2003).

23.2.3 Comparison of Asian Wheat Noodles with Pasta

Asian wheat noodles differ from pasta products in the ingredients used, the processes involved and their consumption patterns. Asian wheat noodles are characterized by thin strips slit from a sheeted dough that has been made from common wheat flour (hexaploid wheat from *Triticum aestivum*[40]), water and salt, i.e. common salt or alkaline salt. Noodles are often consumed in soups. Eggs can be added to give a firmer texture. Asian noodles are sold in many forms. Pasta is made from semolina, coarse flour usually milled from tetraploid durum wheat (*Triticum durum*) and water, extruded through a metal die, and then dried. After cooking, pasta is often eaten with sauces (Hou and Kruk, 1998).

23.2.4 The Basics of Asian Wheat Noodles

About three parts of flour are usually mixed with one part of salt or alkaline salt solution to form a crumbly dough. The dough is passed through a series of rollers to form a dough sheet. The gluten network develops during the sheeting process, contributing to the noodle texture. The sheeted dough is then slit to produce noodles. The noodles are now ready for sale, or are further processed to prolong shelf-life, modify eating characteristics or facilitate preparation by the consumer. In the preparation of instant fried noodles, the steaming process causes the starch to swell and gelatinize. The addition of alkaline salts (*kansui*[41]) to some Chinese-type noodles gives them a yellow colour and a firmer, more elastic texture (Hou and Kruk, 1998).

[40] *See chapter 2.1, page 1 for details on wheat ploidy.*

[41] *Kansui: a mixture of sodium and potassium carbonates (typically 9:1); sometimes it refers only to sodium hydroxide solution.*

23.2.5 Classification of Asian Noodles

There is no systematic classification or nomenclature for Asian noodles; wide differences exist between countries. There is a need to standardize noodle nomenclature using a universal classification system.

Noodles are commonly classified according to (1) the shape of the noodle strands, (2) the nature of the raw materials used in their manufacture, pH and organoleptic qualities, (3) the method of preparation, and (4) the form of the product available on the market (Tab. 119 - Tab. 122).

Classification Based on Shape

White salted noodles vary widely in the size of the noodle strand (Tab. 119). In Japan, the main types classified according to width include very thin noodles (*somen*), thin noodles (*hiya-mugi*), standard noodles (*udon*) and flat noodles (*kishi-men* or *hira-men*). Somen and *hiya-mugi* are dipped in a cup of cold soy-sauce soup and usually served in the summer, while *udon* and *hira-men* are served in a hot soy-sauce soup in the winter along with boiled noodles, tempura, fried bean curds, boiled fish paste, and/or vegetables. Yellow alkaline noodles in Japan are thin and rarely more than 1.5 mm wide.

In China, noodles are similarly classified according to the size of the noodle strands but are known by different names from those used in Japan. The main varieties are very thin noodles (*longxu mian*), thin noodles (*ximian*), flat noodles (*yang chun mian*) and wide flat noodles (*dai mian* or *chu mian*) (Hou and Kruk, 1998).

Classification Based on Raw Materials

Noodles can be made from wheat flour alone or in combination with buckwheat flour (Tab. 120). Wheat flour noodles include Chinese and Japanese type noodles. There are many varieties within each noodle type, representing different formulations, processing and noodle quality characteristics. Noodles containing buckwheat are called *soba*. These noodles are typically light brown or grey in colour with a unique taste and flavour. Chinese-type noodles are generally made from hard wheat flours,

Tab. 119: Classification of Asian noodles by shape

Noodle type	Examples	Width, mm
Very thin	*Somen* (Japanese), *longxu mian* (dragon beard noodles, Chinese)	0.7-1.2
Thin	*Hiya-mugi* (Japanese), *ximian* (Chinese)	1.3-1.7
Standard	*Udon* (Japanese)	1.9-3-8
Flat	*Kishi-men* or *hira-men* (Japanese), *dai-mian* or *chu mian* (Chinese)	5.0-6.0

characterized by a bright creamy white or bright yellow colour and firm texture. Japanese noodles are typically made from soft wheat flour of medium protein content. They should have a creamy white colour and a soft and elastic texture. Noodles can be classified as white (containing salt) or yellow (containing alkaline salt), depending on the absence or presence of alkaline salt in the formula. Alkali gives noodles their characteristic yellowness. White salt noodles comprise Japanese noodles, Chinese raw noodles and dry noodles. Chinese wet noodles, *hokkien* noodles, Cantonese noodles, *chuka-men*, Thai *bamee*, and instant noodles fall into the yellow alkaline noodle category (Hou and Kruk, 1998).

Generally speaking, white salted noodles are popular in China, Japan and Korea; yellow alkaline noodles are popular in Malaysia, Singapore, Indonesia, Thailand and southern China, and instant noodles are popular in East and Southeast Asia (Ang *et al.*, 1999).

Classification Based on the Preparation Process

The simplest way to classify noodles according to their processing is hand-made versus machine-made noodles (Tab. 121). But that is too general. Hand-made types, still available in Asia because of their pleasant texture, were prevalent before the automatic noodle machine was invented in the 1950*s*. In some places, stretching noodles by hand is considered an art rather than just noodle-making. Noodle machines are best suited to mass production. Noodle processing operations include mixing the raw materials, sheeting, compounding and slitting. This series of processes is the same in all countries and for all noodle types. Noodle strands are further processed to produce different kinds of noodles, and this can also be a means of classification.

Classification Based on the Sales Form

Another way of classifying Asian noodles is by the thermal treatment to which they are

Tab. 120: Classification of Asian noodles by the nature of raw materials, pH and organoleptic properties

Noodle type	Wheat flour protein, %	Composition per 100 parts of flour	Properties	pH
White salted	8-10	Flour of low to medium protein level, water (30-35 parts), sodium chloride (2-3 parts)	Soft and elastic texture, smooth surface	6.5-7
Yellow alkaline	10-12	Medium protein hard wheat flour, water (30-35 parts), alkaline salts (1 part)	Firm, chewy, springy texture and bright yellow appearance	9-11
Buckwheat	12-14	High protein wheat flour (30-40 parts), buckwheat flour (60-70 parts), water (45-48 parts), common salt	Firm, chewy, tender texture	6.5-7
Instant	9-11	Medium protein wheat flour, water (30-35 parts), common salt or alkaline salts (2-3 parts), oil	Elastic, chewy texture	5.5-9

Tab. 121: Classification of Asian noodles by the method of preparation

Process type	Preparation
Machine-made	Mechanical dough mixing, sheeting, cutting into strands and subsequent processing steps are most common and remarkably constant from the smallest scale machine to the largest factory.
Hand-made	An experienced hand with considerable skills is required to produce consistent results. The procedure involves stretching and pulling a ball of soft dough repeatedly to create long strands of noodles with uniform thickness.

exposed before sale to the consumer, and hence the physical condition of the noodles when sold (Tab. 122). They can be raw and uncooked, boiled or parboiled, fried, boiled and frozen, or dried.

Yet another way of classifying Oriental noodles is given by Oh *et al.* (1983). They suggest moisture content and the degree of pre-cooking as a means of distinguishing between the noodle types.

23.2.6 Main Varieties of Asian Wheat Noodles

None of the approaches discussed above are sufficient to define each noodle type. For instance, boiled noodles comprise fully cooked and parboiled types. Parboiled types include both *hokkien* and Chinese wet noodles. A possible nomenclature should therefore incorporate key aspects such as formulation and basic processing to fully describe the nature of each noodle type (Hou and Kruk, 1998).

Tab. 122: Classification of Asian noodles by the form of the product available on the market

Noodle type	Preparation
Uncooked, wet	Fresh or raw noodles are sold without any further processing and contain about 35% moisture. They usually have a thin cross section, which allows them to cook rapidly, and are made from relatively strong flour that imparts a chewy texture when cooked. The most important quality characteristics are good colour and a smooth surface. They must be white or light yellow, depending on regional preferences. They have a limited shelf-life and are very prone to enzymatic darkening by polyphenol oxidase, unless stored under refrigeration. Only about 2% of white salted noodles are sold fresh, while a popular form of alkaline noodles is sold fresh in Japan (15.5%). In Shanghai fresh noodles are the most popular.
Dried	Raw noodles that have been hung to dry, either in the sun or in a drying chamber, to about 8 - 10% moisture. The dough must be strong enough to support the noodles as they dry. The noodles should have a uniform shape and cleanly cut sides. Since dull, grey or brown noodles are considered inferior, highly purified flours are generally used to impart the desired colour and opacity. The noodles have an extended shelf-life and retain their bright colour when stored. Most Japanese-style noodles are sold in this form.
Boiled  Improving noodle shelf-life	Fresh noodles, partially boiled for 1 - 2 min until there is only a fine core of raw dough in the centre, reboiled prior to consumption, extending the cooked zone to the centre. After boiling, the noodles are rinsed in cold water, drained, and finally oiled and sold in plastic bags. They are popular in China, Japan, Singapore, Malaysia, and Indonesia. Hokkien noodles are alkaline noodles that are essentially sold as boiled noodles. The moisture content is about 52%, so they have a relatively short shelf-life. They do not discolour because the boiling inactivates the polyphenol oxidase, but they have to be protected from airborne micro-organisms. Their shelf-life can be extended by hygienic manufacturing practices and refrigeration or freezing. In Japan, it has been increased to several months by using retort pouch packaging and partial drying. These noodles are often sold packed in heatproof cups or bowls with various flavourings and toppings.
Frozen boiled	Boiled noodles are washed with water, immersed in cold water below 5 °C, and rapidly frozen to a temperature of -30 °C. Freezing preserves the fresh taste for a long time and has been applied to udon and ramen. This type of noodle is mostly sold from a central factory to noodle restaurants, where it is thawed in a special boiling pot and immediately served to guests.
Steamed and fried or steamed and dried instant	Apart from the non-dried nama type, instant noodles can be classified as either fried or non-fried according to the drying method (Fig. 207). Fried noodles are also called fry-dried noodles. The raw noodles are heated by steam or boiling water, shaped into a mould and fried in cooking oil at 140 - 150 °C. 2 min frying reduces the water content to just a few percent, fixes the gelatinization and gives the distinct flavour. Non-fried noodles are also known as gelatinized dried noodles, or hot air dried noodles. Steamed noodles are dried at about 80 °C for 30 min. Since the drying process takes much longer, these noodles are made thin in order to speed up drying and cooking.

White Salted Noodles

The Japanese form of white salted noodles (*udon*) is perhaps the most intensively studied. They are white or creamy-white in appearance and have a soft, elastic texture. The boiled forms of Japanese *udon* are the most popular types, which are either sold loose or packed in tightly sealed polyethylene pouches for extended shelf-life. They are made from flour, water and salt (Tab. 120). The amount of salt added depends on the type of noodle (boiled or dried), the climate, and consumer requirements. The criteria for judging Japanese noodle quality are cooked noodle texture (eating quality), followed by colour, taste, surface appearance, cooking loss, and noodle yield. The flour used is predominantly made from relatively soft wheat of low to medium protein level (8 - 10%), low flour ash content (0.36 - 0.40%), low damaged starch, and a good colour grade, which gives the noodles their bright, creamy appearance and desirable texture. The low protein level results in less tough and lighter-coloured dough for noodle formation. Any discoloration, visible specks, or dull grey hue is considered unacceptable quality. Extremely low protein content, abnormally weak gluten, and low Amylograph viscosity cause problems in noodle manufacture and reduce the quality of the final product.

Effect of Flour Components on Japanese Noodle Characteristics

Using a laboratory-scale method for white salted noodles (page 347), Ang *et al.* (1999) studied the influence of flour quality on the texture and eating quality of Japanese noodles. Starch characteristics were found to be very important to the eating quality of Japanese noodles, while the protein content of the flour affected the chewiness of cooked noodles. The starch granules were more loosely held within the gluten protein matrix and the presence of 2% salt in the dough resulted in a smoother and more uniform gluten structure than that observed with unsalted dough. The primary and tailing starch fractions were found to be responsible for noodle texture, with the former contributing most to the desirable viscoelasticity in noodle texture. The gluten fraction of the flour affected the colour of the noodles but not their texture, while the water-soluble fraction did not have any effect on noodle properties. An optimum ratio of amylose to amylopectin is necessary for good noodle quality. Increased levels of amylose reduced the water binding of cooked noodles, resulting in firmer noodles with less elasticity. High-quality Japanese noodles have a soft but elastic texture and a smooth surface. Low flour protein, along with high-swelling starch, causes extra water to be imbibed inside a strand to produce a noodle with soft bite. Moreover, low levels of amylase may leach granules to produce the desired elasticity.

Yellow Alkaline Noodles

Yellow alkaline noodles are essentially made from flour, water and a solution of alkaline salts known as *kansui* or lye water. The alkaline salts confer a unique flavour and texture to the noodles and are responsible for imparting the typical yellow colour by detaching the flavones from the starch and allowing their natural colour to appear. Flour from hard wheat, with a protein content in the range of 10 - 12%, with mellow gluten quality, is recommended for fresh alkaline noodles. The desired characteristics are a bright, even, light yellow appearance; absence of any darkening or discoloration; a firm clean bite; a chewy and elastic texture with some degree of springiness; and a satisfactory *al dente* reaction on biting.

Eating Quality of Yellow Alkaline Noodles

The principal factors governing the eating quality of yellow alkaline noodles are protein content, dough strength, and starch paste viscosity. In the interior of alkaline noodles, the inherently low-swelling starches of hard wheats are further restricted from swelling by the carbonate salts. The alkaline salts toughen the dough, affect the pasting properties of starch by retarding gelatinization and increasing paste viscosity, inhibit enzyme activity, and suppress enzymatic darkening. The resulting starch gels are hard and strongly elastic, which together with high protein and relatively small voids, produces chewy noodles.

Cantonese wet noodles – a variety of yellow alkaline noodles – of excellent quality are made from wheat flours with a protein content in the range of 10 - 11.5%, using 1.4 - 1.7% sodium chloride and 0.7 - 1.2% sodium carbonate. Sodium carbonate affects all the properties of cooked noodles. The protein level affects colour and firmness. Sodium chloride has little influence on quality. The alkaline reagent increases both the breaking and the cutting forces of the noodles, while salt and alkaline reagent together strengthen the dough properties. Alkaline salts reduce the dough development time and dough stability and increase the pasting temperature and peak viscosity. Sodium dodecyl sulphate (SDS) sedimentation volume correlates significantly with maximum cutting stress and maximum compression stress and can therefore be used to predict Cantonese noodle quality. Starch pasting properties correlate well with the smoothness and firmness of yellow alkaline noodles. Along with the starch pasting properties, protein content and protein quality should also be considered in evaluating the suitability of flours for making Asian noodles other than Japanese *udon* (white salted) noodles.

In another typical Cantonese modification of alkaline noodles, eggs may be added to the formulation; these impart a brighter yellow colour and firmer texture to the product. Such Cantonese-style noodles are sold raw, that is, without any further processing after cutting into strands. The cooking procedure usually involves frying the noodles thoroughly until the sides are brown (slightly scorched) and crispy and serving with an assortment of meats and vegetables (Ang *et al.*, 1999).

Fig. 206: Beating the buckwheat (source: K. Will, Hamburg)

Buckwheat Noodles, soba

Buckwheat noodles, or *soba*, are long, thin, brownish noodles made from a composite of buckwheat flour (*soba-ko*) and wheat flour (*komugi-ko*). They have a unique flavour and texture and are served plain or in soup. *Soba* cuisine has been enjoyed in Japan for more than 400 years because of its light, sweet taste and is considered a perfect food for any season. Quite different from spaghetti, *ramen*, *udon,* and other wheat noodles, buckwheat noodles do not stretch easily, and the dough has to undergo a process of "beating" to form a smooth sheet. This process is known by the traditional Japanese name as *te-uchi,* meaning "beating the buckwheat dough by hand" (Fig. 206).

The most common method for making buckwheat noodles is by combining 60 - 70 parts buckwheat with 30 - 40 parts wheat flour, to which 45 - 48 parts water are added, depending on the protein content of the mixture. The protein content of the wheat flour is generally higher than for alkaline noodles (12% minimum), which compensates for the lack of gluten-forming protein in buckwheat flour and helps to bind the flour to form a dough. The flour is mixed together in a circular motion by adding the water little by little. To improve the binding capacity of the flour, boiling water can be used in the initial mixing stages (about 80% of the total water used). It penetrates the buckwheat's starch components and activates the binding power of its water-soluble proteins. It is important to add 90% of the water and moisten the flour evenly within the first 30 - 45 s, taking care to avoid the formation of any large lumps. The two most important factors in making successful *soba* noodles are using fresh and well-sifted flour and then performing the initial mixing of the water into the flour in such a way that the buckwheat develops its own viscosity.

The stage where the viscosity becomes apparent is known as the "blossoming" of the dough, and the dough crumbs appear firm, compact, and smooth.

The dough crumbs are then kneaded together, using both hands, until a firm, smooth, polished ball of dough is formed, with as few air pockets as possible. The large dough ball is then broken into five or six small portions, covered with a damp cloth, and allowed to relax for 30 min. Each dough portion is then flattened out with a rolling pin into an oval-shaped sheet with a thickness of approximately 3 mm. The sheet is then sprinkled with buckwheat flour, wrapped with a plastic sheet, and allowed to develop further. This process is repeated with the remaining dough balls, and each new sheet is placed on top of the previous one, with flour sprinkled in between them to prevent them from sticking together. The stacked sheets are then cut in half, folded, and cut into fine strips of noodles.

The *soba* noodles are then dropped into boiling water and stirred gently to prevent them from clumping together. As the starch begins to gelatinize, the cooking water becomes milky and starts to foam. The noodle strands are occasionally lifted from the boiling water and tested for firmness. Once the noodles are done, they are strained and dropped into a bowl of iced water to firm them up and then stirred briskly to remove the starch. Finally, the noodles are drained thoroughly and served *al dente*, that is, tender, but firm and chewy throughout.

Buckwheat noodles (*momilguksu*) are also well known in Korea. *Momilguksu* is a famous local food with a long history. There are many varieties of formulas. For instance, buckwheat (2 parts) is combined with wheat flour (1 part) and water is added. The components are mixed and then kneaded. Finally, the dough is squeezed through a perforated press to form the noodles.

Pure buckwheat noodles are also widely produced in China. Buckwheat *helao* is a famous local food with more than 300 years of history. Buckwheat cat's-ear noodles are a traditional food in Shanxi Province.

Dried noodles made from wheat-buckwheat composite flour and steamed-and-fried instant noodles containing buckwheat are also available in China. The significance of buckwheat noodles also lies in the fact that they are an important food made of composite flour. They provide information on technical processing, formulation and raw material quality for composite flour development, allowing the creation of new noodle products from wheat mixed with other starch sources. Again, such products are very widespread, some being traditional and some new. Almost any grain source (e.g., maize, sorghum, millet, Amaranthus and sweet potato) can be used to give a unique texture, taste and nutritional profile to noodles predominantly made from wheat (Ang *et al*., 1999).

Instant Noodles or Ramen

The first instant *ramen* (pronunciation: *rah-min* or *rah-mane*) were made in Japan in 1958. They are now consumed in about 50 billion meals a year all over the world (Anon., 2004). A staple food of Japanese salarymen and American college students, these Japanese noodles can be used in soups or salads. There are bricks of instant *ramen* in many supermarkets, packaged in cellophane along with seasoning packets. These noodles are usually fried in oil before being dried, so they tend to be high in fat. Asian stores also stock fresh or frozen *ramen* noodles.

Substitutes: *lo mein* noodles ("*ramen*" is thought to be a corruption of the Chinese "*lo mein*"), *saimin* or *soba* (both lower in fat), or rice sticks.

Characteristics of Instant Noodles

Ramen are either steamed and dried or steamed and fried before packaging. Instant noodles are a convenient snack food because of their ease of cooking, needing only 2 - 3 min boiling or rehydration with boiling water. The frying process removes the water from the

Tab. 123: JAS instant noodle definition[a]

1. The main ingredient is wheat or buckwheat flour.
2. Items as 1 with added kayaku (seasoning) or yakumi (spices).
3. Items as 1, processed to improve elasticity and viscosity.
4. Instant noodles have been dehydrated.
5. Items as 1 to 4, with supplied flavourings or pre-flavoured.
6. Instant noodles are edible after simple preparation and cooking.
In noodles processed using *kansui*, the starch component must be pregelatinized.

[a] *Source: Anon., 2004*

noodle strands, resulting in a porous structure that rehydrates quickly when water is added. When reconstituted in boiling water, no fat should separate in the cooking water, and the noodles should have a strong bite and firm non-sticky surface. Soft wheat flour with a low to moderate protein content is desirable because it facilitates rapid cooking upon addition of hot water. They usually have a shelf-life of 4 - 6 months.

Categories of Instant Noodles

Standards were created for instant noodles in 1965, seven years after the invention of instant *ramen*. The JAS (Japanese Agricultural Standards Association) had previously categorized noodles into *nama* (wet, uncooked) and dried types. Now, a new category of "instant noodles" was added (Tab. 123 and Tab. 124; Anon., 2004).

Classification of Instant Noodles by Container, Packaging, Flavour and Processing

Instant noodles come in many varieties. There are packaged noodles and cup-type noodles, and both come in Chinese, Japanese and Western flavours. Then there are many different methods of manufacturing the noodles. And on top of this, when the products are sold, they may also be classified according to flavour and shape. Different sizes and shapes of cup, new tastes like ultra-hot or traditional regional flavours, new manufacturing processes – new varieties of instant noodles are appearing all the time (Anon., 2004; Fig. 207).

Tab. 124: JAS instant noodle categories[a]

Category	Ingredients/characteristics	Examples
Chinese	Wheat flour and *kansui*; can include added vegetable protein or powdered egg	*ramen, yakisoba*
Japanese	Wheat flour (and/or buckwheat flour), yam flour, vegetable protein or powdered egg	*soba, udon*
Western-style	Wheat flour and 30% or more durum semolina flour	Spaghetti
Snack-type (cup-type)	Noodles sold in a serving container, with added flavourings, *kayaku* or *yakumi*	

[a] *Modified from Anon., 2004*

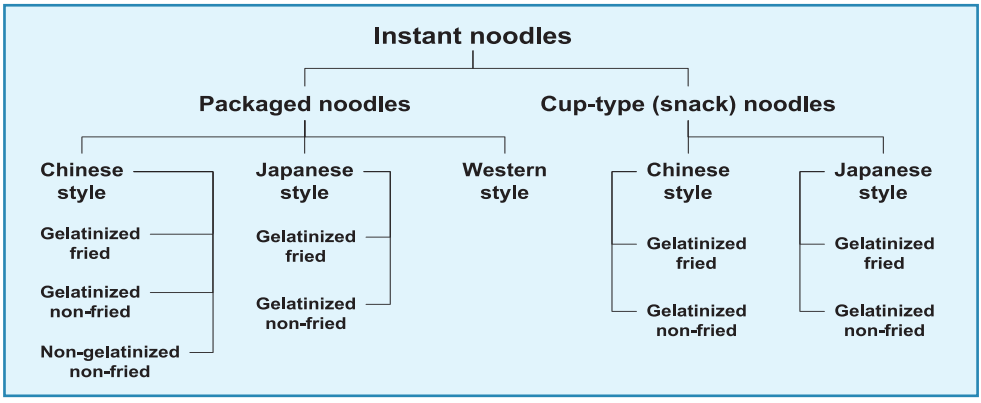

Fig. 207: Classification by container, packaging, flavour and processing

Classification by Ingredients and Manufacturing Methods

The materials used to make instant ramen are defined and regulated by the Food Hygiene Law of the Ministry of Health, Labor and Welfare, and the JAS Standards of the Ministry of Agriculture, Forestry and Fisheries. The main ingredients of noodles are flour (wheat or buckwheat) and hydrolysis adjustment liquid[42]. Semi-bread flour is best for most noodle types; bread flour and all-purpose flour are used for special varieties. Hydrolysis adjustment liquid is used to enable the flour to be kneaded.

Instant ramen can also be divided into fried and non-fried types. Both fried and non-fried noodles are pregelatinized, but the methods used to fix the pregelatinization are different. Starch comprises about 70% of the main ingredients used for noodles, i.e. wheat and buckwheat flour. Pregelatinization is a process of converting this starch into a form that can be eaten easily after just 2 or 3 min cooking. This is usually done by steam heating, although boiling is also possible (Anon., 2004; Fig. 208).

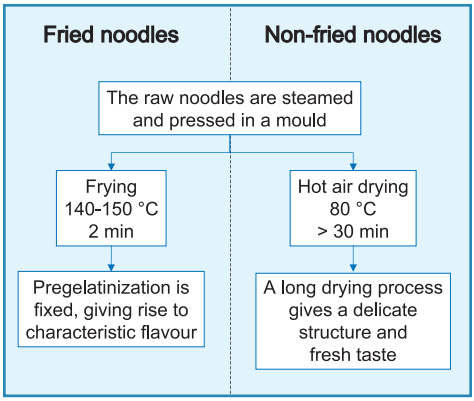

Fig. 208: Manufacturing methods for instant noodles

Consumption Pattern of Instant Noodles

China, Indonesia, Japan and Korea have the largest consumption of instant noodles. In these countries, noodles are a staple food (Tab. 125). Instant noodles are convenient, relatively cheap and well established in each region, which is the reason for their success (Anon., 2003).

23.2.7 Other Asian Wheat Noodles (Alden, 2003)

Chinese Egg Noodles

These wheat noodles are made with eggs, which add flavour, colour and body. They are often used to make *chow mein* (in which the cooked noodles are formed into a pancake and fried on both sides) and *lo mein* (in which the noodles are stir-fried along with the other ingredients). *Chow mein* noodles are usually cut a bit thinner than lo mein noodles, but the two can be used interchangeably. Chinese egg noodles are available both fresh and dried, and some are flavoured with shrimp. The fresh noodles are boiled in water for about 3 min, then dried for about 5 min. They are not to be confused with fried chow mein noodles, which are used in Americanized Chinese dishes, particularly Chinese chicken salad. Some brands are labelled "imitation noodles"; these are not made with eggs, but have yellow food colouring added.

Synonyms: *dan mien*

Substitutes: egg roll wrappers (slices into noodles), Chinese wheat noodles (more delicate), crispy *chow mein* noodles (Americans often use these to make *chow mein*), fettucine, linguine or spaghetti (round, not square).

Chinese Wheat Noodles

Mostly used in soups, fresh, dried, or frozen, and in various sizes, some as thin as vermicelli, others as thick and wide as fettuccine. Before using, the Chinese boil the noodles (about 3 - 4 min for fresh, 5 - 10 min for dried) and then rinse them in cold water.

[42] *Hydrolysis adjustment liquid consists of salt and* kansui *dissolved in water. It is used to improve the quality and flavour of the noodles. Between 10 and 30 g of salt and 1 to 2 g of* kansui *are normally used for every kg of wheat flour. For non-fried noodles, 3 to 6 g of* kansui *are used. A liquid solution is prepared for use in kneading the wheat flour into noodles.*

Tab. 125: National trends in instant ramen *demands (100 mio packets)* [a]

Country / Region	1998	1999	2000	2001	2002
China, Hong Kong	151.8	149.0	148.0	178.0	191.0
Indonesia	80.0	84.0	92.3	99.0	109.0
Japan	51.7	53.0	52.0	53.5	52.7
South Korea	36.0	37.8	37.8	36.4	36.5
USA	26.0	27.2	28.5	30.0	33.0
The Philippines	14.4	15.6	16.5	18.0	20.0
Thailand	12.0	15.1	15.9	16.5	17.0
Vietnam	9.0	10.0	10.5 [b]	11.4 [b]	17.0
Russia	2.5 [b]	5.0 [b]	5.5 [b]	6.9 [b]	15.0
Brazil	7.9	8.1	8.6	10.4	11.9
Taiwan	8.6	8.9	9.0	9.0	9.4
Malaysia	3.6	3.8 [b]	5.8	5.8	7.4
Mexico	1.5	2.0	3.5	5.3	6.4
UK	1.7	1.7	1.7	2.3	2.5
India	1.7	1.6	1.7	1.8	2.3
Poland, Hungary, Czech Republic	0.3	0.3	0.3	1.6	2.0
Australia	1.4	1.5	1.5	1.5	1.5
Canada	0.9	1.0	1.0	1.5	1.5
Germany	1.3	1.3	1.3	1.4	1.4
Cambodia	0.6	0.6	0.6	1.3	1.3
Singapore	1.0	1.1	1.2	1.2	1.2
Fiji and outskirt islands	0.8	0.8	0.8	0.8	0.8
Myanmar	0.7	0.7	0.7	0.7	0.7
Nepal	0.5	0.5	0.5	0.7	0.7
Saudi Arabia, UAE	0.6	0.6	0.6	0.6	0.6
South Africa	0.5	0.5	0.5	0.5	0.5
New Zealand	0.4	0.4	0.4	0.4	0.4
France	0.2	0.2	0.2	0.35	0.35
Norway, Finland, Sweden, Denmark	0.3	0.3	0.3	0.3	0.3
The Netherlands	0.3	0.3	0.3	0.3	0.3
Peru	0.1	0.1	01	0.1	0.2
Belgium	0.1	0.1	0.1	0.1	0.1
Others [c]	1.0	1.7	1.7	2.0	2.0
Total	**419.4**	**436.6**	**463.4**	**498.8**	**547.0**

[a] *Source: Anon., 2004* [b] *Estimated* [c] *Italy, Spain. etc.*

Synonyms: Chinese wheat starch noodles, *ganmien*
Substitutes: Chinese egg noodles (not as delicate) or Japanese noodles. The latter usually cook faster than Chinese noodles. Udon noodles should not be stir-fried – they are too soft. Other substitutes: crispy *chow mein* noodles, pasta rods or ribbons (starchier), *wonton* noodles or *ramen*.

Chow Mein Noodles

Egg and wheat flour noodles used to make *chow mein*, in which the cooked noodles are formed into a pancake and fried on both sides.
Substitutes: Hong Kong noodles, Chinese egg noodles or Chinese wheat noodles.

Crispy Chow Mein Noodles

These fried noodles add crunch to Chinese chicken salad and are also used to make chocolate haystack cookies. They are not to be confused with Chinese wheat noodles, which are sometimes also called *chow mein* noodles.
Synonyms: crunchy or fried *chow mein* noodles
Substitutes: rice vermicelli (deep-fried until crunchy; often used in Chinese chicken salad) or cooked spaghetti, deep-fried until golden.

Chuka Soba Noodles

These are Japanese *ramen* noodles that are dyed yellow and usually lower in fat.
Substitutes: *ramen, soba* or *saimin*

E-fu Noodles

Flat Chinese egg noodles formed into round 8 inch diameter patties, fried and then dried. Before using, they are briefly cooked in boiling water, and then drained. The noodles can then be added to stir-fries, soups, or salads.
Synonyms: *yee-fu* noodles, *yi* noodles, *yifu* noodles, *yi mien*
Substitutes: pancit canton or Chinese egg noodles or Chinese wheat noodles

Gook Soo

A staple food of Korea, these flat wheat noodles resemble fettuccine. They are usually served in a soup.
Synonyms: *gougsou* or *kooksoo*
Substitutes: *somen* or vermicelli

Hiyamugi

Pronunciation: *hee-yah-moo-ghee*. These slender Japanese noodles are often served cold. They are made from wheat flour.
Substitutes: *somen* noodles (thinner than *hiyamugi*, and made from buckwheat) or *udon* noodles (thicker than *hiyamugi*).

Hokkien Noodles

Egg and wheat flour noodles; popular in Malaysia and Singapore. They look like thick yellow spaghetti.

Hong Kong Noodles

These egg and wheat flour noodles are used to make *chow mein*. They are cooked in boiling water, then drained and fried.
Synonyms: Hong Kong-style noodles
Substitutes: *chow mein* noodles

Kishimen

Pronunciation: *kee-she-men*. These are flat and slippery Japanese wheat noodles. They are served both hot and cold.
Substitutes: *udon* (thinner)

Lo Mein Noodles

Popular Chinese egg noodles; often used to make *lo mein*, in which the noodles are stir-fried along with the other ingredients. They come in various sizes. Flat ones are used for stir-fries and the round ones for soups. They are available fresh, dried and frozen, in Asian markets.
Synonyms: Cantonese noodles, Cantonese-style noodles
Substitutes: Chinese egg noodles, fettuccine or Chinese wheat noodles

Mi Chay

These are Vietnamese wheat noodles
Synonyms: *m ì chay*

Miswa

Very slender Filipino wheat noodles; dried, they can be deep-fried to make a crunchy nest, or boiled for 2 - 3 min to make a salad, or added directly to soup.
Synonyms: *misua*
Substitutes: angel's hair pasta or vermicelli

Pancit

In their soups and stir-fries, Filipinos like to use *pancit canton*, yellow noodles made from wheat flour and coconut oil. Slippery corn-starch noodles (called *pancit luglug*) are used in soups and salads.
Synonyms: Filipino noodles

Pancit Canton

Dried yellow Filipino noodles used to make a dish called pancit. They are made with wheat flour, coconut oil and yellow food colouring.
Synonyms: flour sticks, *pancit mian*
Substitutes: *e-fu* noodles (very similar) or rice sticks

Saimin

These noodles are so popular in Hawaii that a soup based on them has been served at McDonald's restaurants there. They are similar to ramen noodles, but made with eggs and not deep-fried.
Substitutes: *ramen* or *chuka soba*

Shanghai Noodles

These thick noodles are often used in stir-fries or soups.
Synonyms: Shanghai-style noodles, *pancit miki, mi xau*
Substitutes: perciatelli or spaghetti

Somen

Pronunciation: *soh-mane*. Very thin Japanese wheat noodles, almost always served cold. They come in different colours, including *cha somen*, coloured with green tea, and *tomago somen*, flavoured with egg yolk. They have to be cooked for about 2 or 3 min.
Substitutes: *hiyamugi* (thicker), angel hair pasta, vermicelli, rice sticks, *soba, ramen* or *lo mein*.

Wonton Noodles

Thin Chinese egg noodles of various widths, usually served in soups. They are available both fresh and dried in Asian markets.
Synonyms: *won ton* noodles, noodles for soup, Chinese soup noodles
Substitutes: Chinese egg noodles or angel hair pasta

23.2.8 Wheat Used in Asian Noodles

Sources

The key noodle wheat growers and suppliers are the United States, Australia and Canada. In the U.S., Hard Red Spring and its subclass Dark Northern Spring, Hard Red Winter, Soft Red Winter, and Soft White wheats are used alone or blended for making noodle flour. A new wheat class, Hard White, has been expanding in production in recent years, targeting Asian products such as noodles and Chinese steamed breads. Australian wheat has been known for decades for its superior performance in Japanese-type noodle making because it gives desirable noodle colour and unique texture. Australian Standard White, Australian Premium White, Australian Hard, Australian Prime Hard and Australian Noodle wheat are the major types of noodle wheats. Canada Western Red Spring, Canada Western Red Winter, Canada Prairie Spring White and Canada Prairie Spring Red wheats are also competitive in noodle production. In many cases, different classes of wheat are blended to achieve relatively consistent quality noodle flour. Due to the complexity of noodle types, there is no single wheat type that can meet all quality requirements, not to mention that the consistency of wheat quality and supply also varies. (Hou and Kruk, 1998).

Quality Requirements

In many cases, physical quality measurements of wheat and wheat test methods are similar and independent of the end products. For example, wheat should be clean and sound, high in test weight, and uniform in kernel size and hardness. These characteristics result in efficient milling and high flour extraction, and, possibly, optimum quality end products. Wheat kernel hardness, diameter, weight and distribution can be measured using a Single Kernel Characterization System (see chapter 6.3, page 45).
Wheat kernel hardness deserves particular attention since it affects the tempering conditions, flour starch damage level, flour particle distribution and milling yield. Damaged starch not only absorbs more water but may also

Tab. 126: Flour specifications for Asian noodles [a, b]

Noodle type	Protein	Ash	Farinograph stability	Amylose content	Amylograph peak viscosity[c]
	%	%	min	%	BU
Chinese raw	10.5-12.5	0.35-0.41	≥ 10	-	≥ 750
Japanese *udon*	8.0-9.5	0.35-0.40	-	22-24	-
Chinese wet	11.0-12.5	0.40-0.45	-	-	≥ 750
Malaysian *hokkien*	10.0-11.0	≤ 0.48	-	-	-
Chuka-men	10.5-11.5	0.33-0.40	-	-	-
Instant fried	10.5-12.5	0.36-0.45	-	-	≥ 750
Thai *bamee*	11.5-13.0	≤ 0.46	-	-	-

[a] *Source: Hou and Kruk, 1998* [b] *14% moisture basis*
[c] *Method: 65 g flour + 450 mL distilled water. Amylograph heating cycle: heat from 30 to 95 °C at 1.5 °C /min; hold at 95 °C for 20 min; cool to 50 °C at 1.5 °C /min.*

reduce noodle cooking and eating quality. Accordingly, noodle wheat should not be too hard, and milling processes should be controlled to avoid excess starch damage. The uniformity of wheat kernel hardness appears to improve milling performance. Low ash content in flour is always an advantage for noodles since flour ash is traditionally viewed as causing noodle discoloration. One of the important noodle flour specifications is ash content, although there is no guarantee that low-ash flour can always make noodles with a desirable colour. The presence of polyphenol oxidase in the flour is believed to be partially responsible for noodle darkening. So it may be useful to measure the activity of this enzyme in the wheat.

Wheat protein content is often determined, and gluten strength can be evaluated by a sedimentation test. Different noodle types require different protein contents and dough strength. Generally speaking, Chinese-type noodles need hard wheat with a high protein content and strong gluten, and Japanese noodles require soft wheat with a medium protein content. Tab. 126 lists flour specifications for various types of Asian noodles, and Tab. 127 more specifically for instant noodles.
Generally, flour protein content has a positive correlation with noodle hardness and a negative correlation with noodle brightness. So there is an optimum flour protein content required for each noodle type. Japanese *udon* noodles require soft wheat flour of 8.0 - 9.5% protein. Other noodles require hard wheat flours with a high protein content (10.5 - 13.0%), giving a firmer bite and springy texture. Wheat with an ash content of 1.4% or less is always an advantage. Most noodle flours require an ash content below 0.5%, but premium quality noodles are often made from flours with 0.4% or less ash. However, ash content is not the only noodle flour quality indicator. In some cases, flour colour may be more related to noodle colour. Flour colour[43] L* >90 measured with a Minolta Chroma Meter is often required. Starch pasting characteristics (as measured on the Amylograph or the Rapid Visco Analyzer) also play an important role.

The ratio of amylose to amylopectin content determines a starch's pasting characteristics. An amylose content between 22 and 24% is often required for Japanese-type noodle making. Measurement of the pasting viscosity of flour or whole meal also relates to noodle quality, and eliminates a starch isolation step. However, the presence of excessive α-amylase activity (breaks down starch) in the flour or

[43] *L* = Lightness*

Tab. 127: Wheat flour specifications for various instant noodles [a]

Property		Common noodles	High quality noodles		Cup noodles
			General	Udon-type	
Moisture	%	13.5-14.0	13.5-14.0	13.5-14.0	13.5-14.0
Ash	%	0.50-0.54	1.40-0.44	0.39-0.42	0.40-0.45
Protein	%	10.3-10.6	9.4-10.6	8.5-8.7	11.0-11.5
Farinograph absorption	%	57.0-59.0	58.0-63.0	56.0-60.0	62.0-63.0
Wheat class		HRW-WW[b]	HRW-WW[c] or AH-ASW[d]	ASW or HRW-WW	HRW-DNS[e]

[a] *Source: Kim, 1996.*
[b] *Blend of the first and second grades (1:1) which is pro-duced from an equal mixture of Hard Red Winter and Western White wheats.*
[c] *All-purpose flour (the first grade flour produced from an equal mixture of HRW and WW).*
[d] *The first grade flour obtained from a mixture of 80% Australian Hard wheat and 20% Australian Standard White wheat.*
[e] *The first grade flour milled from 70% HRW and 30% Dark Northern Spring wheat.*

whole meal will undermine the predicted results because even a small quantity of the enzyme is likely to reduce the paste viscosity. The addition of certain α-amylase inhibitors to the test solution has been shown to improve the correlation between the viscosity of flour or whole meal and the eating quality of Japanese type noodles. Dough properties measured by other relevant tests (sedimentation test, and Farinograph and Extensograph measurements) are often also included in noodle flour specifications because they affect noodle processing behaviour and noodle eating quality. High sedimentation volumes indicate strong dough, which is good for Chinese style noodles that require a firm bite and springy texture. Extensograph parameters measure the balance of dough extensibility versus elasticity. Too much extensibility results in droopy dough, while too much elasticity causes difficulty in controlling final noodle thickness. Farinograph stability time has shown a positive relationship with Chinese raw noodle texture and tolerance in hot soup. It should be cautioned that noodle dough is much lower in water absorption than bread dough (28 - 36% versus 58 - 64%). Rheological tests, initially developed to evaluate bread dough performance, may not be applicable to noodle dough evaluation. There is a need to develop new tests specifically for relating the rheological properties of noodle dough to eating quality (Hou and Krug, 1998).

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Properties of Instant Noodle Flours Produced in Korea

Instant noodles accounted for 85.8% of the total wheat noodle production (727,567 t) in Korea in 2000 (Tab. 128). Bag- and bowl-type instant noodle products are available, the former representing 72.6% of the sales volume in 2000.

In a comparison of instant noodle flour (INF) from 4 Korean milling companies for bag-type and bowl-type instant noodles, the following properties were found (Shin and Kim, 2003):

Wheats used for the production of bag-type INF were Australian Standard White (ASW), Hard Red Winter (HRW) and Western White (WW), and blends of HRW, WW, and ASW. For bowl-type INF, hard wheats, such as Australian Hard (AH) and Dark Northern Spring (DNS), and blends of hard wheats or hard and soft wheats were used. The protein contents for bag- and bowl-type INF were 9.3 ± 0.5% and 11.3 ± 0.8%, respectively. Ash content was 0.41 ± 0.03% for both types of flours. Bag-type INF had higher yellowness values, smaller mean particle size, larger specific surface area, higher flour swelling volume and peak viscosity, and lower Farinograph water absorption, stability and resistance compared with bowl-type INF.

Of the approximately 1.8 mio t of wheat flour produced in Korea in 2001, the major applica-

tions were noodle (37.7%), bread (12.6%), and confectionery (9.3%) products. The volume of noodle products is given in Tab. 128. *Naengmvon*, which is an extruded Korean noodle product served in cold broth, contains a composite of wheat and buckwheat flours. Among wheat noodles, instant noodles accounted for 90.6% of the total production in 1990. This percentage has dropped in recent years, whereas the production of both dry noodles and *naengmyon* has generally increased.

In 2000, an estimated 48.6 billion packages of instant noodles were consumed worldwide. The major instant noodle-consuming countries are China (34.7% of total consumption), Indonesia (20.2%), Japan (11.3%), Korea (8.2%), and the United States (5.9%). The annual per capita consumption in Korea is approximately 80 packages, the highest of all the instant-noodleconsuming countries.

Unbleached flours produced from various blends of wheats are used for noodle production in Korea. Until the early 1990s, flour produced from an equal mixture of HRW and WW wheats from the United States was used for bag-type instant noodles, while a blend of HRW wheats (70 parts) and DNS wheats (30 parts) was used for bowl-type instant noodles. Australian wheats were introduced in 1985 and have now largely replaced HRW and WW.

23.2.9 Noodle Formulation

Seven Major Types

The huge number of Oriental noodle varieties around the world (Tab. 130) is the result of differences in culture, climate, region and other factors. Tab. 129 shows the formulation of seven major types of noodles. Chinese raw noodles and Japanese *udon* noodles have the simplest formulas, containing only flour, water and salt. Chinese raw noodles have proved very useful for screening noodle colour because of their simple formulation.

Chinese wet noodles and *chuka-men* (alkaline noodles) are characterized by the presence of *kansui* (alkali salt), while Malaysian *hokkien* noodles contain sodium hydroxide, which gives the noodles their characteristic yellowness, alkaline flavour, high pH and texture.

Both Chinese wet and *hokkien* noodles are parboiled types, while *chuka-men* can be either uncooked or cooked. Instant fried noodles usually contain guar gum or other hydrocolloids, which make the noodles firmer and easier to rehydrate upon cooking or soaking; polyphosphates allow more water retention on the noodle surface, thus giving them better mouth-feel. Native or modified potato starch or other equivalent starches are often added to premium instant fried noodles to provide

Tab. 128: Production of wheat flour noodle products in Korea [a]

Year	Dry noodles		*Naengmyon* [b]		Instant noodles		Others		Total
	t	%	t	%	t	%	t	%	t
1986	43,389	9.0	9,176	1.9	425,273	88.0	6,755	1.4	**484,593**
1988	36,809	8.1	9,771	2.1	387,764	84.9	22,488	4.9	**456,832**
1990	39,362	6.2	12,765	2.0	571,409	90.6	7,507	1.2	**631,043**
1992	50,781	9.6	21,724	4.1	426,210	81.2	32,526	6.1	**531,241**
1994	57,662	11.5	21,071	4.2	396,017	78.6	28,792	5.7	**503,542**
1996	56,881	9.4	20,474	3.4	496,667	82.1	30,600	5.1	**604,622**
1998	62,191	10.0	19,176	3.1	540,738	86.9	-		**622,105**
2000	76,734 [c]	10.5	26,777	3.7	624,056	85.8	-		**727,567**

[a] *Source: Shin and Kim, 2003*
[b] *Produced using a blend of wheat flour and buckwheat flour and extrusion.*
[c] *Including buckwheat noodles*

springy texture and improved steaming and cooking quality due to a lower gelatinization temperature. Thai *bamee* noodles are characterized by having 10% eggs in the formula. So egg source and quality are additional variables in *bamee* noodle quality (Hou and Krug, 1998).

23.2.10 Noodle Manufacturing Technology

Noodle-making and bread-making processes are quite different and require different testing protocols. Noodle production requires far less water than bread, using about 32 - 35% water addition or approximately half that of a bread dough. The small amount of water does not

Tab. 129: Formulas for major types of Asian noodles[a]

Ingredient (%)[b]	Chinese raw	Japanese *udon*	Chinese wet	Malaysian *hokkien*	*Chuka- men*[c]	Instant fried	Thai *bamee*
Flour	100	100	100	100	100	100	100
Water	28	34	32	30-33	32	34-37	28
Salt	1.2	2	2	2	1	1.6	3
Potato starch	-	-	-	-	-	0-12	-
Sodium hydroxide	-	-	-	0.5	-	-	-
Sodium carbonate	-	-	0.45	-	0.4	0.1	1.5
Potassium carbonate	-	-	0.45	-	0.6	0.1	-
Eggs	-	-	-	-	-	-	10
Guar gum	-	-	-	-	-	0-0.2	-
Poly-phosphates	-	-	-	-	-	0-0.1	-

[a] *Source: Hou and Krug, 1998*
[b] *Baker's percent, parts per 100 parts of flour*
[c] *Chuka-men is a Chinese-style yellow alkaline noodle widely consumed in Japan*

Tab. 130: Major types of Asian noodles[a]

Region	Type
China/Hong Kong	Instant fried, Chinese raw, dried, hand-made
Indonesia	Instant fried, Chinese wet
Japan	Chuka-men (Chinese-style yellow alkaline noodle), Japanese types (include hira-men, udon, hiya-mughi, somen), soba
Korea	Instant fried, dried, buckwheat noodles (momilguksu), udon (Japanese noodle), jajangmyeon (yellow alkaline noodle), hand-made noodles (kalguksu, sujebi), Korean types (include guksu, somyeon)
Malaysia	Hokkien, instant fried, Cantonese (alkaline raw), dried
The Philippines	Instant fried, dried, Chinese wet, udon
Singapore	Hokkien, Cantonese, instant fried
Taiwan	Chinese wet, Chinese raw, instant fried, dried
Thailand	Bamee, dried, instant fried
Europe, Africa	Instant fried
Latin/South America	Instant fried or dried
North America	Instant fried or dried, Chinese raw, udon, soba

[a] *Source: Hou and Krug, 1998*

allow the flour/water mixture to develop the viscoelastic character associated with bread dough. Fig. 209 illustrates the differences between noodle and bread production.

A wide variety of ingredients dissolved in the water are commonly added to the flour during the mixing process. White salted noodles require somewhere between 1 and 5% salt (NaCl), and Chinese alkaline noodles 1 to 3% alkaline *kansui* instead. In addition to ingredients, factors such as the size and shape of the noodles and the final treatment i.e. steaming and frying, steaming and drying, boiling or frying of raw noodles, etc. contribute to the vast number of noodle types.

Laboratory-Scale Method for Asian Noodles

Laboratory testing protocols tend to focus on the most common noodle types and employ standardized conditions in order to facilitate comparisons of different wheat flours. A typical lab-scale preparation of noodles is described below (Daniel *et al.*, 1998).

1. A small Hobart mixer is used for mixing the flour by itself for 30 s prior to the solution being slowly added over another 30 s. Care must be taken not to introduce the liquid too quickly, to avoid local areas of dough formation while others remain too dry.
2. The flour and the liquid are mixed for a total of 4.5 min to ensure an even distribution of the water and to form a uniform crumb consistency.
3. The crumbs are introduced into a small-scale noodle machine (Ohtake, Japan) and pressed between two temperature-controlled (28 °C) rollers which have a 3.0 mm gap setting.
4. After the first pass the noodle sheet is folded and passed through the rollers a second time.
5. A 25 cm piece is then cut from the sheet for use in the noodles. Knowing the size and weight of the noodle piece allows differences to be detected between flours under exactly the same conditions.
6. The noodle sheet is passed through the roller 6 more times, the gap and consequently the noodle thickness being reduced with each passage.
7. After the final pass the noodle sheet length is recorded to determine how much it has stretched. This measurement gives us some idea of the quantity and quality of the viscoelastic proteins in the wheat flour.
8. The noodle sheet is then passed through grooved rollers and cut into long strings, all of equal size.

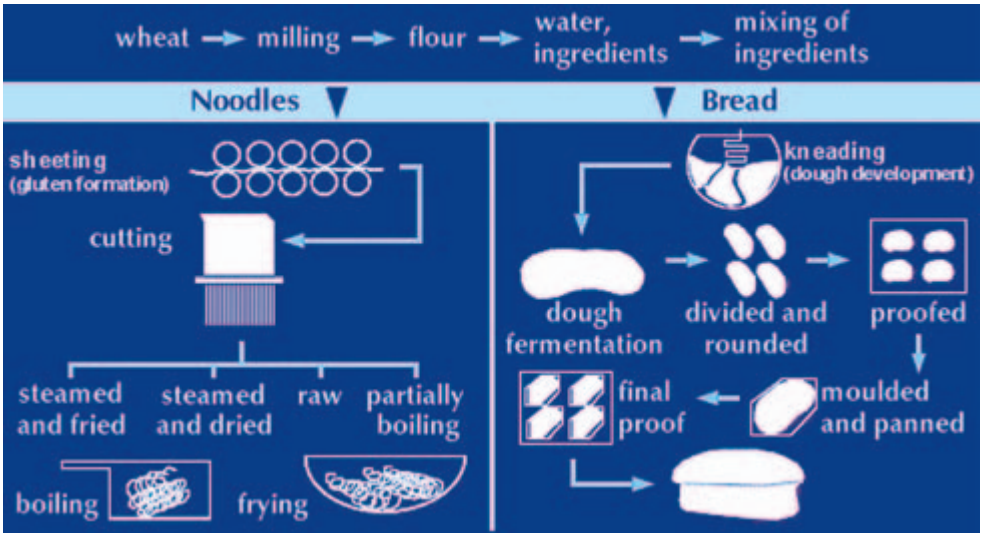

Fig. 209: Comparison of noodle-making and bread-making processes (modified from Daniel et al., 1998)

9. Some noodles are then dried in temperature and humidity controlled driers. Other noodles are immediately cooked. It is critical to optimally cook the noodle as overcooking dramatically changes its eating quality or "mouth feel".

Laboratory-Scale Procedure for White Salted Noodles

A number of researchers have described the lab-scale preparation of Japanese white salted noodles. A typical procedure is given here:
300 g of flour (14% m.b.), 96 mL of water and 6 g of salt are mixed with a flat paddle in a Hobart mixer for 6 min at slow speed. The resulting crumbly dough is sheeted between the steel rollers (diameter 180 mm, gap 3 mm) of an Ohtake (Tokyo, Japan) laboratory-type noodle machine; it is then folded end-to-end and put through the sheeting rollers twice. The dough sheet is rested for 1 h in a plastic bag to allow gluten development and then put through the sheeting rolls three times at progressively smaller gap settings of 2.83, 2.66, and 2.50 mm respectively to reduce the sheet to a final thickness of 2.5 mm. All sheeting operations are carried out in the same direction. This allows the gluten fibrils to align in the direction of sheeting, giving more strength to the noodle structure. The sheet is then cut with a No. 10 cutting roller into strips approximately 30 cm in length with a 0.30 - 0.25 cm cross section. The noodles are cooked in boiling water until the zone of gelatinization has extended throughout the noodles and are then evaluated for colour and textural characteristics.

Recently, Guo *et al.* (2004) desribed a laboratory scale method for white salted noodles using only 35 g of flour and compared it with a pilot plant method. They found a good correlation of both methods.

Laboratory-Scale Preparation of Instant Fried Noodles

Wheat flour (100 g, 14% m.b.), water (34 - 36 g) and sodium chloride (2 g) are blended in a Hobart mixer for 1 min at slow speed (speed 1) and 4 min at medium speed (speed 2) with a cake paddle. The crumbly mixture is pressed into a thick sheet (5.5 mm), rested for 15 min, then sheeted in seven consecutive steps to a final thickness of 0.8 mm. The dough sheet is cut into noodle strings 0.8 mm wide in a crinkly or wavy pattern by moving the collecting plate. Portions of this are then assembled into small blocks and steamed at atmospheric pressure for 3 min to partly gelatinize the noodle strands. The surface of the steamed noodles is dried by forced air at 25 °C for 4 min. The noodles are placed in a wire basket fitted with a lid, and the basket is submerged in hot palm oil (177 °C) for 50 s. The excess oil is drained off the fried noodles for 2 min, and the noodles are then cooled to room temperature for 2 h and stored in a plastic bag until further testing.

Laboratory-Scale Production of Yellow Alkaline Noodles

The basic procedure for making alkaline noodles is similar to that for white salted noodles. The ingredients – 300 g flour (13.0% m.b.), 96 mL water, Na_2CO_3 (2.7 g), and K_2CO_3 (0.3 g) – are mixed in a Hobart mixer for 1 min at slow speed, 1 min at fast speed, and then for 3 min at slow speed. The crumbly dough is sheeted between steel rollers, 2.75 mm apart, in an Ohtake noodle machine. The dough sheet is folded, passed between the rollers twice, and then allowed to rest for 30 min in a plastic bag. The single sheet of dough is then passed between the rollers, with the clearance successively reduced to 2.5, 2.0, and 1.5 mm. The sheet is finally cut into strips with a cross section of 1.5 mm × 1.5 mm. After standing for 3 h at 25 °C, the noodles are placed in wire mesh and cooked in boiling water until the uncooked core has disappeared (~5 min).

Hand-Made Noodles

The art of making hand-made noodles (*tenobe* in Japanese, *la mian* in Chinese and *jajangmyeon* in Korean; Parkinson, 2004a) is rapidly being replaced by mechanized processes, but the traditional noodles have greater value because of their fine texture and pleasant eating quality. Variations of hand-stretched noodles are single hand-stretched noodles, hollow hand-stretched noodles, very

thin noodles; flat noodles, noodles stretched in water, oiled-stretched noodles, and stuffed hand-stretched noodles. The superior textural quality of hand-made noodles is due to the mode of gluten formation (Ang *et al.*, 1999). Hand-pulled noodles are made from a dough of pastry flour (6 parts), regular enriched flour (1.5 parts), and water (3.5 parts). The dough is kneaded until smooth, covered with a wet towel and refrigerated overnight. The next day, it is kneaded for about 10 min until smooth and elastic, then rolled into a long cylinder, 2 to 3 inches in diameter. Holding on to each end of the dough, the noodle-maker raises it above his head and, with a wrist-snapping motion, whacks it against the work surface. It is folded in half after each whack. This process is repeated several times, the work surface being lightly floured to prevent the dough from sticking. This beating action relaxes the gluten and continually stretches the dough. The dough is now ready for pulling and stretching. With both ends held it is pulled and stretched, and the two ends are then quickly folded together. The pull-stretch-fold technique is continued, increasing the number of threads and resulting in many whisker-fine strands of dough. The stretched noodles are boiled for approximately 3 min, and drained (Parkinson, 2004b; Fig. 210).

Processing for Machine-Made Noodles

The basic processing steps for machine-made noodles are outlined in Fig. 211. These steps involve mixing raw materials, resting the crumbly dough, sheeting the dough into two dough sheets, compounding the two sheets into one, gradually sheeting the dough sheet into a specified thickness and slitting into noodle strands. Noodle strands are further processed according to noodle types (Hou and Krug, 1998).

Mixing Ingredients

Mixing the ingredients of the formulation is often carried out in a horizontal or vertical mixer for 10 - 15 min. Since the horizontal mixer seems to achieve better results, it is more commonly used than the vertical one in commercial noodle production.

Mixing results in the formation of crumbly dough with uniform particle sizes. Since relatively little water is added as compared to bread dough, gluten development in noodle dough during mixing is minimized. This improves sheetability, sheeted dough smoothness and uniformity. Limited water absorption also slows down noodle discoloration and reduces the amount of water to be taken out during drying or frying.

Flour proteins, pentosans and starch (especially damaged starch) determine water absorption. Water absorption in noodle dough is not as sensitive to processing as in bread dough. Variations in noodle-dough water absorption between different flours are generally within 2 - 3%, and this is usually determined by dough handling properties. The size of the flour particles and their distribution affect the time the water takes to penetrate into the flour. Coarser flours require a longer time and tend to form larger dough lumps. If the particles are too small, the water hydrates the first particles too quickly, not leaving enough water for others. It is desirable to have flours of relatively fine and evenly distributed particle size to achieve optimum dough mixing.

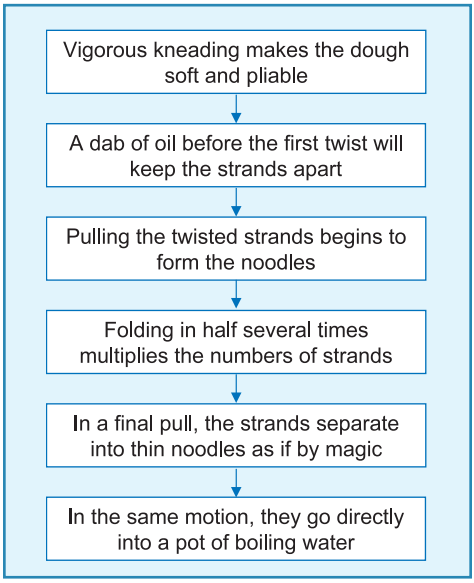

*Fig. 210: Hand-made noodle (*la mian*) process*

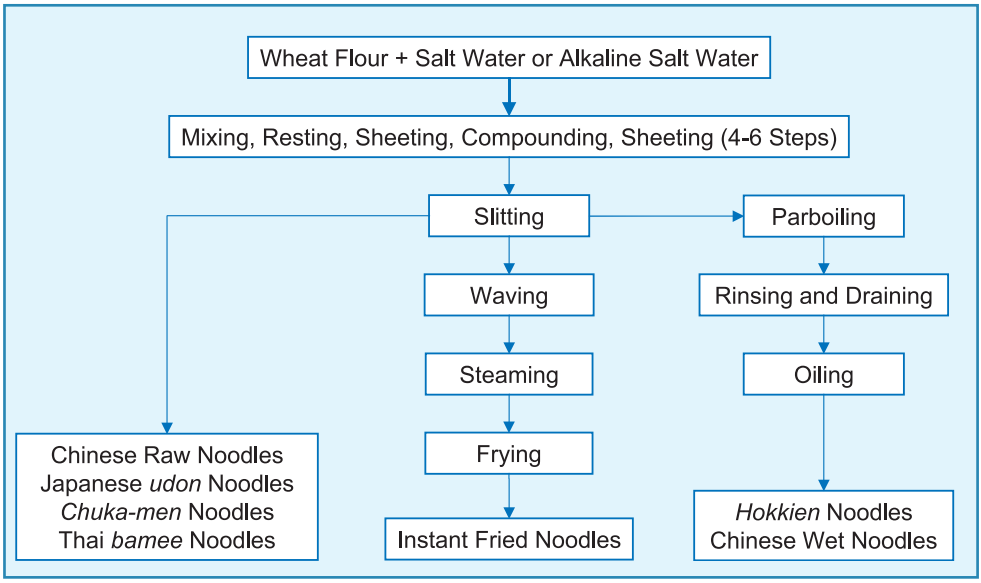

Fig. 211: Noodle-making process (modified from Hou and Krug, 1998)

Dough Resting

After mixing, the dough pieces are rested for 20 - 40 min before compounding. Dough resting helps the water to penetrate the dough particles evenly, resulting in a smoother and less streaky dough after sheeting. In commercial production, the dough is rested in an intermediate container and stirred slowly.

Sheeting and Compounding

The rested, crumbly dough pieces are divided into two portions, each of which is passed through a pair of sheeting rollers to form a noodle dough sheet. The two sheets are then combined (compounded) and passed through a second set of sheeting rollers to form a single sheet. In some cases a third dough sheet is introduced to obtain different rheological properties within the cross-section (Fig. 212). The roller gap is adjusted so that the dough thickness reduction is between 20 and 40%.

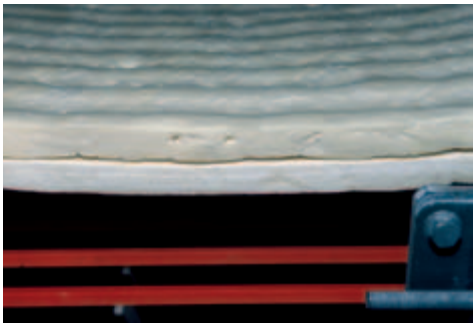

Fig. 212: Dough sheet for udon *noodles*

Second Dough Rest

The combined dough sheet is often carried on a conveyor belt through a temperature and humidity controlled cabinet for 30 – 40 min. This step is to relax the dough for easy reduction in the subsequent sheeting operation.

Sheeting, Slitting and Waving

Further dough sheeting is carried out on a series of 4 - 6 pairs of rollers with decreasing gaps (Fig. 213). At this stage, roller diameter, sheeting speed and reduction ratio determine optimum sheeting.

Noodle slitting is done by a cutting machine (Fig. 214), which is equipped with a pair of calibration rollers, a slitter, and a cutter or waver. The final dough sheet thickness is set

Fig. 213: Reduction rollers in a ramen line (source: H. Moegenburg, Muehlenchemie Asia Pte. Ltd.)

on the calibration rollers according to noodle type and measured using a thickness dial gauge. The desired noodle width determines the size of the noodle slitter to be used (noodle width, mm = 30/slitter number). The sheet is cut into square or round noodle strands of the desired width by using different slitters (Tab. 131). The strands are then cut into the desired length by a cutter. At this stage, Chinese raw noodles, Japanese udon noodles, *chuka-men* and Thai *bamee* noodles are finished. For instant noodles, the strands are subsequently waved before steaming and cutting.

Tab. 131: Dimensions of Asian noodle strands[a]

Noodle type	Thickness mm	Width mm	Slitter number
Chinese raw	1.2	2.5	12
Japanese *udon*	2.5	3.0	10
Chinese wet	1.5	1.5	20
Malaysian *hokkien*	1.7	1.7	18
Chuka-men	1.4	1.5	20
Instant fried	0.9	1.4	22
Thai *bamee*	1.5	1.5	20

[a] *Hou and Krug, 1998*

Fig. 214: Noodle (ramen) cutting machine

Cooking Noodles

The cooking process is either parboiling, boiling, or steaming. *Hokkien* noodles and Chinese wet noodles are usually parboiled for 45 - 90 s to achieve 80 - 90% gelatinization of the starch. The noodles are then coated with 1 - 2% edible vegetable oil to prevent the strands from sticking together. Parboiled noodles have an extended shelf-life (2 - 3 days) and high weight gain (60 - 70%) when they are quickly re-cooked by boiling or stir-frying prior to consumption. Several steps can be taken to ensure optimal cooking: (a) the weight of the cooking water is at least 10 times that of the uncooked noodles, (b) the size of the boiling pot is properly chosen, (c) the pH of the boiling water is 5.5 - 6.0, (d) the cooking time is precisely controlled to give optimal results to the product, and (e) the cooking water temperature is carefully maintained at 98 - 100 °C throughout the boiling process.

Japanese *udon* noodles (Fig. 215) are boiled for 10 - 15 min, rinsed and cooled in running water, steeped in dilute acidic water before packing, and then treated for more than 30 s in a pressurized steamer. This type of noodle usually has a shelf-life of 6 months to one year. It is also called "longevity noodle".

Fig. 215: Continuous cooking of udon *noodles*

For instant noodles, the wavy noodle strands are conveyed to a steamer. As mentioned earlier, the purpose of steaming is to gelatinize the starch and fix the noodle waves. The steaming time varies according to noodle size, but can be determined by squeezing a noodle strand between two clear glass plates. If the white noodle core has disappeared, the noodles are well cooked. Steaming temperature, pressure and time are key process factors affecting product quality.

Drying Noodles

Noodles can be dried by air, deep-frying or vacuum drying. The air-drying process has been applied to many noodle types such as Chinese raw noodles, Japanese *udon* noodles and steamed and air-dried instant noodles. Air-drying usually takes 5 - 8 h for regular noodles (long and straight) and 30 - 40 min for steamed and air-dried instant noodles. Drying by frying takes only a few minutes. Vacuum drying of frozen noodles is a newer technology making it possible to produce premium quality. For the manufacture of regular dry noodles, raw noodle strands of a certain length are hung on rods in a drying chamber with controlled temperature and humidity. Air-drying usually involves multi-stage processes, since too rapid drying causes checking. In the first stage, a low temperature (15 - 20 °C) and dry air are applied to reduce the noodle moisture content from 40 - 45% to 25 - 27%. In the second stage, air of 40 °C and 70 - 75% relative humidity is used to ensure moisture migration from the interior of the noodle strands to the outside surfaces. In the final stage, the product is further dried using cool air. For the manufacture of air-dried instant noodles, wavy noodle strands are first steamed for 18 - 20 min at 100 °C, then dried for 30 - 40 min using blast air at 80 °C. The dried noodles are cooled prior to packaging. Air-dried instant noodles have a low fat content, so some people prefer them. Steaming appears to be very critical to this type of noodle since it affects the rehydration

rate of the product. However, the slow output of the process and the lack of a pleasant shortening taste and mouth feel make the product less popular in Asia compared with instant fried noodles. Drying by frying is a very fast process. Water vaporizes quickly from the surface of the noodles when they are dipped into the hot oil. Dehydration of the surface causes water to migrate from the interior to the exterior of the noodle strands.

Instant Ramen Making Processes

For most types of noodles, 10 separate manufacturing processes are required. The first 5 processes are to make the raw noodles. In the next processes, the noodles are pre-cooked, processed to allow easy storage and instant re-cooking, and packaged (Anon., 2004).

Mixing the Hydrolysis Adjustment Liquid

In this process, a liquid solution is prepared for use in kneading the wheat floor into noodles. This hydrolysis adjustment liquid consists of salt and *kansui* dissolved in water. It is used to improve the quality and flavour of the noodles.

Mixing/Kneading

The wheat flour and hydrolysis adjustment liquid are mixed and kneaded in a mixer for 15 - 20 min to produce noodle dough. For each kg of flour, 0.3 to 0.4 kg of hydrolysis adjustment liquid is added, at a temperature of 20 to 30 °C. It is the fine structure achieved by kneading the dough that gives the noodles their special quality of viscosity and elasticity.

Rolling/Blending

The dough is passed through a pair of rollers to form sheets.

Next, two sheets of dough at a time are rolled together and blended into a single sheet. This gives the sheets of noodle dough strength and consistency. The sheets of dough are now about 10 mm thick. Great care must be taken during this process – if the rollers are set too close together, the quality of the dough suffers. For some types of noodles, the dough is set aside to rest for a certain time before this process.

Rolling/Stretching

The stretching machine consists of at least 4 pairs of roller, each pair further stretching and thinning out the sheet until it is only 1 mm thick. This process helps to weave together the strands of gluten protein in the dough to give the noodles their supple, elastic texture. Uniform thickness is ensured by checking with instruments that can measure to an accuracy of 1/100 mm.

Cutting

After stretching, the sheets of dough are passed through a cutting machine where rotating blades slice the sheets into individual strands of noodle. No. 18 to No. 22 cutters are used for Chinese-style noodles, while No. 10 to No. 26 cutters are used for Japanese-style noodles (Tab. 131). Most *ramen* have a wavy shape. This is obtained by a separate process, using a shaping machine and a special conveyor.

Steaming

The raw noodles are then pre-cooked by passing them through a continuous steamer, normally at 100 °C for 1 - 5 min. This process causes gelatinization, improving the digestibility and texture of the noodles.

Moulding

Most types of instant noodles are cut to length and shaped into blocks for packaging into individual serving sizes. Apart from noodles sold as straight bundles, these servings are then shaped into blocks using round or square moulds.

Drying

Two main methods are used for drying:

a) In the frying method, the noodles are deep-fried in metal frames at 140 - 150 °C for 1 - 2 min. This reduces the water content of the dough from 30 - 40% to just 3 - 4%, and promotes further gelatinization.
b) In the non-frying method, the noodles are dried in metal frames for at least 30 min at around 80 °C. They are called gelatinized dried noodles.

Other, less common, drying methods include freeze-drying.

Cooling

After the drying process, the noodles are cooled to room temperature or less using blast air. At this stage, various inspections are performed. Noodles are checked for weight, shape and colour, and to ensure that they have been correctly dried, fried and cooled.

Packaging

The finished blocks of noodles are now packaged together with separate pouches of seasonings or *kayaku* (extra ingredients like green onions). Bag-type noodles are sealed in soft film, while cup-type noodles are sealed into their containers using aluminium foil lids, etc.

The increased interest in additives to optimize the quality of instant noodles reflects the harshly competitive, and declining, market for commonly packaged *ramen*. However, there is still a healthy and growing market for premium types such as cup noodles (Ang *et al.*, 1999).