# Fortification Basics

## Instant Noodles[1]: A Potential Vehicle for Micronutrient Fortification

### Introduction

Instant noodles appear to have originated in Japan in the 1950s and, today, are produced in over 80 countries worldwide. In 2001, over 1 million MT of instant noodles were produced in China, about 700,000 MT in both Japan and Indonesia, 270,000 MT in South Korea, 200,000 MT in Vietnam, 80,000 MT in Thailand, 50,000 MT in Taiwan, and 40,000 MT in the Philippines. Convenience and affordability are important factors contributing to its increasing popularity. Consumption has risen steadily since 1995 in several Asian countries, except in Japan where it has remained stable (Table 1). In 2001 per capita annual consumption of instant noodles ranged from about 5.5 kilograms in South Korea and Japan to 0.57 kilograms in the Philippines.

Table 1
**Per capita annual consumption (kilograms per person per annum) of instant noodles in selected Asian countries**

| Country | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|
| South Korea | 4.016 | 4.137 | 4.266 | 4.965 | 5.213 | 5.385 | 5.537 |
| Japan | 5.649 | 5.681 | 5.610 | 5.507 | 5.496 | 5.507 | 5.586 |
| Indonesia | 2.543 | 2.823 | 3.078 | 2.901 | 3.095 | 3.219 | 3.363 |
| Vietnam | 0.956 | 1.043 | 1.187 | 1.394 | 1.690 | 2.074 | 2.550 |
| Taiwan | 1.880 | 1.942 | 2.004 | 2.004 | 2.040 | 2.004 | 2.058 |
| Thailand | 0.758 | 0.849 | 0.994 | 1.042 | 1.138 | 1.244 | 1.362 |
| China | 0.512 | 0.534 | 0.577 | 0.692 | 0.822 | 0.898 | 0.988 |
| Philippines | 0.278 | 0.316 | 0.358 | 0.403 | 0.452 | 0.506 | 0.570 |

Source: EuroMonitor Report, May 2002.

The increasing consumption of noodles has led to concerted efforts to explore the feasibility of using instant noodles as a vehicle for micronutrient fortification. While several technological and implementation challenges remain, this food appears to have the potential to be an effective food vehicle for micronutrient fortification.

### Production of Instant Noodles

Instant noodles are made from wheat flour, starch, water, salt or kan sui (an alkaline salt mixture of sodium carbonate, potassium carbonate, and sodium phosphate), and other ingredients that improve the texture and flavor of noodles (Table 2). Other flours may be mixed with wheat flour to make specific types of instant noodles; for example, buckwheat flour is added at 10-40% of wheat flour in the production of buckwheat noodles or soba. The popular noodles include instant Chinese noodles, instant Japanese noodles, and instant European style noodles, which vary in the basic ingredients used to make the noodles. Instant Chinese noodles use kan sui, whereas instant Japanese noodles do not, and the European style noodles often are made with semolina (a coarse ground product of durum wheat).

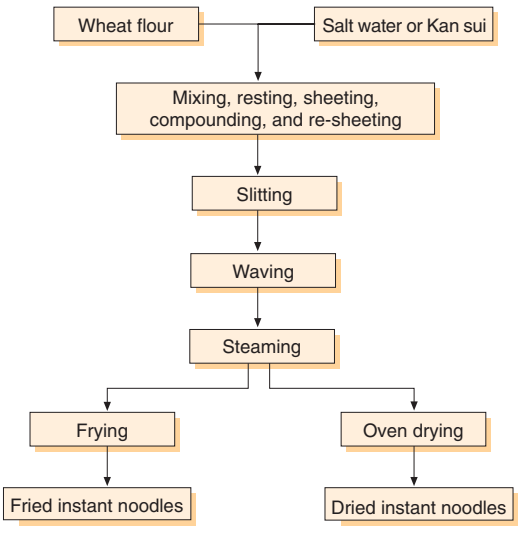
The first step in noodle manufacturing involves dissolving the salt or kan sui, starch, flavorings, and other ingredients (except flour) in water (Figure 1). This mixture is added to the flour and the crumbly dough is rested to mature and then kneaded to uniformly distribute the ingredients and hydrate all the flour particles. The dough is then passed through two rotating rollers to produce two sheets which are compounded into a single noodle belt or sheet. The sheet is repeatedly folded and passed through the rollers to facilitate gluten development, which gives the noodle its stringy and chewy texture. The gap between the finishing rolls is adjusted to produce the desired thickness of the noodle belt that is then immediately cut. The wavy noodles are produced by setting the conveyor belt at a slower pace than the cutting rolls above it. Alternatively, noodle strands emerging from the slitter are hindered by metal blocks (weights) resulting in the

Table 2
**Ingredients used in the manufacture of instant noodles**

| Ingredients | Approximate amount |
|---|---|
| **Main ingredients** | |
| Wheat flour | 85-94% |
| Water | As needed to make the dough |
| Salt (or Kan sui) | 1-3% (or 0.5-1% of kan sui) |
| **Additional ingredients** | |
| Starch | 1-2% |
| Edible oil | 1-3% |
| Antioxidants | Minimum needed for technical effect; varies with antioxidant used |
| Stabilizers | 0.1-0.5% |
| Emulsifiers | 0.1-0.5% |
| Eggs/egg powder | 1-3% |
| Vital gluten | ~2% |
| Polyphosphates | 0.1-0.2% |
| Preservatives | Minimum needed for technical effect; varies with preservative used |
| Colorings | As needed |

Adapted from: Hou G. 2001. Oriental noodles. Adv Food Nutr Res 43:140-93.

Figure 1
**Simplified flow chart of instant noodle-making procedure**




Adapted from: Hou G. 2001. Oriental Noodles. Adv. Food Nutr Res 43:140-93.

1. This document does not include fortification of traditional noodles such as spaghetti, macaroni, or other pasta products.

Figure 2
**Instant noodle-making production lines**

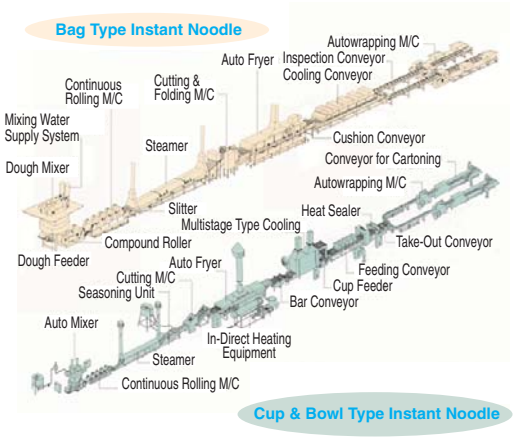
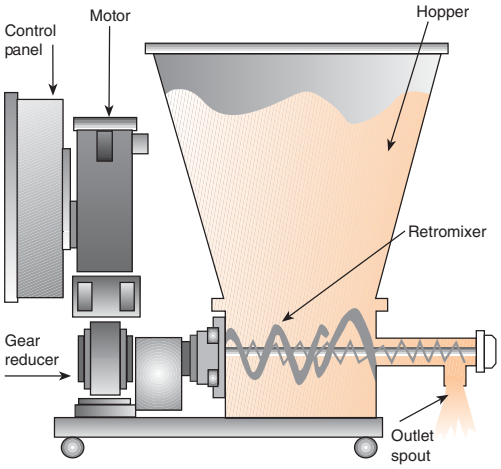



Figure 3
**Volumetric feeder for adding micronutrient premix**




**Information poster on fortified instant noodles in Thailand**


*Source: Nutriview 2000/1*

noodle waves. Liquid seasonings are sometimes added to the noodle strands prior to cutting and molding into blocks or another suitable shape. The noodles are then steamed at 100 ºC for 1-5 minutes, which gelatinizes the starch and improves the texture of the noodles.

The next step is drying the noodles either by frying in oil (fried instant noodles) or drying with hot air (non-fried instant noodles). Frying the noodles in oil at 140-160 ºC for 1-2 minutes decreases the moisture content of noodles from 30-50% at the steaming step to about 2-5%. While any edible oil is suitable for frying, palm oil or palm olein is often used in Asia and mixtures of canola, cottonseed, and palm oils are commonly used in North America. In hot air drying, the noodles are held at 70-90 ºC for 30-40 minutes to achieve an 8-12% moisture content. The heating during frying or hot air drying further gelatinizes the starch and the noodles now obtain a porous texture. Frying is the preferred method of drying and more than 80% of instant noodles are fried because hot air drying can result in uneven drying that adversely affects the texture of the finished noodles. Non-fried instant noodles also require a longer cooking time. The disadvantage of frying, however, is that fried noodles contain about 15-20% oil (compared with a maximum of 3% fat in hot air-dried noodles) and are more susceptible to oxidation and spoilage; the use of antioxidants prolongs the shelf life of fried instant noodles. The dried noodles are then quickly cooled, checked for moisture, color, shape and other quality characteristics, and packaged with seasonings using films that are impermeable to water and air.

Instant noodles are commercially available in two packaged forms - in a cup with the seasoning sprinkled over the noodles or in a pouch (or bag) with the seasoning provided in a sachet inside the pouch. Figure 2 shows the production line to manufacture these two types of instant noodles. Instant noodles come in several different flavors added to the seasoning - beef, chicken, pork, shrimp, oriental, creamy chicken, chicken mushroom, and others. In the cup style instant noodles, dehydrated vegetables and meats, as well as textured soy protein or flour are often added. Because of their low moisture content and a fairly high sodium content (about 2,100 mg per 100 g product), and the resulting low water activity, instant noodles are stable and have a shelf life of 4-6 months in tropical areas and 6-12 months in the northern hemisphere.
They can be served after boiling in water for 1-2 minutes or soaking in hot water for 3-4 minutes.

### Fortification of Instant Noodles

To ensure that the most vulnerable groups of the population benefit from food fortification, the food vehicle must be consumed on a regular basis and in regular amounts throughout the year by a large proportion of the population. It should also be a food that is centrally manufactured by few plants so that micronutrients can be added under controlled conditions and monitoring can be done effectively. Both the choice of micronutrients and the amounts to add must be based on the consumption patterns of the food vehicle and micronutrient needs of the population, while still remaining within the safe upper limits of micronutrient intake. In the case of instant noodles, a non-staple food, a micronutrient fortification level of 10-30% of the RDA per serving (typically about one package of 55 grams) can complement well any existing fortification of staple foods. The bioavailability of the fortificant also needs to be considered in determining the amount of fortificant added. In addition, fortificants must be chosen so as not to alter the organoleptic properties or shelf life of the food.

Instant noodles can be fortified either by fortifying the flour used to make the noodles or by fortifying the seasoning consumed along with the noodles. Micronutrients including vitamin A, $B_1$, $B_2$, niacin, folic acid, iron, and iodine can be added although the micronutrients and their overages will vary with each approach. Choosing the appropriate form of fortificant is important to minimize nutrient-nutrient as well as nutrient-food interactions and any resulting adverse effects. Iron, for example, is a difficult mineral to add to foods as the most bioavailable forms tend to promote fat oxidation resulting in the development of unacceptable sensory changes in the finished food. Whereas dried ferrous sulfate is the preferred form of iron to fortify wheat flour that is used within 1-2 months of production, electrolytic iron (of particle size: 98% <48 μm) or ferrous fumarate are better suited for wheat flour that is stored for a longer time[2] before being used in instant noodles production. Electrolytic iron may be also an appropriate form of fortificant for instant noodles seasoning to minimize sensory problems. The use of encapsulated fortificants will minimize interactions but these forms are expensive

2. Nestel P. and Nalubola R. 2002. INACG Technical Brief. Technical brief on iron compounds for fortification of staple foods. INACG (ILSI), ILSI Press, Washington, D.C.

and may increase the cost of fortification and, consequently, may negatively influence the affordability of the food by the vulnerable segments of the population. Additionally, the bioavailability of encapsulated iron fortificants and their stability during food processing, especially at elevated temperature and pressure conditions characteristic of extrusion used in noodle making, are not known.

***Flour fortification*** - Wheat flour fortification at the mill has long been practiced throughout the world and involves relatively simple technology. The fortification process is accomplished by adding a micronutrient premix through a volumetric feeder (Figure 3) located towards the end of the milling process. Micronutrients are usually added together in the form of a single premix because it provides better control over the concentration and distribution of micronutrients in the flour. When considering fortification with multiple micronutrients, it is important to consider interactions among the nutrients and, if necessary, use separate vitamin and mineral premixes. Used as an ingredient, wheat flour that is fortified can result in a fortified instant noodle provided appropriate considerations are given to the effects of the noodle making procedures on the stability of the nutrients added to flour. When flour is fortified at the instant noodle manufacturing plant, a volumetric feeder and mixer added early on in the production line prior to the mixing of flour with the salt/kan sui liquid will adequately fortify the flour before it is made into a dough and fed into the rollers. In the production line illustrated in Figure 2, fortificants may be introduced immediately prior to the "dough mixing" step. It is important to ensure proper mixing and even distribution of the micronutrients in the flour before dough formation.

***Seasoning fortification*** - Fortifying the seasoning consumed along with the noodles is commonly practiced in some parts of the world. In commercial preparations of fortified instant noodle seasoning in South East Asia, fortificants are added along with the other seasoning ingredients to a ribbon blender and mixed thoroughly. The fortified seasoning is then packaged into a sachet (for pouch style) (Figure 4) or sprinkled over the noodles (for cup style). In the production line illustrated in Figure 2, the fortified seasoning is introduced as a sachet immediately prior to the "auto wrapping" step for pouch style of instant noodles, and between the "feeding conveyor" and the "heat sealer" for the cup style of instant noodles. It is important to ensure proper mixing and even distribution of the micronutrients in the seasoning mixture. Fortifying the seasoning rather than the flour has an advantage in that the fortificants are not exposed to heat and moisture related to noodle processing. In addition, the fortificants are better protected being packed in a sachet in the pouch type of instant noodles. While it is relatively simple to add the fortificants, the challenge of ensuring the stability of the nutrients in the seasoning mixture throughout the shelf life of the instant noodles remains. This challenge is greater as more micronutrients are added because micronutrients interact not only with each other but also with other ingredients in the seasoning matrix. However, at least three countries - Thailand, Indonesia, and the Philippines - have succeeded in fortifying instant noodles seasoning at a commercial level. Thailand and Indonesia are currently evaluating its use as a public health intervention and exploring ways to improve the formulation and effectively implement a national fortification program.

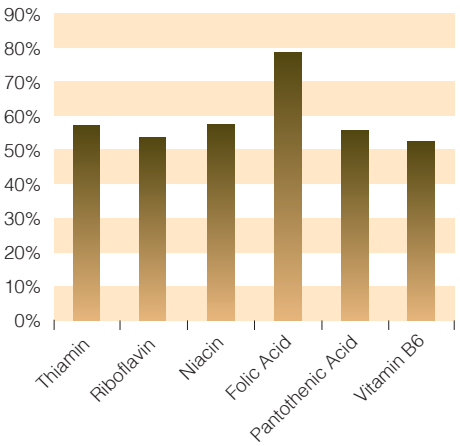
### Stability of Micronutrients

Data on the stability of micronutrients added to wheat flour during processing, storage, and cooking of instant noodles are not available. However, micronutrients are routinely added to wheat flour that is made into traditional noodle products such as spaghetti, macaroni, and other pasta products. Minimal losses of the B-vitamins were observed during noodle production with 80-100% retention after drying at a temperature of 75°C. About 60-75% of the B-vitamins added to flour were retained after cooking the noodles (Figure 5). Based on these data and given the similarity in the exposure of food and micronutrients to different processing factors (heat, pressure, and moisture) between pasta and instant noodle production, micronutrients added to wheat flour are expected to be fairly stable during the manufacture of instant noodles as well as during subsequent cooking/soaking.

Vitamins added to the seasoning sachet are also stable, although their stability varies with the type of packaging, seasoning ingredients, and moisture content of the seasoning mixture. Ideally, the sachet for the seasoning mixture should be impermeable to light, moisture, and air. Packaging with aluminized polyethylene/polypropylene films is advisable. Using optimum packaging, data from Hong Kong show that about 85-100% of vitamins, including A, C, $B_1$, $B_2$,

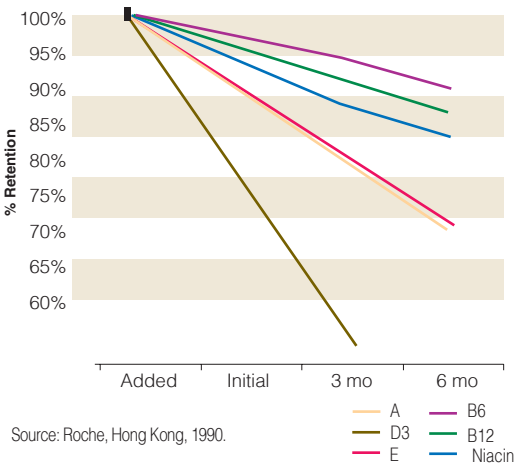
Figure 4
**Seasoning sachet-forming machinery**


Figure 5
**Retention of vitamins in cooked noodles***




Source: Cereal Chem 62 (6): 476-477,1986.
* This study was done on traditional noodles, not instant noodles.

Figure 6
**Stability of vitamins in instant noodles seasoning during processing and storage at room temperature**




Source: Roche, Hong Kong, 1990.

niacin, $B_6$, $B_{12}$, folate, biotin, pantothenic acid and E added to the seasoning mixture were retained after 3 months of storage at room temperature. As vitamins are gradually lost, about 75-90% of the added levels were retained after 6 months of storage (Figure 6). In Thailand, vitamin A palmitate, encapsulated reduced iron, and potassium iodide added to seasoning were stable for up to 3 months at room temperature.

Micronutrients added to the seasoning remain uniformly distributed during storage, although some settling was observed in studies in Thailand. The micronutrient premix can be formulated to avoid or minimize adverse effects on the sensory characteristics of the seasoning mixture or the finished instant noodles. For example, studies in Thailand showed that ferrous fumarate and iron EDTA reacted with some ingredients (such as nutmeg) of the seasoning mixture resulting in an unacceptable black color of the instant noodle soup. Encapsulated reduced iron, on the other hand, did not produce any adverse effects on the seasoning mixture or the finished instant noodles. The bioavailability of this form of iron fortificant, however, is not known.

## Quality control

Quality assurance and control ensures that the manufactured food is safe, unadulterated, properly labeled, and meets all company quality specifications and any government regulations. Quality control procedures for the fortification step can be easily incorporated into the existing quality assurance system for the manufacture of instant noodles. The micronutrient premixes must be tested against reference standards. Periodic testing must be done to ensure that the desired amounts of micronutrients are in the final product, especially the ones that are most unstable, such as vitamin A. Quality criteria should be established for all key characteristics of the product, including fortification levels. Facilities, procedures, and properly trained staff are, therefore, essential.

Determination of vitamins A, $B_1$, $B_2$, niacin, $B_6$, and folic acid is done using quantitative methods that employ the use of an HPLC or a spectrophotometer. Minerals such as iron can be determined using atomic absorption or spectrophotometric methods. When instant noodles are fortified with more than one micronutrient using vitamin mineral premixes, one micronutrient (for example, iron) may be chosen as a reference nutrient and its level determined during routine quality control procedures. All micronutrients, however, should be determined occasionally to ensure adequate fortification with all micronutrients intended to be present in the food.

## Cost

The cost of fortifying instant noodles includes the cost of the micronutrient premix, equipment (feeders and/or mixers), equipment maintenance, and added cost of quality control and personnel. The retail price of a 55 gram instant noodle package is about 2-18 roubles (US$ 0.05-0.48) in Russia, 5.00 baht (US$ 0.12) in Thailand, and 800 rupiah (US$ 0.09) in Indonesia. In Thailand, adding 20 mg of a micronutrient premix to the seasoning to provide 267 µg of vitamin A, 5 mg of iron as encapsulated reduced iron, and 50 µg of iodine as potassium iodide per package of instant noodles is estimated to cost about 0.02 baht (US$ 0.0005), amounting to a cost of fortification of 0.3% per package. In Indonesia, adding 6 mg of a micronutrient premix containing 270 µg of vitamin A, 28 mg of calcium, and 4.2 mg of iron (added to the dough) along with several other B-vitamins to the seasoning is estimated to cost about 1.8 rupiah (US$ 0.0002) per sachet of seasoning, amounting to a cost of fortification of about 0.23% per package of instant noodles. The total cost of fortifying wheat flour in the U.S. with 6.4 mg/kg of vitamin $B_1$, 4.0 mg/kg of vitamin $B_2$, 52.9 mg/kg of niacin, 44.1 mg/kg of iron, 1.54 mg/kg of folic acid is less than US$ 1.00 per metric ton of flour or about 0.1% of the retail price of flour.

In the United States, the cost of a volumetric feeder varies widely between US$ 5,000 and 7,000, while that of a ribbon or paddle blender/mixer varies between US$ 9,000 and 15,000. This equipment, however, may be available locally at lower prices.

## Country Practices

Fortification of instant noodles with vitamin A, $B_1$, $B_2$, niacin, $B_6$, folic acid, iron, and casein (a milk protein) was initiated in 1994 in Indonesia. A survey conducted in 1996-97, however, found that consumption of fortified noodles is related to socio-economic status with consumption being lowest in the poorer segments of the population[3]. Although the efficacy of fortifying instant noodles has not been fully determined, one study conducted in Indonesia provided promising results. Compared with a control product (containing about one-half the vitamin A and iron as the fortified product), consumption of instant noodles fortified with 750 µg (2,500 IU) of vitamin A and 9 mg of iron per 100 g for 3 months had a beneficial effect on vitamin A and iron status of pregnant women and children under 5 years of age[4]. Currently, about 50% of the instant noodles marketed in the country are voluntarily fortified.

Thailand initiated voluntary fortification of seasoning in instant noodles with vitamin A, iron, and iodine in 1996 after feasibility and stability studies showed promising results. The government reduced taxes on imported fortificants, which facilitated gaining the commitment of manufacturers, and established labeling guidelines. Instant noodles fortified in amounts providing one-third of the Thai RDI are labeled “Fortified with iodine, iron, and vitamin A” on the front panel. However, given that fortification is not mandated by government regulation, not all instant noodles are fortified. Currently, about 80% of instant noodles produced in the country are fortified and efforts are underway to improve the formulation and extend the shelf life, and promote universal fortification of instant noodles.

In the Philippines, about 85% of the instant noodles available in the market are now voluntarily fortified. Although the fortification range varies, most instant noodles contain seasoning that is fortified with one-third of the national RDA of vitamin A, and some with iron and iodine. Vietnam is also currently exploring the fortification of domestically produced instant noodles.

Unlike micronutrient fortification of cereal flours, sugar, and oil/margarine, fortification of instant noodles, especially of the seasoning that accompanies instant noodles packages, is a relatively new undertaking. Unfortunately, there is insufficient information on critical issues such as the stability of micronutrients, bioavailability of fortificants, efficacy of fortification, and effectiveness of the intervention. Nevertheless, overall consumption of instant noodles is growing steadily in many countries, the fortification technology is available, and preliminary data on stability and efficacy are promising. Consequently, some countries are exploring the potential of instant noodle fortification as an effective public health intervention while manufacturers voluntarily fortify their products.

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3. Melse-Boonstra A, de Pee S, Martini E, et al. 2000. The potential of various foods to serve as a carrier for micronutrient fortification, data from remote areas in Indonesia. Eur J Clin Nutr 54 (11): 822-7.
4. Muhilal. 1998. Noodles: a suitable vehicle for fortification. Nutriview 95/2.