

Development of new tools for quality evaluation of pasta

Summary of Doctoral Thesis

Kentaro Irie

Graduate School of Veterinary Medicine and Life Science

Nippon Veterinary and Life Science University

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Pasta is a global food actively traded internationally. While domestic pasta products are commonly sold in Japan, large amount of dry pasta products are imported from Italy, Turkey, Tunisia, Greece, the United States etc. Pasta products are sold in various forms (dried, quick boil dried, fresh, frozen, boiled, luncheon type etc.) in Japan. Required quality of pasta depends on occasion and place where it is eaten. Regional difference in preference is also recognized. The quality of the Italian pasta products may not always be standard for Japanese consumers. It is, therefore, necessary to supply wide range of products with quality which meets the needs of the consumers in each region and country. In order to understand the preference of the consumers accurately, it is essential to have methods and indices to evaluate the quality of the pasta more precisely and clearly. The size of pasta is small as secondary processing food of wheat, and its moisture distribution is inhomogeneous and variable after boiling. This makes us difficult to analyze the mechanical properties and moisture distribution of cooked pasta for explanation of its characteristics and quality accurately. In addition, lexicons which describe the qualities of pasta sensorially have not been developed. This situation inhibits smooth communications about the qualities of pasta between sections within a company, between companies, and between countries.

In this study, the textures of various types of cooked spaghetti including quick boil spaghetti are evaluated by correlating the moisture distribution measured by MRI to the data of mechanical shearing test. A sensory lexicon for dried long pasta with the definition to each descriptor is developed in order to evaluate the quality of pasta in detail with concrete terms.

#### Chapter 1: Moisture distribution and texture of various types of cooked spaghetti

Five types of cooked spaghetti (boiled fresh spaghetti, boiled dried spaghetti, boiled frozen spaghetti, heated luncheon spaghetti, and heated long-life spaghetti) were selected for this research. They covers the typical types of cooked spaghetti products commonly sold in the Japanese market. They were examined for moisture distribution by magnetic resonance imaging (MRI). Moisture content was calculated from spin-spin

relaxation time ( $T_2$ ) of water proton, based on the correlation between  $T_2$  and moisture content of pulverized durum semolina standard gel samples. Boiled samples of dried and frozen spaghetti had a moisture gradient from the surface to the core, and a distinct low moisture region at the center, which were not clearly observed in the other types of cooked spaghetti samples. In particular, the moisture content of long-life spaghetti was almost homogeneous. Texture of cooked spaghetti samples was evaluated using force-distance curve of a mechanical shearing test. For dried and frozen spaghetti, higher force was observed at the region corresponding to the low moisture core compared with the other types, namely the state known as “al dente” was detected. The luncheon spaghetti and long-life spaghetti showed a lower breaking force and a larger dip after the peak force representing soft and brittle texture caused by moisture homogeneity. These results indicated that MRI could be used for the quality evaluation of cooked spaghetti through imaging of the moisture distribution, which reflects the mechanical properties.

## Chapter 2: Analysis of moisture distribution and texture of quick boil spaghetti

Lengthwise grooving was adopted to produce quick boil spaghetti with standard thicknesses after boiling. Ordinary dried spaghetti with a 1.6 mm diameter (Sample A, 7 min boiling time) was compared to quick boil spaghetti samples, namely spaghetti with a V-shaped groove (Sample B, 4 min boiling time) and spaghetti with three windmill-shaped grooves (Sample C, 3 min boiling time). The quick boil spaghetti samples had lower moisture content (58-59 g/100g) than Sample A (63 g/100g) after cooking. The  $T_2$  images of MRI during boiling showed that the region around the tips of their grooves absorbed water and swelled particularly rapidly resulting in closure of the grooves. While the region with low moisture content at the core of the strand after boiling was round in Sample A, those in Sample B and C were U-shaped and like a triangle, respectively. The shearing test force-strain curves of boiled Sample B and C varied depending on the shearing direction, which reflected their non-concentric moisture distributions. Thin high moisture region at the surface of boiled Sample A did not have a large effect on the mechanical properties.

## Chapter 3: Establishment of a sensory lexicon for dried long pasta

Pasta is a common and popular food all over the world. However, neither a detailed sensory profile nor sensory lexicon of pasta quality has been reported. In this study, a lexicon for describing the sensory attributes of cooked, dried long pasta was developed using a large sample set of pasta collected from the countries in the world. The target dried pasta samples were spaghetti ( $\phi$ 1.6–2.2 mm) or spaghettini (around  $\phi$ 1.5 mm) made of 100% durum semolina. One hundred twelve commercial dried long pasta samples were boiled and then classified into four groups according to similarities in their sensory characteristics. Among them, 50 samples were selected as representative samples covering wide range of the sensory characteristics of boiled long pasta. A highly experienced and trained panel generated expressions following a sensory evaluation of the 50 boiled pasta samples. As a result of the consolidation of them by the panel discussion, the final lexicon consisted of 35 terms (5 for appearance, 11 for aroma/flavor, and 19 for texture) were obtained. Definitions and references were determined for each term. Each descriptor was ranked for general one or specific one, according to its frequency of use by the sensory evaluation and discussion. Eight samples made in Italy were selected from each group as representative samples and evaluated using the general descriptors of the lexicon which can be used for quantitative evaluation as a trial. Principal component analysis (PCA) was conducted for the results obtained in this evaluation, and the data was reviewed correlating the physical and chemical analysis data such as color, moisture, protein, ash contents, weight increase after being cooked, etc., to the sensory characteristics. The results showed that the descriptors were appropriate for differentiating the sensory qualities among the samples.

As mentioned above, visual evaluation of the textures of cooked spaghetti in various forms and cooked quick boil spaghetti was realized by correlating the moisture distribution shown in MRI to the data of the measurement of mechanical properties. By this method some characteristics that had not been detected by conventional techniques were found in this study. In addition, a sensory lexicon for dried long pasta was established, and each term of the lexicon were defined and referenced. All of the general descriptors of this lexicon were found to be appropriate to differentiate the sensory qualities among the samples by applying it to evaluation of representative samples.

The information obtained in this study will give a useful guidance to develop high quality pasta products in the future, and it will contribute to the development of the pasta industry.