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Texture Profile Analysis of Noodle Strands Using a Texture Analyser Interfaced with an IBM-Compatible Computer

Wan Soo Kim

Department of Grain Science, Kansas State University, Manhattan, KS, USA

컴퓨터를 이용한 동양식 국수의 물성 측정에 관한 연구

김 완 수

캔사스대학

적 요

국수의 물성 측정에 있어서 기존의 방법들은 많은 시간을 요하고 또한 시간 경과에 따른 국수의 물성값에 오차를 주는 단점이 있다. 컴퓨터의 소프트웨어(Xtra)를 이용한 Texture Analyser로 부터 얻어낸 Texture Profile Analysis (TRA)곡선은 국수의 물성변화를 6~8개의 상수들을 사용해서 설명할 수 있었다. 이 측정방법은 빠르고 효율적이며 시간을 단축할 수 있었다. 그러므로 국수와 파스타(pasta)의 물성 연구에는 이 방법을 도입할 것을 제시하였다.

INTRODUCTION

The texture measurement of cooked noodles and pasta is important to evaluate flour quality for making product. Texture perception occurs during the entire process of mastication; however, the first bite has an important effect on our description of texture, which, in turn, most of texture-measuring devices derive their measurements from tests simulating the first bite to some extent. The first-known measurement of bite force date back to the 17th century, Borelli, an Italian anatomist, placed a string with weights over the molars to enable measurement of the maximal weight that could be lifted by the mandible. The first attempts to measure forces used during chewing were performed by Black in 1895, who studied a series of foods in vitro by means of an instrument called a phagodynamometer, which crushed foods with a straight hinge motion[1].

Noodles consist of gelatinized starch and denatured protein, that is, they are essentially boiled dough strings prepared from a mixture of wheat flour and salted water and/or alkaline solution. Several instruments have been used to measure the texture of noodles and pasta, including Extensimeter[2], FTC Model T-2100 Texturecorder[3], GRL Compression Tester[4], GF Texturometer[5], Rheometer[6,7], and Instron[8~10].

Texture profile analysis (TPA) simulating chewing of noodle or pasta using molar teeth, could be used to measure the texture of those products. Originally, GF Texturometer introduced to measure TPA, in which several textural parameters are analyzed from the plotted force-time curve. Continuously, the technique was adopted by other researchers to different instrument, such as Instron[11], the Kramer Shear Press[12], etc. Since the texture is a complicate, multi-point property of foods, and the procedure of extracting and analyzing the data is time-consuming, it seems likely that TPA tecnnique has greatly contributed in terms of giving a better and more complete understanding of the textural properties of foods[11]. Texture Analyser (TA. XT2), which is, in general, available to study the textural properties of any kind of food products, thus, can be applied to measure the TPA of noodles and pasta, along with software program, which can measure and analyze the data automatically for the study of the noodles and pasta. Compared to Instron Universal Testing Instrument, preliminary work on the texture of noodles using Texture Analyser interfaced with a computer program provides (i) simple for handling, (ii) time-saving (about 15-20 minutes for each assay including the interpretation of data) and efficient operation for bench-top work, (iii) quantitative and reproducible method to define the texture of noodles, (iv) easy set-up for running, (v) flexible operational menu, (vi) automatically programmed measurement, and (vii) direct storage and analysis of data to the personal computer (PC). Therefore, TPA testing of noodles and pasta is available as a keyboard-selected standard test. There is, however, no report on TPA measurement of noodles using Texture Analyser with computer-aided, software program.

In this study, it was to devise a TPA of noodles using the Texture Analyser instrument interfaced with a computer using software program.

II. MATERIALS AND METHODS

1. Sample Preparation

To make instant fried ramen noodles in the laboratory, Western white wheat (www), which was purchased from Western Wheat Quality laboratory, Agricultural Research Service, U.S. Department of Agriculture, Pullman, WA, USA, and Kansas hard white winter (HWW) wheat, composite, and milled to 72% extraction rate at the Department of Grain Science, Kansas State University, Manhattan, KS, USA, were used.

Briefly, a noodle dough was prepared from flour and brine solution (1% NaCl with 34~36% distilled water based on a 100 g wheat flour, 14% mb); pressed (5.5 mm thick); rested (15 min); sheeted between rolls (from 5.5 to 0.7 mm thick) and cut into noodle strands (approx. 20~25 cm), which were then randomly placed in a wire net basket fitted with a lid for steaming for short period of time (about 3 min) and dried off an extra steam on the both surfaces of fried noodles for 30 seconds using an electric fan. Finally the steamed noodle strands inside basket were deep-fried (350°F for 50 sec), drained an extra oil (2 min) and cololed at room temperature (2~3 hours).

The noodles examined were laboratory prepared or commercially available instant fried ramen (Korea, Japan, and USA brands) noodles, and commercial chinese (dried and thin) and Japanese (dried Udon) noodles. The commercial samples were purchased from a local grocery store.

2. Instrumentation

The operation conditions for TA.XT2 (Texture Technologies Corp., Scarsdale, NY, USA) were as follows; 1.5 diameter cylindrical probe (Probe TA-4); 1.0 mm/sec probe speed; 50% of noodle thickness defined as compression distance (0.5 mm for Chiness noodle 0.8 mm for instant fried noodles; 1.5 mm for Udon noodle); 0.1 sec hold time before 2nd compression; force mode in compression; texture profile analysis. The operational menu for Xtra software program (Texture Technologies Corp., Scarsdale, NY, USA) were as follows; force-time graph type; maximum force (approximately 400~1,200 g-force for instant fried ramen and Udon noodles; 2,000~3,000 g-force for Chinese noodles).

3. Development of Instrumental Test Procedure

Each noodle sample (20 g) was cooked in 1 L of boiling distilled water to optimum which were 2.5, 3, and 6 min for Chinese, instant fried ramen, and Udon noodles, respectively. The cooked noodles were drained 2 min. For Chinese noodles, an additional washing step with cold water was needed before draining step, as indicated by the instruction from the package. Several noodle strands were then placed individually in flat dishes, and equilibrated 20 min at 90% RH using conc aqueous sulfuric acid in a desiccator. The thickness of a cooked noodle strand was measured using caliper. After cooling the cooked noodles in 90% RH, one noodle strand was placed on the Whatman #541 filter paper (12.5 cm) attached to the plexiglass with double sided sticky tape, which was then tested the texture of noodle strand using computerized software program. From the force-time curve of each noodle strand, several textural parameters were measured, calculated, and averaged. All assays of textural measurement were done at least five times.

In preliminary work, several methods, including a weighing paper or filter paper attached to the plexiglass with a paper paste, super glue, laboratory tape or stationery tapes were tried to hold the noodle strand after pulling the plunger away from the compressed noodle surface to eliminate the lifting problem of noodle strand. The combination of double sticky stationery tape with filter paper showed the best method to hold down the compressed noodle strand and no noodle piece was observed under the plunger surface after decompressing the plunger from the noodle strand.

III. RESULTS AND DISCUSSION

Figure 1 shows an idealized TPA curve using a GF Texturometer[11,13]. A bite-sized food was compressed two times in a reciprocating motion imitating the action of the jaw. A force-time curve was then plotted, giving seven textural parameters-five measured from curve (fracturability; hardness; adhesiveness; cohesiveness; and springiness), and two calculated (gumminess; and chewiness). Each of the textural parameters gave excellent correlations

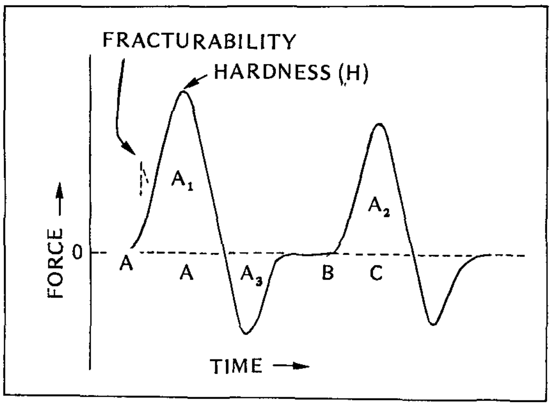

Fig. 1. A Typical Texture Profile Analysis (TPA) Curve[13].

Fracturability (dotted line): The force at the first significant break in the curve
Hardness (H): The peak force during the first bite
Adhesiveness (A_3): The negative force area for the first bite
Cohesiveness (A_2/A_1): The ratio of the 2nd positive area to the 1st one
Springiness (BC): The interval from the start to the peak during 2nd compression
Gumminess: hardness x cohesiveness
Chewiness: hardness x cohesiveness x springiness %
Recovery: (BC/AA)×100

Table 1. The Reproducibility of TPA Method Using Different Instant Fried Noodle Strands[a]

Noodle Strands	1st peak hardness (Kg—Force)	2nd peak hardness (Kg—Force)	Cohesive-ness	Adhesive-ness (Kg—Force—sec)	Springi-ness (sec)	% recov-ery (%)
Commercially available instant fried ramen noodle 1[c]						
avg	1.15	0.98	0.71	−0.031	0.50	76.40
s.d.	0 04	0.04	0.01	0.005	0.02	2.84
c.v.[b]	0.04	0.04	0.01	−0.161	0.04	0.04
Commercially available instant fried ramen noodle 2[d]						
avg	0.58	0.49	0.61	−0.013	0.38	56.28
s.d.	0.04	0.02	0.05	0.002	0.03	3.58
c.v.[b]	0.07	0.05	0.08	−0.154	0.07	0.06
Laboratory prepared fried noodle using WWW flour						
avg	0.39	0.25	0.47	−0.005	0.36	52.45
s.d.	0.03	0.02	0.01	0.001	0.02	3.23
c.v.[b]	0.07	0.08	0.03	−0.200	0.07	0.06

a. The value is an average of five replications
b. c.v. = coefficient of variation = s.d./average
c. From Nissin Foods Company
d. From Campbell Soup Company

with sensory ratings[14]. From this noodle work, an additional parameter, % recovery, was also found to be excellent to differentiate their cooked texture among noodle products.

All steps for sample preparation in experimental procedure must be done carefully to insure the uniform condition before measurement of noodle texture, because the noodles are temperature and time-sensitive foods. In this measurements, it was attempted to be compressed to 50% of the original thickness of each noodle strand (50% compression). Table 1 shows the reproducibility of TPA method using three different instant fried ramen noodle products. The variables which are hardness, co-

Table 2. Texture Profile Analysis of Different Noodle Strands[a]

Noodle Strands	1st peak hardness (Kg—Force)	2nd peak hardness (Kg—Force)	Cohesive-ness	Adhesive-ness (Kg—Force—sec)	Springi-ness (sec)	% recov-ery (%)
Udon[b]	0.41	0.37	0.82	−0.017	0.71	86.59
Chinese[b]	2.53	2.32	0.87	−0.126	0.65	88.33
Instant Fried Ramen						
Com 1[c]	0.78	0.67	0.72	−0.011	0.60	83.33
Com 2[d]	1.17	0.99	0.83	−0.010	0.58	80.27
Lab 1[e]	0.43	0.39	0.84	−0 010	0.66	79.66
Lab 2[f]	0.62	0.52	0.63	−0.015	0.65	78.31

a. The value is an average of five replications.
b. Both Udon and Chinese noodles were commercial products.
c. Ichiban (Japanese) commercial instant fried ramen noodle.
d. Nongshim (Korean) commercial instant fried ramen noodle.
e. Laboratory prepared fried ramen noodle using HWW wheat flour.
f. Laboratory prepared fried ramen noodle using WWW wheat flour.

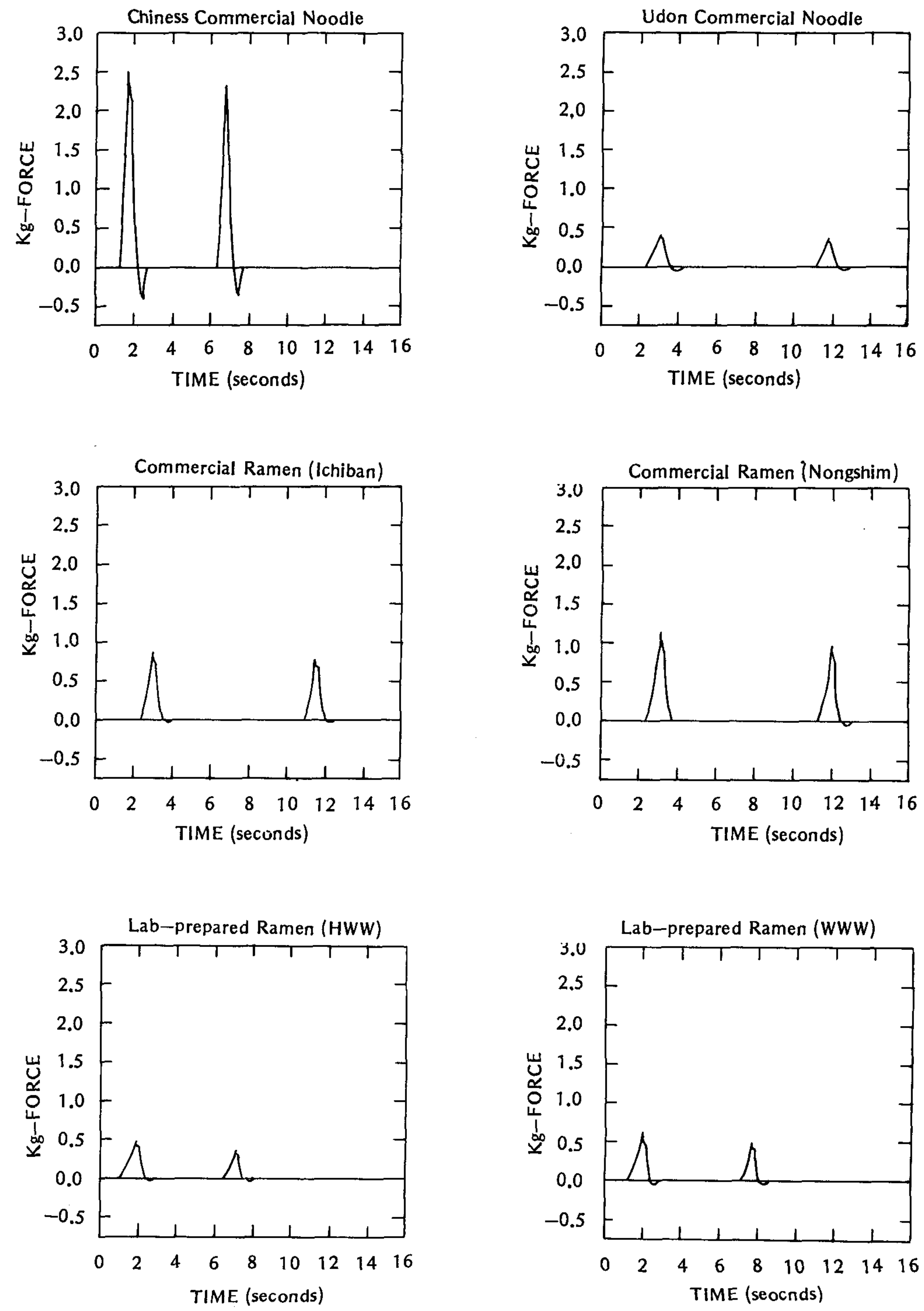

Fig. 2. Texture Profile of Different Noodle Strands Using Texture Analyser with Xtra Software.

hesiveness, adhesiveness, springiness, were obtained from each texture profile. The % recovery was obtained from the ratio of the deformed thickness to the original thickness of noodle strand. From the coefficient of variation (c.v.), most parameters except adhesiveness gave approximately 4~8%. As it was expected, adhesive force gave the largest c.v., which needs more work. In comparing data between two commercial instant fried ramen noodles, the differences in ingredients or processing steps could explain why values were so different between two commercial products. Additionally, extra ingredients, such as modified starch or other additives in the commercial product gave a different textural properties, compared to those of laboratory-prepared instant fried ramen noodle. At this point, it was concluded that the TPA curves are quantitative and reproducible, and can be used to illustrate the quality of cooked noodle texture.

Table 2 and Figure 2 show different TPAs of noodle strands from various products using TA. XT2 with Xtra program. Udon noodles showed the lowest and Chinese noodles the highest in hardness value from the first and second compression curves. The adhesiveness of Chinese noodles was the largest, probably because the resistant force was high, so better adhesion to the surface of the probe. In addition, possible release of starch or amylose material on the noodle surface in an alkaline condition during cooking could explain more stickiness or adhesiveness of the TPA of Chinese noodle than that of any other noodle strand. On the other hand, laboratory-prepared instant fried ramen noodles from WWW or HWW wheat flours, or commercial instant fried ramen noodles gave medium range of hardness value. In fried ramen noodles, the fat content (about 25% based on 100 g fried noodles) is probably an important factor for noodle texture. This agrees with the classification of the textural characteristics of food, referring moisture and fat content of food[15]. During the relaxation time in which head of probe was stopped at the point of maximum set distance, the slope of curve was changed, depending on viscous flow, elasticity or fat content.

IV. CONCLUSION

TPA has not been applied to noodles in the past because the procedure was time-consuming and the properties of noodles changed with time. Six to eight parameters from TPA curve using Texture Analyser equipped with computerized program illustrated the texture of noodles. This method was simple, efficient, quantitative and reproducible as an objective method for noodles, compared to the other instrument (s) used in the past including Instron Universal Testing Instrument. Approximately 15 ~20 minutes of time for each assay is needed, which is much time-saving than that of Instron, giving speeding up the texture analysis of the noodle samples. The TPA curves from various noodle products using this instrument could be differentiated due to different cooking quality from each product.

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