Note on An Improved Apparatus for Testing Spaghetti Tenderness[1]

R. R. MATSUO and G. N. IRVINE, Canadian Grain Commission,
Grain Research Laboratory, Winnipeg, Manitoba

Recently an apparatus for measuring the tenderness of cooked spaghetti was described (1). For measurement of this parameter the apparatus was designed with a cutting edge to which an increasing force could be applied. As the strand of cooked spaghetti is sheared by the applied force, the movement of the cutting edge is measured and recorded. The resultant curve is interpreted in terms of rate of shear and designated as tenderness index. Soft samples yield high values of tenderness index, while firm ones give low values.

Tenderness or firmness is an important characteristic, but it is not possible to evaluate qualities such as "doughiness", "chewiness", or "springiness" with this apparatus. A sample can be firm and yet lack elasticity or springiness, so that the product is doughy or pasty. An evaluation only in terms of tenderness, therefore, is not adequate.

In an attempt to obtain a better overall evaluation of cooked spaghetti, the tenderness testing apparatus was adapted to measure parameters related to chewing in addition to the tenderness index. Chewing is essentially a compressing or squashing from which one characterizes the product as doughy, mushy, or *"al dente"*. Thus it was decided to obtain parameters related to squashing or compressing and the ability of the sample to recover from compression.

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To carry out this test, the cutting blade of the apparatus was replaced by a blunt-edge blade for compression. A fixed load was applied to the end of the beam on top of the rod connected to the blade; the load was removed after 15 sec. The sensing element is as described previously (1).

The shape and dimensions of the compressing blade and the sample holder are given in Fig. 1. The slot in the sample holder is fractionally wider than the blade to

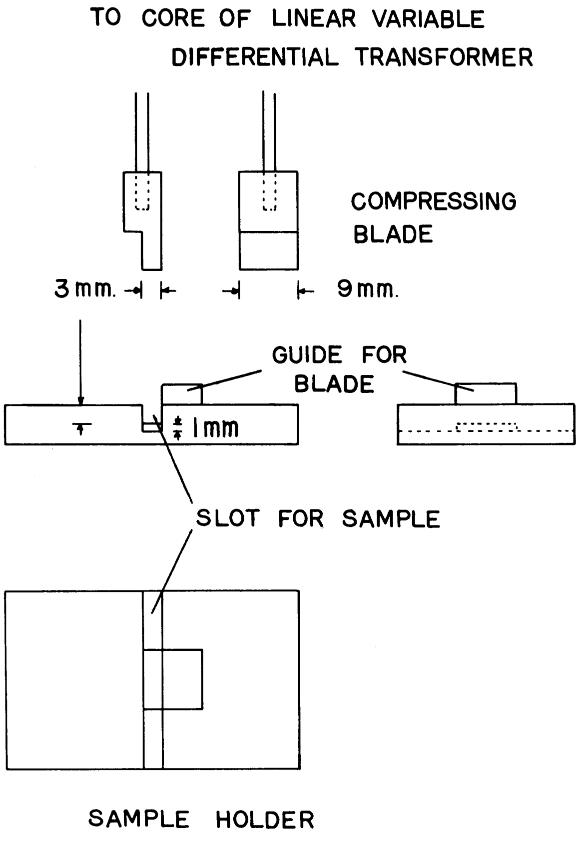

Fig. 1. Diagram of compressing blade and sample holder for compressibility test.

eliminate frictional force. A little platform was inserted in the slot (as shown in Fig. 1) so that the sample would be compressed uniformly and symmetrically. The weight used for the test was adjusted to give the greatest difference in curve characteristics. A force calculated to be 1.2 kg. per cm.^{2} on the blade was found to be optimal.

The test is carried out as follows. Spaghetti is cooked as described previously (1) and a strand about 3 cm. long is placed in the slot of the sample holder. The beam of the apparatus is adjusted to give a slight positive pressure to the blade so that the "recovery" part of the test will not be influenced. The recorder is turned on and the weight is placed on the end of the beam manually. The entire length of the blade compresses the center portion of the test piece. After 15 sec. the weight is removed, and the curve recorded for another 15 sec. Figure 2, left side, shows curves for four samples of different cooking quality derived from the compression test, while Fig. 2, right side, shows the curves for the shear test. Curve A was spaghetti processed from severely sprouted wheat. The sample was very soft and mushy. Curve B was a sample processed from a grade of Canadian amber durum; curve C, from a durum variety, Pelissier; and curve D, spaghetti commercially processed in Europe with excellent cooking quality.

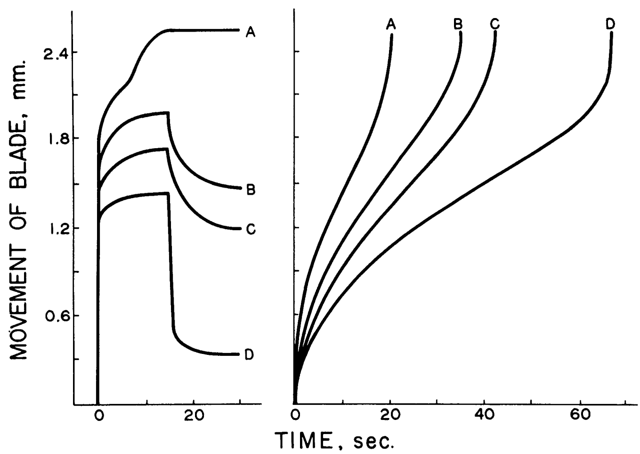

Fig. 2. Compressibility curves for four samples of different quality (left); shear test curve for same samples (right).

The interpretation of the compression test curves is given in Fig. 3. X represents the diameter of the cooked spaghetti; Y is the penetration of the blade into the sample; Z is the extent to which the elastic component forces the blade back. *Compressibility* is defined as the ratio of Y to X, and *recovery* is the ratio of the distance that the blade is forced back (Y–Z) to the penetration, Y.

Numerical values for samples shown in Fig. 2 are given in Table I.

Spaghetti samples processed in Switzerland and in Italy and considered *al dente* were tested by this compressibility method. Sample D, for example, has low tenderness index, low compressibility, and high recovery. A large number of durum wheat varieties of varying quality were also studied. A few examples are given in Table II to show the differences detectable by the new test for normal and overcooked samples.

The normal cooking time for these samples was 12 min. On the basis of tenderness index alone it is difficult to assess the eating quality adequately as shown by these samples. For example, the tenderness index for sample 1 cooked for 12 and 17 min. and for sample 6 are essentially the same, but the compressibility and recovery are quite different.

All these samples were subjected to organoleptic evaluation by the senior author and two co-workers. Samples with low tenderness index, low compressibility, and

TABLE I. COOKING QUALITY PARAMETERS FOR SAMPLES SHOWN IN FIG. 2

Sample	Cooking Time min.	Tenderness Index mm./sec. X 10^3	Compressibility %	Recovery %
A	12	70	100	0
B	13	51	78	23
C	13	40	69	33
D	14	30	55	73

TABLE II. COOKING-QUALITY PARAMETERS FOR A NUMBER OF DURUM VARIETIES, AND EFFECT OF OVERCOOKING

Sample	Cooking Time min.	Tenderness Index mm./sec. X 10^3	Compressibility %	Recovery %
1	12	52	80	23
	17	53	100	0
	22	61	100	0
2	12	40	69	31
	17	44	85	25
	22	53	100	0
3	12	32	63	49
	17	46	72	37
	22	49	74	32
4	12	42	71	30
5	12	43	61	43
6	12	51	68	35

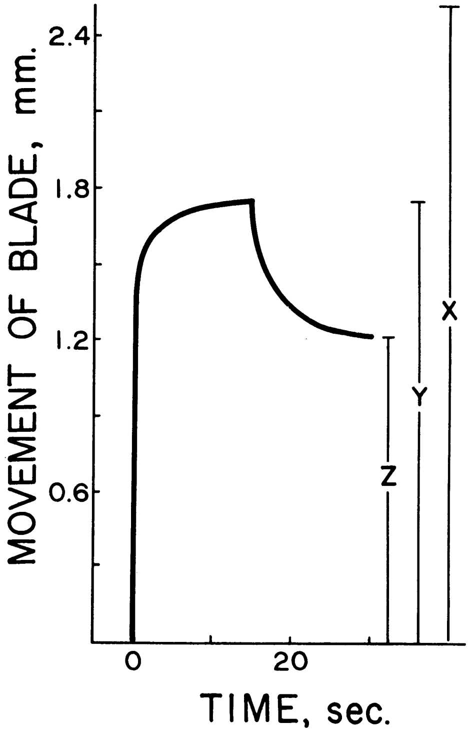

Fig. 3. Values derived from compressibility curves: X is diameter of cooked spaghetti; Y is blade penetration into sample; Z is related to the elastic components.

high recovery were judged to be good in terms of bite, texture, and firmness. Samples which rated poor invariably yielded high tenderness index, high compressibility, and low recovery. In this somewhat limited organoleptic evaluation, the subjective test correlated remarkably well with the objective measurement of the instrument.

The ultimate test of cooking quality is still organoleptic and subject to individual bias. The parameters derived from our apparatus are reproducible and yield numerical values from which comparisons can be made. This method of assessing cooking characteristics has proven useful in evaluating new durum varieties, in comparing domestic and foreign varieties, and in studying the effect of various factors associated with quality.

Literature Cited

1. MATSUO, R. R., and IRVINE, G. N. Spaghetti tenderness testing apparatus. Cereal Chem. 46: 1 (1969).

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