INTERNATIONAL STANDARD

Rice — Determination of viscoelastic properties at various stages of cooking — Method using a viscoelastograph

Riz — Détermination des propriétés viscoélastiques à différents temps de cuisson — Méthode au moyen du viscoélastographe

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6648 was prepared by Technical Committee ISO/TC 34, *Agricultural food products*, Sub-Committee SC 4, *Cereals and pulses*, in collaboration with the International Association for Cereal Science and Technology (ICC).

This second edition cancels and replaces the first edition (ISO 6648:1985), which has been technically revised.

Rice — Determination of viscoelastic properties at various stages of cooking — Method using a viscoelastograph

1 Scope

This International Standard specifies a method using a viscoelastograph for the determination of certain viscoelastic properties of rice (i.e. swelling, firmness, elastic recovery and viscoelastic index) at various stages of cooking.

It also gives a method for the determination of the quantity of water absorbed (i.e. the coefficient of water absorption) by the rice at the same stages of cooking.

This International Standard is applicable to all whole-grain rice (i.e. husked rice and milled rice) whether or not it has been subjected to technological treatments such as precooking or parboiling.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 firmness: Resistance of grains of cooked rice to crushing when subjected to stress. It is expressed in units of firmness.

2.2 elastic recovery: Tendency of grains of cooked rice to return to their initial form once the stress to which they have been subjected is released. It is expressed as a percentage.

2.3 coefficient of water absorption: Ratio of the mass of rice after cooking to the mass of the same rice before cooking.

2.4 swelling: Thickness of grains of rice after cooking. It is expressed in millimetres.

NOTE 1   Swelling is in reality the increase in volume of the rice during cooking. It can be measured as the increase in thickness of the grain by determining the thickness of the rice before and after cooking. Measurements of thickness after various cooking times give a curve indicating the course of swelling.

2.5 viscoelastic index: Ten times the ratio of the mean value of the elastic recovery to the difference between the mean value of firmness and 100.

3 Principle

Cooking of a known quantity of whole grains of rice in boiling distilled water for various times. Weighing the "cooked" grains in order to establish the coefficient of water absorption. Determination, by means of a viscoelastograph, of the thickness of the grains of "cooked" rice, and of their thickness both when subjected to a constant force for a given time and after this force has been removed. From these values, determination of the swelling, firmness, elastic recovery and viscoelastic index. Preparation of graphs giving these parameters as a function of cooking time.

4 Apparatus

Usual laboratory equipment and, in particular, the following.

4.1 Viscoelastograph, or equivalent apparatus, equipped with a set of thickness gauges.

4.2 Thermoregulated bath, filled with a liquid (for example, a mixture of water and ethylene glycol), capable of operating at a temperature of 104 °C $\pm$ 1 °C, and equipped with a plate with holes suitable for accommodating 250 ml beakers.

4.3 Metal sieve, of aperture size 2 mm.

4.4 Flat tray, the base of which is covered by a sheet of sponge soaked in water.

4.5 Beakers, of 250 ml capacity.

4.6 Watch glasses, of 80 mm diameter.

4.7 Petri dishes, of 60 mm and 80 mm diameter.

4.8 Timer.

4.9 Spatula.

4.10 Balance, accurate to within 0,01 g.

5 Sampling

It is important that the laboratory receive a sample which is truly representative and has not been damaged or changed during transport or storage.

6 Preparation of test sample

Use the laboratory sample as received, after careful mixing.

7 Procedure

7.1 Preparation of beakers

Place the required number of beakers (4.5) in the thermoregulated bath (4.2), fill them to the brim with distilled water and cover with watch glasses (4.6), convex side down. Regulate the temperature of the bath in such a way as to maintain the water in the beakers at boiling point and such that, once a beaker has been uncovered for 30 s, boiling starts once again in less than 4 min, i.e. at approximately 104 °C.

7.2 Cooking

7.2.1 Establish a cooking programme to evaluate the state of the rice from the beginning of cooking until it is overcooked. In general, the following programmes are suitable:

a) for milled rice, from 10 min to 35 min, with intervals of 5 min;

b) for husked rice and parboiled rice, from 10 min to 45 min with intervals of 5 min;

c) for precooked rice, from 3 min to 15 min, with intervals of 3 min.

Follow the method specified in 7.2.2 to 7.4 for all cooking times.

7.2.2 Place 1,5 g of the rice, m_0, weighed to the nearest 0,01 g, in one if the beakers filled with boiling water (see 7.1), cover immediately with a watch glass and start the timer (4.8).

7.2.3 When each chosen cooking time has elapsed (see 7.2.1), remove the watch glass and, wearing rubber gloves, remove one beaker and pour its contents into the sieve (4.3) which has previously been tared to the nearest 0,01 g. Drain the rice by shaking the sieve gently for 15 s, then weigh the sieve and its contents to the nearest 0,01 g. Deduce the mass, m, of the "cooked" rice.

7.2.4 Empty the contents of the sieve into a Petri dish (4.7) of 60 mm diameter, placed on a sheet of damp sponge in the flat tray (4.4). Separate the whole grains, removing those which are broken or which are damaged in the course of this operation. Cover the 60 mm dish with an 80 mm dish (4.7) in such a way that the latter forms a sealed joint with the water saturating the sheet of sponge (see figure 1). Leave the "cooked" rice thus for 45 min to 1 h at ambient temperature before carrying out the measurements specified in 7.4.

7.3 Adjustment of the viscoelastograph

Adjust the viscoelastograph in accordance with the manufacturer's instructions, checking in particular the linearity of response for thicknesses between 0 mm and 3 mm using the thickness gauges.

Ballast the loading platform in such a way that the total mass placed on the samples is 700 g (taking into account the mass of the loading platform specified by the manufacturer).

Adjust the measurement cycle so that a force equivalent to a mass of 700 g is applied for 40 s and that measurement continues for 20 s after the load has been removed.

7.4 Testing with the viscoelastograph (see figure 2)

7.4.1 Place three grains of the "cooked" rice (7.2.4) in a triangular arrangement on the lower plate of the viscoelastograph. Place the grains flat, taking care that the long sides of the grains form the sides of a triangle.

Start the cycle and record, in millimetres, the thickness δ_0 of the grains of rice before the load is applied, the thickness δ_1 after the load has been applied for 40 s, and the thickness δ_2 taken 20 s after the load has been released.

7.4.2 Carry out the operations specified in 7.4.1 a further five times, using a different group of three grains each time, with different cooking times.
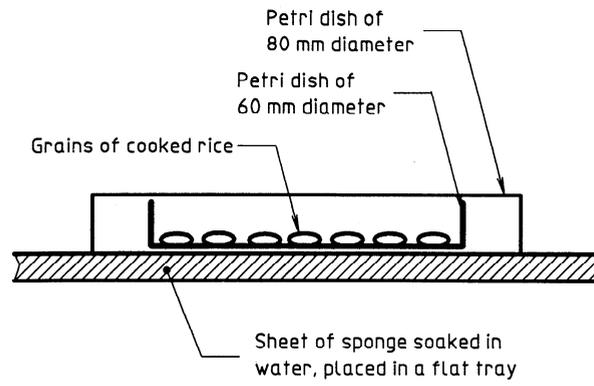
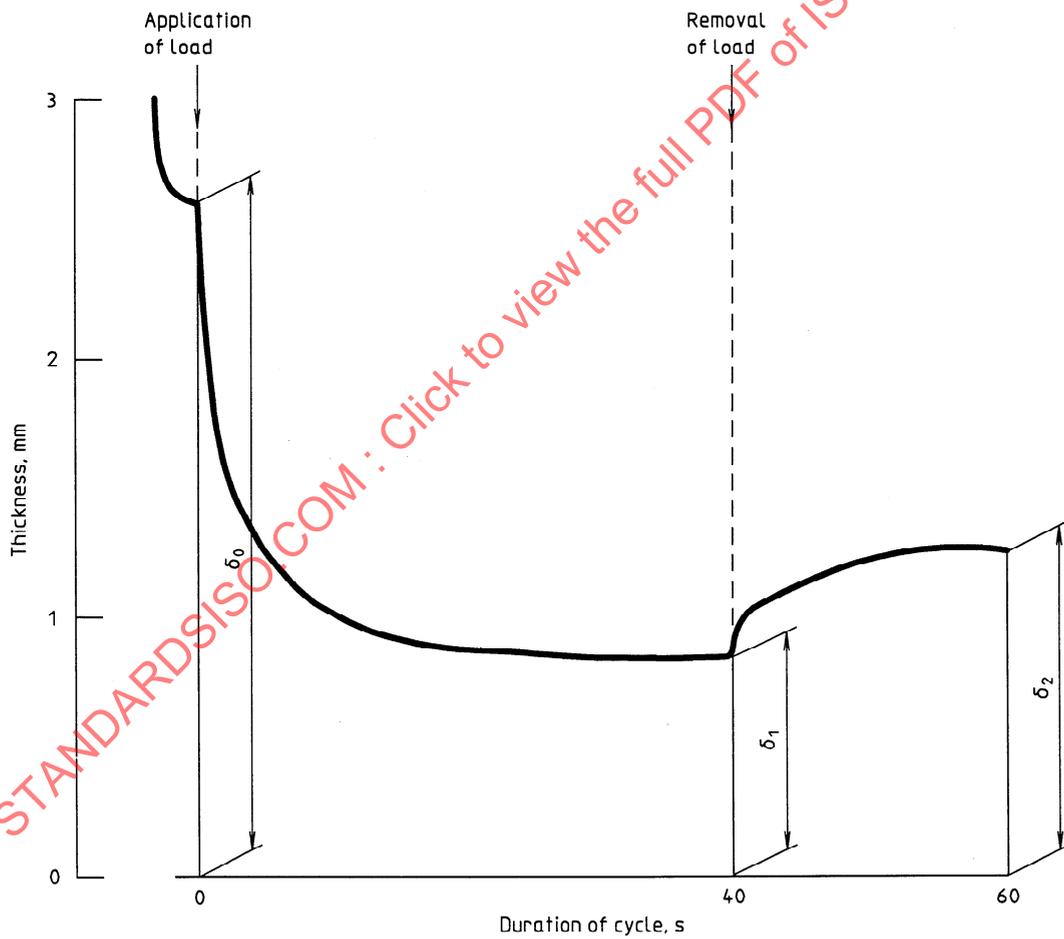**Figure 1 — Keeping the "cooked" grains of rice before testing**

Figure 2 — Example of a viscoelastogram

8 Expression of results

8.1 For each measurement, calculate

a) the firmness F by means of the formula

$$F = \frac{\delta_1}{\delta_0} \times 100$$

b) the elastic recovery R by means of the formula

$$R = \frac{\delta_2 - \delta_1}{\delta_0 - \delta_1} \times 100$$

where δ_0, δ_1 and δ_2 are the thicknesses, in millimetres, recorded in 7.4.

8.2 For each cooking time, calculate

a) the coefficient of water absorption from

$$\frac{m}{m_0}$$

where

m is the mass, in grams, of the rice after cooking and draining (7.2.3);

m_0 is the mass, in grams, of the rice before cooking (7.2.2);

b) the mean swelling $\overline{\delta_0}$, in millimetres, from the six measurements of thickness δ_0;

c) the mean firmness $\overline{F}$ from the six values of firmness F, calculated as in 8.1;

d) the mean elastic recovery $\overline{R}$ from the six values for the elastic recovery R, calculated as in 8.1;

e) the viscoelastic index I_q from the formula

$$I_q = 10 \times \frac{\overline{R}}{100 - \overline{F}}$$

8.3 Plot curves giving the mean swelling, mean firmness, mean elastic recovery and mean viscoelastic index as functions of cooking time.

9 Repeatability

The absolute difference between two independent single test results (i.e. two series of six measurements), obtained using the same method on identical test material in the same laboratory by the same operator using the same equipment within a short interval of time, for pure varieties, should not be greater than:

— for swelling: 0,08 mm;

— for firmness: 6 units;

— for elastic recovery: 15 % of the mean value.

Reject both results if the difference exceeds these values and carry out two new single determinations (i.e. two series of six measurements).

10 Test report

The test report shall specify

— the method in accordance with which sampling was carried out (if known),

— the test method used,

— the test results obtained, and

— if the repeatability has been checked, the final quoted result obtained.

It shall also mention operating details not specified in this International Standard, or regarded as optional, together with details of any incidents which may have influenced the test results.

The test report shall include all information necessary for the complete identification of the sample.