Nutritional Standards and Methods of Evaluation for Food Legume Breeders

Prepared by the International Working Group on Nutritional Standards and Methods of Evaluation for Food Legume Breeders

J. H. Hulse, K. O. Rachie, and L. W. Billingsley

Monograph on nutritional quality standards in legume plant breeding — discusses the recommendation/s for standards of food composition, physical and chemical analysis, and biological evaluation technique/s.

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Criteria for Cooking Quality and Acceptability of Cowpeas

Florence E. Dovlo

Because of limitations in the amino acid composition of proteins in leguminous grains, such grains have poor nutritional quality. For this reason, there is currently a growing concern for improvement of the quality of protein in these relatively inexpensive food legumes to increase their nutritional contribution to diets of low-income groups in particular, and also to make cowpea meals suitable for infant feeding.

Legume breeders are urged to include improvement of the amino acid profiles of legume proteins in their breeding programs, and to eliminate certain undesirable characteristics of food legumes, as well as identifying high-yield genotypes that are also weevil-resistant. It is equally important for breeders to take into account the cooking quality and consumer acceptance of the new cowpea cultivars.

Cowpeas (Vigna unguiculata) are among the most widely used of the food legumes. Cowpeas are of different sizes, shapes, and colour, and are used in a great variety of ways (1). In addition to their visual characteristics, cowpeas have intrinsic differences in their cooking quality, texture, and flavour. Consumer studies show that consumers have particular preferences for various uses of the different types of cowpea. It is therefore essential that legume breeders be cognizant of these preferences (2). For consumer acceptance it is important that the type of cowpea be fast-cooking and capable of doubling in quantity. Ability of the grains to bind is another desired quality for certain types of dishes. Taste and flavour are important factors for consumer acceptance.

For plain cooking, and for combinations with cereals, the brown type of cowpea is preferred and generally used to avoid monotony in the colour of the dish. The bright maroon-red cowpeas are usually preferred for stew, with the grains remaining firm after cooking.

Cowpeas are also processed into paste or flour and used in making certain cowpea dishes that are fried or steamed. In this process, the grains are first dehulled, then ground to make the paste, or alternatively, dried and ground into flour. For this operation, ease of soaking and dehulling are essential. The cream-coloured cowpea has been found easiest to dehull (2).

For some processed cowpea dishes, the paste or flour is whipped before use. In this usage, desirable characteristics of the flour or paste are
its binding quality and capacity to rise.

Assessing Cowpea Characteristics

Dehulling test
This is a simple household test. Note the type of seed coat i.e., shiny, wrinkled, etc., of the dry cowpea sample. Soak a few cowpeas in water at room temperature for a brief period (10 min). Rub the soaked seeds between the fingers and note the effort needed to remove the coat or testa. Relate the ease of dehulling to the nature of the sample's dry surface.

Estimation of cooking quality
Weigh into individual perforated containers approximately 10 g of cowpea samples. Immerse each sample in a litre of boiling water. Remove from water, drain, and record weight increase at 5-min intervals. Cooking time is the time at which the grains become soft and cease to gain weight.

Softness can be determined manually by simply mashing the cooked grains between the fingers or with a spoon. Water uptake or swelling capacity can be correlated with cooking time. Note changes in the colour of the grains after cooking. The grains initially absorb water linearly with time taken, and swelling capacity is directly related to water absorption (3).

Alternatively, samples can be screened by boiling the grains for one standard time and ranked for softness. A more scientific and accurate measurement of the cooking quality of cowpea can be done mechanically by using texture-measuring instruments, such as a textile meter or a shear compression cell.

Breeders should take note of the influence of certain salts on the cooking time of cowpea. Phytin, calcium, magnesium, and free pectin content of beans affect their cooking quality (4).

Functional properties
Functional properties of the flour or paste such as fat absorption, foaming characteristics, emulsification, water absorption, and nitrogen solubility are important specific product requirements.

Fat absorption — Weigh a 2-g sample of flour into a 15-ml conical centrifuge tube and add 5 ml of edible oil. Stir the mixture thoroughly with a brass wire. Allow the tubes to stand for 30 min, then centrifuge at 2100G for 25 min. Read the volume of supernatant oil and calculate the percentage oil absorbed (5).

\[ \% \text{ oil absorbed} = \frac{X - Y}{X} \times 100 \]

where \( X \) = initial oil used and \( Y \) = supernatant oil.

Water absorption — Weigh a 2.5-g sample of flour into a centrifuge tube. Add 15 ml of water. Agitate the tube by hand until the sample is dispersed in water. Place a stopper on the centrifuge tube and shake for 1 h at No. 10 speed on a Burrel shaker. Centrifuge at 1200G for 25 min. Remove the supernatant by pipette. Determine the water retained by weighing and express as a percentage of the original sample weight (6).

\[ \% \text{ water retained} = \frac{Y - X}{X} \times 100 \]

where \( X \) = initial weight, \( Y \) = weight after absorption, and \( Y - X \) = weight of water retained.

Foaming quality — Weigh a 6-g sample of flour into 60 ml water. Whip in a small bowl with mixer at high speed for varying lengths of time. Transfer the resulting foam to a 250-ml graduated cylinder and measure the initial foam volume. Evaluate the foam stability by measuring the foam value after standing for intervals of 5, 10, 30, 60, and 120 min (7).

Emulsification — Weigh a 7-g sample of flour and disperse in 100 ml of water and 100 ml groundnut oil. Using a blender, emulsify the 200-ml mixture at high speed for 1 min. Divide 200 ml of the emulsion into four 50 ml centrifuge tubes and centrifuge at 1300G for 5 min (8).

\[ \% \text{ emulsified} = \frac{X}{Y} \times 100 \]

where \( X \) = height of emulsified layer and \( Y \) = height of whole layer. Measure the emulsion stability by heating the emulsion, prepared as above, at 80 °C for 30 min. Cool under tap water and centrifuge at 1300G for 5 min. The emulsion stability can then be expressed as a percentage.

\[ \% \text{ emulsion stability} = \frac{X}{Y} \times 100 \]

where \( X \) = height of remaining emulsified layer and \( Y \) = height of whole emulsion layer in tube.

Determination of nitrogen solubility index — Using a modification of Lyman's method (9), weigh a 1-g sample 60 mesh screen) into a 300-ml Erlenmeyer flask with four glass beads. Add 100 ml of distilled water and shake the flask rapidly on a mechanical shaker in an incubator or water bath at 37 °C for 1 h.

Centrifuge the material at 3000 rpm for 5 min. Filter through coarse filter paper. Pipette 50 ml of supernatant into a Kjeldahl flask. Add 2 ml of conc. H\(_2\)SO\(_4\) and evaporate almost to dryness, on the digestion rack. Determine nitrogen by
Kjeldahl method.

\[
\% \text{ w/w nitrogen} = \frac{\text{titre } \times \text{ normality } \times 0.014 \times 100}{\text{wt of sample}}.
\]

Nitrogen solubility index = \( \frac{\% \text{ soluble nitrogen} \times 100}{\% \text{ total nitrogen of sample}} \).

Sensory Evaluation

In addition to mechanical assessment of the acceptability of a pulse, taste-panel evaluation is also essential.

Samples of a new cultivar of cowpea should be evaluated by a well-selected panel. For visual characteristics, the new cultivar and samples of other local types should be coded and ranked in order of preference for grain colour, size, and eye type. Cooked samples should be graded for taste and texture.

Selection of panelists

Panel members may be selected from research staff or personnel from the office. It is important to select people in good health. Anyone with a cold should not take part.

Panelists should have a high sensitivity and degree of personal integrity and intellectual curiosity, and should be willing to spend time on the evaluation. Out of several trials, a group of reliable panelists can be formed. The number of panelists should be 8–10. The services of a well-qualified home economist may be used to undertake the cooking tests and studies of the functional properties, and to conduct the sensory evaluation.

Sample Evaluation Forms

1. Visual Characteristics
   Rank these cowpea samples in order of preference for colour, grain size, and eye type.

<table>
<thead>
<tr>
<th>Choice</th>
<th>Colour</th>
<th>Grain size</th>
<th>Eye type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   Any comments:

2. Samples Cooked for Standard Period
   Evaluate these samples for softness (texture).

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Too soft</th>
<th>Slightly soft</th>
<th>Just right</th>
<th>Slightly tough</th>
<th>Very tough</th>
<th>Not cooked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   e.g., 058

   Any comments:

3. Test for Taste
   Taste these samples of cowpea and check your preference.

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Like very much</th>
<th>Like slightly</th>
<th>Don't like</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   e.g., 049

   Any comments:

References