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# Physicochemical characteristics of lentil varieties as related to their cookability

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## Introduction

Lentil *(lens esulenta)* is one of the most important legumes consumed as food in Egypt. There is little information regarding the methods for evaluating the cookability of lentil varieties grown in Egypt.

Good correlation has been reported between the cooking-quality of dry peas and their content of phytic acid (1, 2). It is well known that phytic acid is one of the antinutritional factors, and the decrease in phytate content may increase the availability of many essential minerals such as zinc (3), iron (4), magnesium (5), and calcium (6).

Therefore the phytic acid content as well as the viscosity and gelatinization characteristics along with volume expansion ratio during the cooking process have been used to account the differences in cooking-behaviour of the lentil varieties in this study. Moreover, the amylose and protein contents as well as the amino acid contents of lentil varieties in relation to their cookability are evaluated in this investigation.

## Material and methods

*Source of samples*

Dry lentil samples were obtained from 1979 crop of the experimental plots of legume Research Section, Agricultural Research Centre, Giza, Egypt. The varieties tested were Giza 9, NEL 225 and, NEL 254. Samples were hand cleaned, weighed, their seed coats were removed and the percentage of the seed coat and cotyledon fractions were calculated. Other samples were ground into fine powder, passed through a 40-mesh sieve, and the sead coat was removed, whereas the cotyledon flour was subjected for analysis.

*Gelatinization and viscosity measurements*

The decoated seeds (cotyledon flour) was subjected for the gelatinization and viscosity measurements using Barbender amylograph according to the official method (7). For the complete curve, a 13 % slurry was prepared, and the temperature of the suspension is raised at a constant rate of 1.5 °C/min. from 20 °C to 95 °C. Gelatinization temperature was estimated with the range of ± 0.5 °C and peak viscosity was measured in Barbender Units (B.U.) which was reproducible to ± 30 B.U.

*Analytical methods*

Amylose was estimated by iodine colorimetric method (8) using pure lentil amylose as a standard, and a Spekol spectrophotometer was used for the absorbance reading at 660 nm Kjeldahl nitrogen (9) was determined from which protein content was calculated by multipling it with the factor 6.25. The phytic acid phosphorus was determined colorimetrically (10) using the same spectrophotometer at 480 nm.

Amino acid contents in two lentil varieties that showed variable cookability were determined after hydrolyzing the samples with 6 N HCl (11). The hydrolyzates were analysed with Technicon amino acid analyzer (12).

*Cookability*

A known weight (2 g) of the whole seeds was cooked by immersing in boiling water (12 ml) for the desired time. The softness of the cooked seeds was tested by finger-pressing, and the rupture of their coats was tested by binocular. The volume-expansion ratio was calculated as the volume of the cooked seeds in relation to the volume of the raw seeds (13).

The cooking-time was taken as the number of minutes required to reach the maximum volume expansion ratio (14).

## Results and discussion

*Physicochemical characteristics*

As shown in table (1), it is quite evident that lentil variety (NEL 254) possessed lower degree of milling than the other two varieties (NEL 225 or Giza 9), which gave nearly the same degree of milling. This was indicated by the lower yield of cotyledon fraction and the higher seed coat fraction of NEL 254. Decoated seeds of the three tested varieties contained higher protein content than the whole seeds (table 1). Similar observations have been reported for broad bean varieties (15). It could be concluded that lentil seed coat contained low value of protein. This was confirmed by the findings of Marquardt et al. (16), who stated that low protein and high fiber as well as high tannin contents were present in the seed coat of broad bean.

Protein contents of lentil varieties ranged from 24.6 to 27.11 (table 1). These levels of protein are of the same order of magnitude as levels reported by other investigators (17, 18).

Table 1. Seed coat:cotyledon ratio and distribution of protein and phytic acid phosphorus in lentil varieties.

| Variety | | | Protein (NX 6.25) % | | Phytic acid phosphorus (mg/100 g sample) | |
|---|---|---|---|---|---|---|
| | Seed coat % | Cotyledon % | Whole seeds | Decoated seeds | Whole seeds | Decoated seeds |
| Giza 9 | 12.1 | 87.9 | 24.60 | 26.65 | 140 | 143 |
| NEL 225 | 11.7 | 88.3 | 27.11 | 28.41 | 155 | 170 |
| NEL 254 | 16.0 | 84.0 | 27.03 | 28.53 | 122 | 126 |

Phytic acid phosphorus-data indicates a narrow range among the tested varieties, and their decoated seeds contained higher values than the whole seeds (table 1).

The gelatinization and viscosity measurements along with some chemical analysis for the decoated seeds of lentil varieties are shown in table 2. Generally, amylograph curves for the tested lentil varieties were typical to those of other legumes as was found by El-Saied and El-Farra (19), but they gave some differences between the varieties. Gelatinization temperatures of decoated lentil seeds ranged from 72 to 77 °C and were associated with the variety. These values were not correlated with the amylose and protein contents of the same samples (table 1, 2). Similar observations have been reported for broad bean (19) and milled rice (13, 20). Gelatinization temperature for milled rice seemed to be sensitive to protein level, but there was no consistent trend (13). In general, the tested varieties indicated a narrow range of their gelatinization times (28–31.5 min). Good correlation has been found between the obtained gelatinization temperatures and gelatinization times. High gelatinization temperature was associated with long gelatinization time (table 2). Peak viscosities ranged from 160 to 280 B.U. and generally were independent of either amylose content or protein content (table 1, 2). The same conclusion was observed for milled rice varieties with different amylose and protein contents (13, 21).

*Cookability*

The maximum volume-expansion ratio as a measurement of cookability for variety NEL 225 was lower than those for the other tested varieties (table 3). It is apparent that this characteristic is related to amylose content, since variety NEL 225 with low amylose content absorbed less amount of water than varieties Giza 9 and NEL 254 which contain more amylose contents (table 2, 3). Giza 9 was similar to NEL 254 in water-uptake behaviour, as their amylose contents were nearly the same (27 %, 26 % respectively). This confirmed the findings of Tani (22), who stated that high amylose Indica rice generally absorbs more water and expands more during cooking in excess water than low amylose Japonica rice. Rao et al. (23) similarly found that volume expansion and water absorption during cooking were positively correlated with amylose content of 22 samples of Indica rice. The maximum volume-expansion ratio was independent with protein and amino acid contents (tables 1, 3, 4). Similar

Table 2. Physicochemical measurements for the decoated seeds of lentil varieties.

| Variety | Amylograph measurements | | | Amylose |
|---|---|---|---|---|
| | Gelatinization | | Peak viscosity | |
| | Temp. (°C) | Time (min) | (B.U.)* | % |
| Giza 9 | 75 | 30.0 | 250 | 27 |
| NEL 225 | 77 | 31.5 | 160 | 24 |
| NEL 254 | 72 | 28.0 | 280 | 26 |

* Barbender unit.

Table 3. Volume-expansion ratio of lentil varieties at different cooking-periods.

| Variety | Volume-expansion ratio at cooking-periods (min) | | | | Cooking-time (min) |
|---|---|---|---|---|---|
| | 15 | 25 | 35 | 50 | |
| Giza 9 | 2.69 | 2.93 | 3.28 | 3.45 | 50 |
| NEL 225 | 2.10 | 3.03 | 3.03 | 3.07 | 25 |
| NEL 254 | 2.60 | 3.28 | 3.31 | 3.34 | 25 |

observations have been reported for Egyptian broad bean (19), Egyptian rice (14), as well as, Indica rice and Japonica rice (13). Since phytic acid phosphorus data indicated a narrow range and low levels (0.12–0.15 %), no correlation was found between phytic acid phosphorus and cookability of the tested varieties (tables 1, 3). Cooking-time for Giza 9 was longer (50 min) than those of NEL 225, and NEL 254, which were the same (25 min); however, the seeds of NEL 254 contained the highest value of seed coat (table 1). Apparently, the seed coats, which were very fine, seemed to be an unimportant factor for the cooking time of lentil. Moreover, the softness of the cooked seeds and the rupture of their coats for each variety were associated with its cooking-time. Apparently, cooking-time (period) was the principle factor for controlling cookability of lentil varieties.

Table 4. Amino acid patterns for lentil varieties of variable cookability as compared with the provisional FAO amino acid patterns (g/16 g N).

| Amino acid | Variety and degree of cookability Giza 9 (Maximum) | NEL 225 (Medium) | FAO (1957) provisional pattern (25) |
|---|---|---|---|
| Aspartic acid | 8.37 | 9.76 | |
| Threonine[a]) | 3.84 | 5.70 | 3.02 |
| Serine | 5.26 | 4.96 | |
| Glutamic acid | 17.49 | 22.08 | |
| Proline | 4.59 | 3.84 | |
| Glycine | 4.16 | 4.54 | |
| Alanine | 3.94 | 4.56 | |
| Valine[a]) | 4.88 | 5.17 | 4.54 |
| Cystine | 0.91 | 0.99 | |
| Methionine[a]) | 0.86 | 0.70 | 2.42 |
| Isoleucine[a]) | 4.06 | 4.32 | 4.54 |
| Leucine[a]) | 7.20 | 7.62 | 5.15 |
| Tyrosine | 3.36 | 2.62 | |
| Phenylalanine[a]) | 5.28 | 4.96 | 3.02 |
| Lysine[a]) | 7.18 | 7.20 | 4.54 |
| Tryptophan[a]) | [b]) | [b]) | 1.51 |
| Histidine | 2.72 | 2.94 | |
| Arginine | 8.05 | 6.98 | |
| Protein % | 24.6 | 27.11 | |

[a]) Essential amino acid.
[b]) No value available.

*Amino acid patterns*

Amino acid data for lentil varieties of variable cookability indicated a narrow range with exception to glutamic acid (table 4). The tested varieties contained at least 17 amino acids, and the predominant amino acid was found to be glutamic acid, whereas the other amino acids were found in variable amounts. Similar observations were stated by Hsu et al. (17). Giza 9 contained lower values for glutamic acid and threonine than those of NEL 225. From the results shown in tables 2, 3, 4 it could be concluded that the amino acid patterns were independent of not only gelatinization temperature and peak viscosities, but also cookability of lentil varieties.

*Summary*

Some physical and chemical characteristics of three varieties of lentil were studied along with their cookability. Gelatinization temperature and peak viscosity were found to be independent of amylose content as well as protein and amino acid contents. The maximum volume-expansion ratio was positively correlated with amylose content and independent of protein and amino acid contents. Seed coats of the tested varieties were very fine and seemed to be an unimportant factor for their cookability. No correlation was found between phytic acid phosphorus content and cookability of the tested varieties. The amino acids were determined quantitatively by the amino acid analyser. Glutamic acid was found in higher level, whereas the other amino acids were found in variable amounts.

*Key words:* lentil varieties, cookability, physicochemical characteristics

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