## Influence of Genetic Strain and Environment on the Protein Content of Pulses

*Abstract*. About 100 pure-bred samples of nine varieties of pulses raised in different state agricultural farms of India in 1957, when analyzed, indicated variations in the protein content of a single variety extending up to 60 percent in some cases, depending upon the strain and the locality where grown.

Pulse is one of the most important sources of vegetable protein food in India. There are six or seven important varieties, and the total annual production comes to more than 10 million tons (*1*). Studies with limited data on the chemical composition, digestibility, and biological values (*2*) indicate that the protein content of these pulses varies from 20 to 30 percent; the digestibility, from 75 to 95 percent; and the biological value, from 45 to 70 percent.

In view of the importance of protein food in the maintenance of the health of an increasingly vast population, large-scale experiments have already been undertaken in different parts of the world, particularly in the United States, which show that the nutritional value of the plant food supply, and particularly of specific food nutrients, apart from the total quantity produced, is governed by various factors such as genetic strain and environment, including climate and soil conditions. There is experimental evidence in the literature that the strain and the nature and degree of fertilization greatly influence not only the yield of a particular crop but also the nutrient content of a specified harvested crop. It has been shown that a given variety of wheat can vary as much as 20 percent in protein content, according to the locality where it is grown (*3*). The influence of genetic factors on the protein content of the corn kernel (*4*), and of plant variety and amount of nitrogen fertilization (*5*) on the protein and amino acid distribution in corn, has also been demonstrated.

In view of the foregoing findings and the fact that any nutritional program must proceed on the basis of nutritional quality of the foods grown in a particular locality, it was considered desirable to undertake a nutritional survey of all varieties of pulses grown in different parts of this country in order to study the degree of variation in the protein contents of pulses grown from various strains and under different soil and climatic conditions (*6*).

About 100 samples of pure strain pulses were collected from the 1957 crop from different state agricultural farms for the purpose of this study. The significant findings regarding the distribution of protein are summarized in Tables 1, 2, and 3.

Table 1. Variation in pulse protein obtained from pulses of the same strain grown in different localities.

| Variety | Strain | Locality | Yield (lb/acre) | Protein (N × 6.25) on dry basis (%) | Variation (%) |
|---|---|---|---|---|---|
| Red gram (*Cajanus cajan*) | E.B. 38 | New Delhi | | 23.54 | 12.96 |
| Red gram (*Cajanus cajan*) | E.B. 38 | Nagpur | 1020 | 26.59 | 12.96 |
| Bengal gram (*Cicer arietum*) | T. 87 | Berhampur | 1275 | 22.68 | 22.05 |
| Bengal gram (*Cicer arietum*) | T. 87 | Kanpur | | 27.68 | 22.05 |
| Green gram (*Phaseolus aureus*) | T. 1 | Saurastra | 120 | 23.79 | 25.05 |
| Green gram (*Phaseolus aureus*) | T. 1 | Berhampur | 288 | 28.24 | 25.05 |
| Green gram (*Phaseolus aureus*) | T. 1 | Kanpur | | 29.75 | 25.05 |
| Cow peas (*Vigna sinensis*) | Phili. | Junagadh | | 26.97 | 33.63 |
| Cow peas (*Vigna sinensis*) | Phili. | Saurastra | 1950 | 36.04 | 33.63 |
| Bengal gram (*Cicer arietum*) | Chaffa | Niphad | 800 | 20.05 | 33.82 |
| Bengal gram (*Cicer arietum*) | Chaffa | Junagadh | 518 | 26.83 | 33.82 |

Table 2. Variation in pulse proteins in pulses of different strains grown in the same locality.

| Variety | No. of strains | Locality | Range of protein (%) (on dry basis) |
|---|---|---|---|
| Bengal gram (*Cicer arietum*) | 4 | Berhampur–W. Bengal | 22.68–27.94 |
| Bengal gram (*Cicer arietum*) | 6 | Ujjain–Madhya Bharat | 17.92–24.33 |
| Bengal gram (*Cicer arietum*) | 4 | Nagpur–Bombay | 17.55–23.73 |
| Bengal gram (*Cicer arietum*) | 4 | Parbani–Bombay | 20.46–22.64 |
| Red gram (*Cajanus cajan*) | 4 | Berhampur–W. Bengal | 24.80–28.42 |
| Red gram (*Cajanus cajan*) | 4 | Nagpur–Bombay | 23.30–26.59 |
| Red gram (*Cajanus cajan*) | 4 | Parbani–Bombay | 17.98–23.55 |
| Lentil (*Lens esculenta*) | 3 | Berhampur–W. Bengal | 29.15–30.84 |
| Black gram (*Phaseolus mungo*) | 4 | Ujjain–Madhya Bharat | 21.97–28.60 |

Table 3. Maximum variation in pulse proteins when both the strain and the environment vary.

| Variety | Strain | Locality | Yield (lb/acre) | Protein (N × 6.25) on dry basis (%) | Variation (%) |
|---|---|---|---|---|---|
| Lentil (*Lens esculenta*) | C.T. 31 | Berhampur | 1440 | 30.84 | 17.71 |
| Lentil (*Lens esculenta*) | T. 36 | Kanpur | | 26.20 | 17.71 |
| Khesari (*Lathyrus sativus*) | Indore $T_2$-12 | Bhuwa | 925 | 32.49 | 26.13 |
| Khesari (*Lathyrus sativus*) | No. 11 | Nagpur | 432 | 25.76 | 26.13 |
| Pea (*Pisum sativum*) | D. Comando | Junagadh | 1905 | 27.77 | 28.92 |
| Pea (*Pisum sativum*) | Khaperkhata | Ujjain | | 21.54 | 28.92 |
| Black gram (*Phaseolus mungo*) | Gwalior 2 | Gwalior | 600 | 28.60 | 30.18 |
| Black gram (*Phaseolus mungo*) | Ujjain 15 | Ujjain | | 21.97 | 30.18 |
| Green gram (*Phaseolus aureus*) | G.G. 188 | R. Nagar | 550 | 34.01 | 42.96 |
| Green gram (*Phaseolus aureus*) | T. 1 | Saurastra | | 23.79 | 42.96 |
| Bengal gram (*Cicer arietum*) | Select 10 | Berhampur | 1440 | 27.94 | 59.20 |
| Bengal gram (*Cicer arietum*) | D8 | Nagpur | 543 | 17.55 | 59.20 |
| Red gram (*Cajanus cajan*) | Gwalior 3 | Gwalior | 1200 | 28.86 | 60.51 |
| Red gram (*Cajanus cajan*) | No. 76–23 | Parbani | | 17.98 | 60.51 |

The results as recorded in Table 1 tend to show that when the same strain of any variety of pulse is raised in different localities, a variation of 13 to 34 percent in the protein content occurs, depending upon the nature of soil conditions.

Similar variation in the protein content is also found (see Table 2) where pulses of different strains are grown in the same locality. The degree of such variation depends mainly on the nature of the genetic strain.

In Table 3, the pulses with maximum and minimum protein content, as grown in different parts of the country, are reported.

It may be seen from the results that a wide variation in the protein content exists, exceeding even 50 percent in some cases, depending upon the genetic strain and the locality where the pulses are grown. It is difficult to conclude at this stage, with the limited data, whether any relationship exists between the yield and the protein content. It will be, however, of much advantage if the protein level can be raised, even when the yield is not sufficiently increased in the production of these important plant foods. Work is in progress regarding the nutritional quality of the additional protein produced by the influence of genetic strain or environment or both.

G. C. Esh
T. S. De
U. P. Basu
*Bengal Immunity Research Institute, Calcutta, India*

References and Notes

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6. This study was supported by the Indian Council of Medical Research, Government of India. We are also indebted to all state agricultural authorities for their kind cooperation in supplying pure strain samples of pulses.

28 July 1958

## Changes in Psychological Test Performances of Brain-Operated Schizophrenics after 8 Years

*Abstract.* Long-term effects of topectomy showed statistically significant losses not present shortly after psychosurgery in eight of 14 psychological test measures. Site of operation, length of postoperative interval, age, and nature of the measure were factors determining the effects of brain damage.

Increasing and differentiated populations of brain-damaged subjects have become available for studies by neurologists and psychologists as a result of developing techniques in brain surgery, first in cases of brain wounds and tumors and later with the advent of "psychosurgery." In both fields of study there are sources of ambiguity, and the contradictory findings that have been reported (often in apparently similar investigations) are not surprising.

The New York State Brain Research Project, 1948–1950 (*1*), the last of three related projects that sought to control some of the variables in earlier studies, reported conclusions of no "permanent" decrements in "intellectual function" following psychosurgery (topectomy). This finding was based on comparisons of psychological test scores from preoperative and postoperative (within 120 days following surgery) examinations of 45 operated and 33 nonoperated schizophrenics. The conclusions were in agreement with findings of no losses in the two related projects [Columbia-Greystone I (*2*) and II (*3*), which also included control subjects] and of numerous other studies. Early postoperative losses were interpreted as transient in the Columbia-Greystone studies because of increasing scores by the operated subjects in successive postoperative tests; in the New York State Brain Research Project, because of smaller decrements in the single examinations administered after greater postoperative intervals. The "drop and rise" pattern was considered a reflection of temporary physiological conditions in the brain.

In 1957, after a postoperative interval of 8 years, 28 operated and 24 nonoperated subjects of the original New York State Brain Research Project were retested with the same psychological instruments. These 52 subjects had been originally grouped according to age (as of March 1957) and symptom complex into a C group—older (mean age 57.5 years, with primarily a retarded hebephrenic symptom complex)—and a D group—younger (mean age 41.9 years, with primarily a paranoid symptom complex). Controls had been drawn from the same pool of patients satisfying the selection criteria of several cooperating disciplines. The present follow-up study was restricted to subjects still at Rockland State Hospital, Orangeburg, New York; the remaining subjects were not available, due to transfers, deaths, and parole of four controls and three operated patients.

Surgery consisted of either an orbital topectomy [bilateral excision of Brodman's areas 11 (sometimes including portions of 47) and 10, and of Walker's area 13, from the lower regions of the forebrain], or superior topectomy [bilateral excision of Brodman's areas 9 (sometimes including parts of 10), 8, and 32, from the upper regions of the forebrain]. The amount of cortical tissue excised in either operation was reported to be 30 to 35 g from each hemisphere of the forebrain.

Following procedures of the original study, the 11 subtests of the Wechsler-Bellevue Form I, the revised Capps Homographs, the Porteus Maze, and the Weigl Sorting test were readministered twice to each subject, with an interval of 30 days between the two administrations. Comparisons of the 8-year postoperative and preoperative mean scores showed poorer performances by the operated subjects in all 14 different measures, intelligence quotients, and composite scores (sums of 13 standard scores). Differences among operated and control subjects were further analyzed and tested for significance by the analysis of covariance in comparisons of groups on the bases of operation (operated and nonoperated subjects), site of excision (orbital and superior topectomy), and age (younger and older subjects). Losses by the operated groups among the 14 different measures showing poorer performances were statistically significant in several measures for each of these three factors, as shown in Table 1.

Differences between the two operative sites are shown in the table by the direct comparisons of the superior and orbital groups, as well as by comparisons of each operated group with its appropriate control. The greater losses resulting from superior topectomy when compared to orbital topectomy are in agreement with results of early postoperative studies of cases with superior lesions by Malmo (*4*), Penfield (*5*), and Petrie (*6*).

Differences in the effects due to age of the subject are shown in the table by the statistically significant losses by older operated groups (C groups). These differences appeared also when preoperative, early postoperative, and 8-year postoperative scores were compared. The older operated group showed a gradient of successive postoperative losses in seven of 13 measures. This gradient of increas-

Table 1. Table of significant differences. Comparisons of preoperative and 8-year postoperative test scores for C-group (older) and D-group (younger) and for superior-group and orbital-group topectomized patients, with appropriate controls (Weigl shift or nonshift performance is omitted). DSp, Digit Span subtest; Arith, Arithmetic subtest; PA, Picture Arrangement subtest; BD, Block Design subtest; OA, Object Assembly subtest; DSbl, Digit Symbol subtest; FS, Full Scale IQ; VS, Verbal Scale IQ; PS, Performance Scale IQ; PM, Porteus Maze test; CH, revised Capps Homographs; CS, Composite Score.

| Groups | No. | Test | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wechsler-Bellevue Examination Form I | | | | | | | | | PM | CH | CS |
| | | Dsp | Arith | PA | BD | OA | DSbl | FS | VS | PS | | | |
| All operated<br>All control | 28<br>24 | 10.36* | 9.63† | | | | 6.96† | | | | | 5.13† | 14.79* |
| All superior<br>All control | 17<br>24 | 4.82† | 6.97† | | | | 14.44* | 6.49† | 4.12† | | 4.93† | | 17.33* |
| All superior<br>All orbital | 17<br>11 | 6.14† | | | | | | | | | | | |
| D superior<br>D control | 12<br>11 | 4.59† | | 4.58† | 5.81† | | 8.89† | | | | 4.51† | 7.22† | |
| D superior<br>D orbital | 12<br>7 | | | 6.57† | | | | | | | | | 8.36† |
| C operated<br>C control | 9<br>13 | | 6.69† | | | | | | | 4.48† | | | |
| C orbital<br>C control | 4<br>13 | | | | | 7.77† | | | | | | | |
| D operated<br>D control | 19<br>11 | | | | | | | | | 6.33† | | | 9.81* |

* Significant at the .01 level. † Significant at the .05 level.