



FIG. 3. Relationship between adiabatic compressibility and intermolecular free length of dicarboxylic acids at 170°C.

Fig. 3. All the evaluated points for different substances are found to lie below the straight line.

The association factors x calculated for different substances by the relation

$$z = \left[\frac{L_f'}{L_f} \right]^3$$

are shown in column 7 of Table II. It is interesting to observe that association decreases with increase of molecular weight of the acid. When association is taken into account, Lagemann's rule⁹ for normal liquids is obeyed by these substances as well and the product $[xM]^{\frac{1}{2}} \Delta c / \Delta t$ is found to be constant as shown in column 8 of Table II with an average value of 39.08.

The first three members of the homologous series of dicarboxylic acids decompose near their melting points and as such their ultrasonic behaviour is being studied by solution method and their results will be published elsewhere.

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NUTRIENT COMPOSITION OF BARBADA OR MALMANDI (*INDIGOFERA GLANDULOSA*)

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ABSTRACT

The seeds of *Indigofera glandulosa*, a wild legume grown in some parts of Deccan region, have been analysed for nutrient composition and amino acid profile. The legume contains 26% protein and is a good source of minerals and B-complex vitamins. Aminogram and bioassay for acute toxicity reveal that the seeds do not contain undesirable constituents. The possibilities of exploiting such innocuous wild legumes with good nutritive potential for edible purposes have been discussed.

INDIGOFERA GLANDULOSA, commonly known as barbada, malmandi or befri is an annual herb found in parts of U.P., Bihar, Gujarat and the Deccan plateau. It has been described as nutritious and is believed to possess the qualities

of a tonic in Indian medicine^{1,2}. Seeds of this wild legume are reported to contain 31% protein and cultivated varieties appear to contain even higher amounts³ (37%). However, complete information on the nutrient composition and the

essential amino acid profile of this legume is not available. In view of the reported good qualities of this legume, it was of interest to investigate in

RESULTS

The data on the nutrient composition are indicated in Tables I and II.

TABLE I

Nutrient composition of seeds of *Indigofera glandulosa*, compared with other common pulses

Nutrient	<i>Indigofera</i> * <i>glandulosa</i> (malmandi)	Chick pea (Chena)	Pigeon pea (Tuar)	Green gram (Mung)	Black gram (Urad)
Protein g%	26.1	17.1	22.3	24.0	24.8
Total ash g%	2.18	3.0	3.5	3.5	3.2
Calcium mg/100 g	154	202	73	124	154
Phosphorus mg/100 g	291	312	304	326	385
Ca : P	1:1.9	1:1.5	1:4.2	1:2.6	1:2.5
Iron mg/100 g	22.4	10.0	5.8	7.3	9.3
Molybdenum mg/100 g	2.76	1.95	2.22
Thiamin mg/100 g	0.8	0.30	0.45	0.47	0.42
Riboflavin mg/100 g	0.31	0.15	0.19	0.27	0.2
Niacin mg/100 g	4.47	2.90	2.90	2.10	2.00

* Data on the basis of present investigation.

Data on other pulses drawn from *Nutritive Value of Indian Foods*.⁹

detail the nutrient composition, the essential amino acid content and also to examine the possible presence of unusual toxic amino acids.

MATERIALS AND METHODS

Sample of seeds of *Indigofera glandulosa* was obtained by the courtesy of the Department of Extension of the Ministry of Agriculture, Southern Region, Bangalore.

Proximate principles were determined by standard techniques⁴. Mineral and trace element composition were determined by methods described by Sandel⁵. The B-complex vitamins were estimated by fluorometric or microbiological methods⁴. Essential amino acids were assayed by both microbiological assays and by the use of automatic amino acid analyser, using appropriately processed protein hydrolysates of the sample⁶. Free amino acids were examined by two-dimensional paper chromatographic method using extractives of 70% alcohol, using butanol : acetic acid : water (12 : 3 : 5) and phenol : water (4 : 1) with NH_4OH as described by Ivor Smith⁷.

Acute toxicity studies on extracts from 70% alcohol extract were carried out on day-old chicks by intraperitoneal administration of appropriate dosages of the extract concentrates⁸.

It can be seen from the results that malmandi is a good source of protein. The protein, however, is deficient in methionine and in tryptophan. Like other legumes, it is a good source of lysine. Arginine content in the seed protein is very high, being threefold higher than the levels seen in other legumes. In regard to the mineral composition, it compares favourably with the most of the commonly used pulses. It is a better source of iron and B-complex vitamins. The amino acid profile determined by both the automatic amino acid analyser and the two-dimensional paper chromatography did not reveal the presence of any unusual amino acid.

Acute toxicity studies by daily intraperitoneal administration of concentrates of 70% alcohol extracts to baby chicks for about a week did not indicate any demonstrable signs and symptoms of toxicity.

DISCUSSION

The seeds of the wild legume, *Indigofera glandulosa*, are a good source of protein, minerals and vitamin B-complex. The quality of protein as measured by the amino acid profile compares favourably with other pulses which are commonly used. Since the crop is drought resistant and can be grown in dry

TABLE II

Essential amino acid composition and protein quality of malmandi compared with other pulses

Amino acid	<i>Indigofera</i> * <i>glandulosa</i> (malmandi)	Chick pea (Chena)	Pigeon pea (Tuar)	Green gram (Mung)	Black gram (Urad)
Arginine g/16 g N	24.7	9.12	5.76	8.0	8.32
Lysine	7.12	7.04	7.68	7.36	6.40
Threonine	4.92	3.52	3.20	3.20	3.52
Methionine	0.84	1.28	0.96	1.28	1.44
Tryp ophan	1.03	0.80	0.69	0.96	1.12
Leucine	8.56	9.28	7.9	8.11	8.00
Isoleucine	4.69	5.12	4.00	5.60	5.44
Lecuc/Isoleucine	1.82	1.81	1.80	1.44	1.47
Histidine	3.91	2.56	4.0	2.72	2.72
Phenylalanine	4.17	5.76	7.36	5.6	4.96
Valine	5.1	4.96	4.16	5.12	4.96
Biological value†	50.52	68	57	54	63
Protein efficiency ratio‡	1.02	1.7	1.5	0.8	1.0
Digestibility§	83%	82-86%	85%	86-94%	83-85%

* Data on the basis of present investigation; † B. V. reported; ‡ P.E.R. reported; § Data reported^{10,11}.

regions, it appears to be a good and low-cost source of nutritious food. Since it is a good source of B-complex vitamins, particularly niacin, consumption of this pulse, in combination with jowar, could control endemic pellagra seen among the low income groups.

The arginine content of this seed is unusually high. Several other hardy legumes such as *Lathyrus* and *Canavalia* species which are also drought resistant crops contain appreciable amounts of higher homologues of arginine¹².

β -Nitropropionic acid, a neurotoxic amino acid from *I. enneaphylla*¹³ and indospicidine, a hepatotoxic amino acid from *I. spicata*¹⁴, have been reported to restrict the utilisation of these species as food for cattle or human. Long term studies are now under progress to examine any possible untoward effects due to prolonged consumption of the seeds of *Indigofera glandulosa*.

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