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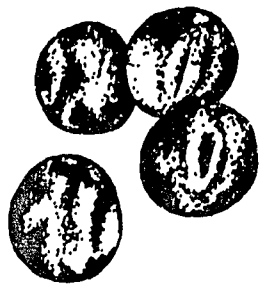
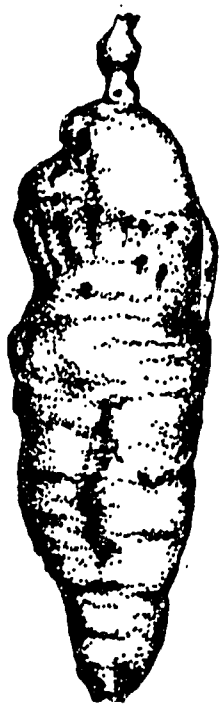
the winged bean flyer





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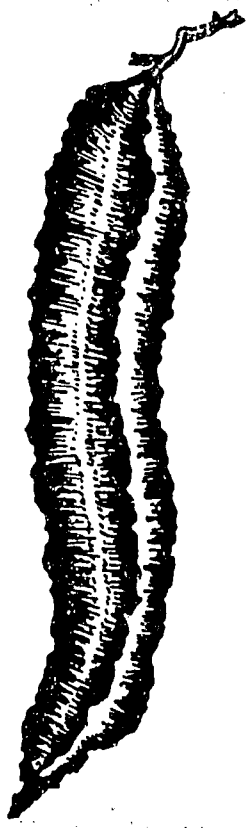

Sponsored by

The International Council for Development of Underutilized Plants

THE INTERNATIONAL COUNCIL FOR DEVELOPMENT OF UNDERUTILIZED PLANTS (ICDUP)

Established in January 1978 by specialists who participated in the First Workshop/Seminar on the Potential of the Winged Bean, the International Council for Development of Underutilized Plants was organized to encourage greater knowledge and use of promising underutilized plants needed by man. It was directed to concentrate its efforts initially on the winged bean, a hitherto neglected tropical legume which has outstanding potential for meeting the increasing needs for plentiful and nutritious food. The Council is a private, non-profit organization, incorporated in the United States, with headquarters in California. The foundation members and officers of the Council are:

The late Dr. Jose D. Drilon, Jr., President, Director, SEARCA, Philippines

Dr. Edward S. Ayensu, Vice-President; Director, Office of Biological Conservation, The Smithsonian Institution

Dr. Norman Borlaug, Nobel Laureate, CIMMYT, Mexico

Professor J.P.M. Brenan, Director, Royal Botanic Gardens, Kew, England

Dr. M.S. Swaminathan, Secretary to the Government of India, Ministry of Agriculture and Irrigation

Dr. Eduardo Alvarez Luna, Director-General, Instituto Nacional de Investigaciones, Agricolas, Mexico

Mr. Louis Lazaroff, Director General/Treasurer

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The Winged Bean Steering Committee, composed chiefly of winged bean specialists, is responsible, under the direction of the Council, for the details of work on the winged bean. The Committee is composed of the following:

Dr. Narong Chomchalow, Deputy Governor, TISTR, Thailand
Dr. Setijati Sastrapradja, Director, LBN, Indonesia
Dr. V. Kesavan, University of Papua New Guinea
Prof. A.A. Duncan, University of Florida, U.S.A.
Dr. S.K. Karikari, University of Ghana
Dr. Tanveer Khan, Dept. of Agriculture, Western Australia (Research Coordinator)
Dr. Wong Kai Choo, Universiti Pertanian Malaysia
Mr. Louis Lazaroff, ICDUP (Coordinator)

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Dr. Noel D. Vietmeyer, National Academy of Sciences, U.S.A.

the winged bean flyer

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Edited by
RUSS A. STEPHENSON

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Philippines

The Winged Bean Flyer was established in 1977, with the support of The Asia Foundation, as part of the Foundation's effort to encourage development of a cooperative international program on the winged bean, *Psophocarpus tetragonolobus* (L.) DC. The International Winged Bean Workshop/Seminar and Public Forum, held in January 1978, in Los Baños, Philippines, which the Foundation had the foresight to propose, resulted in the establishment by the participants of a new organization, the International Council for Development of Underutilized Plants. With the establishment of the International Council, the responsibility for the international winged bean program, including the publication of *The Winged Bean Flyer,* was assumed by the Council.

The *Flyer* is being produced with the welcome and able cooperation of the Agricultural Information Bank for Asia (AIBA) which is headquartered in the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) in the Philippines. The Editor of the *Flyer* is Dr. R.A. Stephenson. All communications should be sent to him at the following address:

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Maroochy Horticultural Research Station
Nambour
Queensland 4560
Australia

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I. EDITORIAL

Contributors will be relieved to know that, in this issue, all outstanding reports have been included. The large delay in including some of this material is regretted. It is hoped that the information on the Second International Winged Bean Seminar which dominated *The Winged Bean Flyer* Vol. 3 No. 2 will compensate for this.

All contributions to *The Flyer* are appreciated and we look forward to your continuing support. Vol. 4 No. 2 is due to be published later this year and more articles, letters and reports are required to make it a worthwhile issue.

I had hoped to present a report on the establishment of the new Winged Bean Research Institute in Sri Lanka in this issue but legislative delays have forced the postponement of the inaugural Board meeting. I anticipate that a comprehensive report will be available for Vol. 4 No. 2. Other important developments arising from the Sri Lankan meeting are the Second Series of International Variety Trials and the publication of the full proceedings of the Seminar. Progress reports should be available for Vol. 4 No. 2. It should also be possible to present a preliminary report on the survey questions which were included in Vol. 3 No. 2. If you have not returned your survey forms, please do so promptly.

It is my intention that, from this year onwards, two issues of *The Winged Bean Flyer* will be produced regularly each year. This can only be achieved by your cooperation in sending in material of interest. You can assist by including a concise summary of lengthy papers or reports. This would relieve the editor of an onerous task and reduce the possibility of misinterpretation of material submitted. Summaries, generally, should be restricted to about one-half a typed quarto page. It would further assist the editor if correspondents would ensure that their country of residence is included in their address. Printed letterheads are often not designed for international use.

Finally, I trust *The Winged Bean Flyer* is proving to be of interest to readers. If you have any suggestions which would make it a more effective organ of communication between winged bean workers, please send them to the Editor.

II. INAUGURATION OF INTERNATIONAL DAMBALA (WINGED BEAN) INSTITUTE

The International Dambala (Winged Bean) Institute was formally chartered by the government of Sri Lanka in early February 1982 as an Independent International Agricultural Research Body. This is the first international institute devoted to work with an underutilized plant. The members of the first board of directors, appointed by H.E. The President of Sri Lanka, consist of the following:

Dr. Cyril Ponnamperuma
(Chairman)
Director, Laboratory of Chemical
Evolution
University of Maryland
U. S. A.

Dr. M.S. Swaminathan
(Vice-Chairman)
Director General, IRRI
Philippines

Dr. Eduardo Alvarez-Luna
President, International Council
for Development of Underutilized Plants
Mexico

Dr. Alexander Grobman
Chief, Instituto Nacional de Investigacion
y Promocion Agropecuaria (INIPA)
Peru

Dr. H.M.W. Herath
Head, Department of Agricultural Biology
University of Peradeniya
Sri Lanka

Dr. W. David Hopper
Vice President, South Asian Region
The World Bank

Mr. Louis Lautroff
(Secretary-Treasurer)
Director General, International Council
for Development of Underutilized Plants
U. S. A.

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Director, Environmental Management Service
United Nations Environment Program
Kenya

Dr. Victor Rabinowitch
Director, Board on Science and Technology
for International Development
National Academy of Sciences
U. S. A.

Mr. Ranjan Wijeratne
Secretary, Ministry of Agricultural Development
and Research
Sri Lanka

The government of Sri Lanka is providing the International Institute with approximately 483 acres of prime land six miles east of Kandy in the central part of Sri Lanka. There are buildings on the land which can readily be converted to institute use. Roads, electric, telephone and water lines are in place.

On March 16, 1982, the institute was formally inaugurated with the first meeting of the Board of Directors, held on the land being provided the institute. Among other business conducted, the board appointed a search committee to select a Director General. An interim Director General will be named pending selection of the Director General. The board also appointed Dr. H.M.W. Herath of the University of Peradeniya, Sri Lanka, to be Deputy Director General.

The next meeting of the board will be held in November. Funding for the institute is expected from The World Bank, the Government of Sri Lanka, and other national and international development agencies which have expressed interest in providing support.

III. APPOINTMENT OF NEW MEMBER, BOARD OF DIRECTORS, ICDUP

Dr. Joseph C. Madamba, the new Director of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA),

the Philippines, has been elected to the Board of Directors, The International Council for Development of Underutilized Plants. Prior to his appointment to SEARCA, Dr. Madamba was director of the Southeast Asian Fisheries Development Center Institute of Aquaculture (SEAFDEC-IA) and served as Director General of the Philippine Council for Agriculture and Resources Research and Development (PCARRD).

Dr. Madamba was one of the architects of PCARRD. He has served with distinction also at the international level as a member of the Technical Advisory Committee (TAC) of the consultative group for International Agricultural Research, and is now Secretary-General of the International Federation of Agricultural Research Systems for Development (IFARD), Philippines and member, Board of Trustees, of the International Council for Research in Agro-Forestry (ICRAF) in Kenya.

Dr. Madamba is noted for his rich and unique experience in agricultural research, development and education.

IV. LETTERS TO THE EDITOR

1. Breeding for white winged beans?

We have analyzed some 30 different lines of mature winged bean seed from various regions of Asia (Papua New Guinea, Malaysia, Indonesia, Thailand and Burma). We have found that the seed protein profiles, as determined electrophoretically in sodium dodecyl sulfate using polyacrylamide gradient gels, are essentially identical (also found previously for some 80 lines from Papua New Guinea (1)). Furthermore, the levels of the anti-nutritional factors (trypsin and chymotrypsin inhibitors and hemagglutinins) are very similar in these lines. Therefore, from a protein quality point of view there are as yet no marked differences to recommend one winged bean line over another.

With respect to the seed, the only distinguishing feature of interest is the colour of the seed coat. Protein extracts prepared at pH 8 from whole seed meal of light coloured seeds (e.g. Thailand lines MHS 10, MHS 19, NLZ and CR 6) produce clear to pale coloured

extracts. Darker seed varieties (e.g. UPS 122, UPS 102, Tpt 1) produce yellow to brown extracts while UPS 66 produces a deep purple extract which turns dark brown on standing. The light coloured extracts resemble those obtained from soybean and would be favoured as grain legume product by the food processing industry. The lower tannin content of the light coloured seeds may also yield enhanced levels of available protein. As the protein content of all the winged bean lines tested so far is similar, it may be desirable to select (amongst other desirable plant characteristics) for white seeds with a view to greater acceptability by consumers and processors alike.

(1) Gillespie, J.M. and Blagrove, R.J. *Aust. J. Plant Physiol* 5, 371-5 (1978).

A.A. Kortt & R.J. Blagrove
Division of Protein Chemistry
C.S.I.R.O.
Parkville, Melbourne, Vic. 3052
AUSTRALIA

2. Names given to the winged bean.

Thanks for the copy of *"The Winged Bean Flyer"*, Vol. 3, No. 1, December, 1980 which I received only on 5-10-1981. In this issue in Article IV names given to the winged bean on page 8, last line, the typographical error may be corrected "Chau-dhari-phali" instead of "Choud-haari phali". Other names by which it is called in different part of India are:

Choughula sem	-	INDIA	-	Orissa & Madhya Pradesh
Kattu Avarai	-	INDIA	-	Tamilnadu
Errachi Avarai	-	INDIA	-	Kerala
Rakkai Avarai	-	INDIA	-	Kamataka

R. Rajendran
Indian Institute of Horticultural
Research (I.C.A.R.)
P. O. Box 8025
255 Upper Palace Orchards
Bangalore -560080
INDIA

3. Plant Breeding Abstracts

Would you be able to arrange for us to be placed on the mailing list (for *The Winged Bean Flyer*) and if, as I suppose, it contains items of interest to breeders would you also be able to grant us permission to summarize such items in Plant Breeding Abstracts?

Miss O. Holbek
Director
Commonwealth Bureau of Plant
Breeding and Genetics
Department of Applied Biology
Pembroke Street
Cambridge CB2 3DX
ENGLAND

4. Winged bean research register

I am preparing a doctorate in the University of Pierre and Marie Curie, Paris and am conducting my research in the Phytotron Laboratory of the National Centre of Scientific Research in Gif/Yvette. I have been working on the winged bean using the tissue culture method since the past three years. With two other colleagues, I have published an article on "Direct *in vitro* bud formation from fragments and thin cell layers of different organs of the winged bean" (in press in Z Pfalzenphysiologie) and am in the process of writing up another article. I will be grateful if you can inform me of how I can go about becoming a member of "the winged bean research programme" and be included in the information and circulation list.

Mr. H. Lie-Schricke
Centre National de la Recherche
Scientifique
Le Phytotron
91-Gif-sur-Yvette (Essonne)
FRANCE

5. Photoperiod insensitivity

The enclosed photographs show that my selections for flowering under long day conditions do pretty well. On ETH-Selection I, first flowers appeared after 64 days with a range of 60 - 69 days. For ETH-Selection II, the values were 58 days (55-60). Both were selected within TPT-8. Plants were grown in a sixteen hour photoperiod and day/night temperatures around 27/23°C. As far as space is available in the controlled environment units, I grow them also in lower and higher temperature (range about 20 - 30°C). Flowering was not impared but only slightly hastened in the higher temperatures or slightly slowed down in the cooler environments. I will distribute seed to whoever has good use for it.

Dr. J. Rüegg
Institut für Pflanzenbau
Swiss Federal Institute of
Technology (ETH)
Zürich, SWITZERLAND

V. MORE ABSTRACTS FROM THE SECOND WINGED BEAN SEMINAR

1. Beaumont, J.H.; Bodger, D.; Caygill, J.C.; Coward, L.D.G.; Davis, J.B.; Dench, J.E.; Brancis, B.J.; Hammonds, T.; Harris, R.V.; Jones, M.R.; Machin, D.H.; McFarlane, N.; Parr, W.H.; Poulter, N.H.; Quaraishi, A.R.; Southwell, K. and Wood, J. Food uses of the winged bean. 15 p. 10 tables.

The seeds are hard, and decortication is a problem, but oil of good quality can be obtained by an efficient expeller and simple bleaching operation or, on a large scale by solvent extraction and conventional refining. No highly toxic fatty acids were noted. The resulting meal or cake might be used as an animal food ingredient, but much more work is required to define adequate heat or other processing conditions required to bring its nutritive value up to the potential indicated by its chemical composition. Protein isolates with excellent functional properties can be prepared from winged bean meals but in rather poor yields. The tubers, primarily because of their relatively high protein content, would appear to be a good food source but again, there are indications of antinutritional factors which require further study.

2. Chomchalow, S.; Visuttipitakul, S.; Piraman, P.; Tojun, P.; Juntarasami, M.; Boonmalisont, D.; Poonsawasdi, S.; Norman, B.; Tiensri, S. and Kachasenee, P. Inoculum production for winged bean and other grain legumes in Thailand.

The type of legume inoculant produced by TISTR is suitable for large scale commercial production since it is produced using universally accepted procedures and the product can be stored for a long time. Moreover, it is convenient in long distance transport which is beneficial in a country like Thailand. At TISTR the inoculants for winged bean, peanut, mungbean, and ipil-ipil stored in a cold room at 12° - 15° were still effective after five months, having more than 85% nodulation in the greenhouse. Soybean inoculant, however, was good for only three months in storage with 84% nodulation in the greenhouse, and percentage of nodulation dropped readily thereafter. Storage can be improved by lowering the temperature, adding supplementary nutrients, and adjusting the moisture content in the carrier The farmer's field tests on the inoculants produced by TISTR indicated an increase on the average of 14-27% over the uninoculated treatment. Further studies need to be done in order to arrive at the target of 30% increase in the yield.

3. Flechtmann, C.H.W. Observations on winged beans in São Paulo, Brazil. 6 p.

Winged beans grow satisfactorily during the summer in São Paulo, Brazil (approx. Latitude 23°S - Tropic of Capricorn). The aerial part of the plant can be attacked by the insects such as *Podalia* sp. caterpillars, Lepidoptera, Megalopygidae, *Caliothrips phaseoli* (Hood, 1912) and *Echinothrips mexicanus* Moulton 1911 - Thysanoptera, Thripidae. *Diabrotica speciosa* (Germar, 1824) - Coleoptera, Chrysomelidae, Galerucinae. *Acrosternum* sp - Hemiptera, Pentatomidae and Mites (Acari) *Polyphagotarsonemus latus* (Banks, 1904) - Prostigmata, Tarsonemidae.

Tetranychus urticae Koch, 1844 and *T. desertorum* Banks, 1900 - Prostigmata, Tetranychidae. The roots are hosts to *Meloidogyne incognita* (Kofoid - White, 1919) Chitwood, 1949 and *M. javanica* (Treub, 1885) Chitwood, 1949 - Nemata, Heteroderidae. Stored seeds are not attacked by *Lasioderma serricorne* (Fabr., 1792) and *Tribolium castaneum* Herbst, 1797, however, these beetles develop large populations on the dry tissues of the pods.

4. Giraldo, G. Preliminary evaluation of winged bean material at CIAT.

Although CIAT does not support any research program on winged bean some materials of this species which had been stored in the germplasm bank of the Center were evaluated as part of a cooperative project with the University of Papua New Guinea and IITA from Ibadan, Nigeria. In 1976, scientists were invited to send their most promising winged bean materials for a second evaluation under CIAT's climatic conditions namely, 1000 mm rainfall, latitude 3°N, 1000 m (asl), and 24°C mean temperature. The best materials, out of 32 actually sent, were previously selected on the basis of adaptation, resistance to insect pests and diseases, yield per plant and other agronomic characteristics and then evaluated in a yield experiment with two replications conducted during the first planting season of 1979 at CIAT. Results were discussed.

5. Hildebrand, D.F.; Chaven, C.; Hymowitz, T. and Bryan, H.H. Variation in protein and nitrate content of vegetative growth of winged beans.

The 68 winged bean accessions evaluated showed considerable variability in protein and nitrate % and vigor of second year vegetative growth. Protein content of vegetative growth ranged from 11 to 32% with a mean of 22%. Nitrate content ranged from 0.01 to 1.02%. The 3 *Psophocarpus scandens* accessions evaluated tended to have about the same protein %, lower nitrate % and greater vegetative growth than *P. tetragonolobus*.

6. Kim Ki-June. Experimental adaptation of winged beans in different latitudinal locations in Korea.

A possible mutant type of UPS-63 variety, K-K#1, was tested for the effect of planting dates at three locations, Seoul, Jinju and Jeju in Korea and the effect of mulching and the planting densities at two locations, Jinju and Jeju was observed. In the southern-most location, Jeju, K-K#1 was two to six days earlier in initial flowering as compared to the Seoul location, the northern-most location. It was considered that the relatively higher temperature and shorter day-length in Jeju caused flowering to hasten and thus higher yield. Mulching plants at planting time increased the germination rate due mostly to higher soil temperature.

Mulching also helps to conserve soil water, to destroy weeds, and, as a result promotes higher yield. Maximum yield was obtained from the 75 row spacing and 35 cm between hills within row. In a higher latitudinal country like Korea, day-length is longer during the growing season, temperature is lower at planting time and after September. It would be possible to grow winged beans for green feed and vegetable pods. If a variety flowered early to reach full maturity, it should have enough potential to grow economically in Korea.

7. Rao, N.R.G.; Shivashankar, K.I.; Shivashankar, G. and Sulladhamath, U.V. Preliminary evaluation of winged bean germplasm for green pod yield, seed yield and their attributing characters.

Winged bean, also known as Goa bean or Four-angled bean, has interested plant breeders recently because of its high protein content in seed as well as tuber and the moderate oil content in its seeds. Even though winged bean is being grown in scattered pockets in some of the States of India, its importance and use were not recognised by the majority of the people. This crop could be used to solve the problem of malnutrition. With the object of popularising the importance and use of the winged bean crop in the State, and also to develop high yielding strains suitable to different agro-climatic conditions, the division of Agricultural Botany, Agricultural College, Hebbal, Bangalore has started a collection of different genotypes of winged bean from various sources. As a result, about 64 genotypes including two local strains viz., CFTRI-1 and T. local were received from I.A.R.I., New Delhi; IIHR; Bangalore; NBPGR Regional Station, Amaravathi; California; Puerto Rico and Sri Lanka.

8. Syukri, H.Z. "Winged bean trials in Indonesia".*

Winged bean variety trials were conducted at two locations: Cipanas, at 1100 m above sea level, and Pasarminggu at 30 m above sea level. The experiment at Pasarminggu failed to produced dry pods, due to heavy rain. Data from the experiment at Cipanas are reported. Fifteen varieties of winged bean were tested, nine of which were local varieties collected from Kalimantan and Java, one variety derived from Papua New Guinea, while the other five varieties were provided by the National Biological Institute, Bogor. The first flowering date for all local varieties ranged from 65 to 76 days while the range for the other varieties was from 87 to 99 days. Local varieties produced higher yields than those which were introduced. A variety collected from Sambas, Kalimantan produced the highest yield: 1969 kg per hectare dry seed. Beside yield, the number of days to the last harvest, the number of pods per plant and the average length per pod, weight of 100 seeds and disease index of false rust were recorded.

*The abstract received by the Editor was not accompanied by a title.

VI. RESEARCH ABSTRACTS

A. AGRONOMY

1. Banerjee, A. and Bagchi, D.K. Preliminary studies on winged bean, a high protein crop for the tropics. (To be presented at the Indian Science Congress (Agriculture Section), 1982.

The growth behaviour and nitrogen retention of winged bean at two stages of growth were conducted in the fields of the Indian Statistical Institute, Calcutta. The data reveal a slow initial growth of the plant, and the period the plant takes to grow to full maturity from the time of sowing, was observed to be remarkably more than other bean crops. Good yields of its various parts and high nitrogen concentration both at the green and mature pod stage, suggest that the crop may prove to be a good protein yielding crop in this region. However, as a source of leaf proteins, it did not perform well. The crop demands special attention as it is well suited to varied soil types and climatic conditions suggesting its cultivation for protein yields as a food crop and also for soil conservation.

2. Benya, E.G.; Lesseps, R.J. and Hutton, Beth G. The winged bean (*Psophocarpus tetragonolobus*) in South East Louisiana.

Seeds were sown about 1 June 1977 and vegetative growth patterns, flowering habits, pod set, bean production and fleshy root production were subsequently noted. After 12 weeks vegetative growth was profuse and healthy, but there was no flower bud formation. The first flower bloomed in a semi-shaded area on 16 September, the vines then being 108 days old. Abscission of flowers after blooming occurred for about 2 weeks (a time of drought) until about 30 September when the first two pods were noticed. Irrigation was provided thereafter.

Abnormalities in newly formed leaves became apparent after 2 or 3 cold fronts (not frosts) passed through the area. There were various degrees of curling along the edges, leaflets were more elongated (less lobes) and interveinal areas were raised and "wrinkled."

Harvesting of pods and roots began on 3 December, when the plants were 186 days old, 78 days after the first flower bloomed. The pods were not yet mature. Pod yields were poor, being 263.3 and 279.9 g/plant respectively from two sample plants. Excellent yields of edible roots were obtained. They were found to be simply fleshy, not tuberous. The largest single root weighed 118.9 g and was 10 cm long and 17.2 cm in circumference. Edible root yield averaged 80.3 g per harvested plant. Harvested seeds,

though pods were not mature at harvest, have successfully germinated at a rate of 21% after soaking for 24 hours in water and planting under greenhouse conditions.

3. Csizinsky, A.A. (1980). Methods of increasing seed germination of winged bean *Psophocarpus tetragonolobus* (L.) DC. *HortScience* 15(3):252.

Accessions Tpt-1 and Chimbu, treated in dilute H_2SO_4 (8:1 by volume in water) for 5 minutes at 62°C followed by a 5 minute rise under running tap water gave 96 - 100% germination in 7 days with no apparent injury to the emerging seedlings. A cold (22°C) sulphuric acid treatment for 5 minutes without rinsing gave 82 - 85% germination. In contrast, control seeds gave 34 - 58% germination over a similar period. Soaking in water at 22°C gave variable results of 32 - 58% germination.

4. Csizinsky, A.A. (1981). Performance of two winged bean accessions in Florida. *HortScience* 16(1):62-3.

Winged bean accessions 'Chimbu' and 'Tpt-1' grown with seepage irrigation on raised, plastic mulched beds, yielded 10.76 and 6.81 mt/ha green pods. 'Chimbu' had a higher dry seed yield and tannin concentration, 1.49 mt/ha and 1.50% respectively, than 'Tpt-1', 1.08 mt/ha and 0.72%. Both winged bean accessions had a long harvest season for green and ripe pods and were considered suitable only for home gardens.

5. Data, E.S. (1980). Patterns of pod growth, development and respiration in the winged bean. *Tropical Agr.* 57(4):309-17.

Characteristics of developing flowers and fruits of winged bean cultivar 'Tpt-2' at various ages after anthesis and various aspects of growth were studied. For use as fresh beans, this cultivar should be harvested between 15 and 20 days after anthesis; after 20 days they are too tough. A 'seed index', proposed for judgement of snap bean maturity, did not give useful results with winged beans.

6. Karikari, S.K. The potential of the winged bean (*Psophocarpus tetragonolobus* (L). DC.) as a root crop. Presented at the 5th International Symposium on Tropical Root Crops, Manila, Philippines. 17-21 September, 1979.

Root crops feeding over half the world's population are cassava, yams, cocoyam and potatoes. These are however regarded as inferior to

cereals because of their low protein contents. The winged bean plant contains high protein in all parts including the roots; therefore efforts should be concentrated to improve its root production. The potential yields of the winged bean as a root crop in comparison with other root crops are discussed. Breeding for development of male sterile types will create self-pruned plants and offer high sink-strength for desirable tuber formation.

7. Nangju, D. and Baudoin, J.P. (1979). Performance of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) in Nigeria. *Journal of Horticultural Science* 54(2):129-36.

Winged beans were grown at Ibadán (sub-humid) and Onne (humid) under different management practices. The plants took about 11 days to emerge from the soil but this period could be shortened by soaking the seed in water or pregermination prior to sowing provided the soil was moist at planting. Staking (minimum 1 m) was essential for high yields and a woody legume, *Leucaena leucocephala*, could replace trellises, and also improved seedling emergence and soil fertility. All cultivars tested at Ibadan showed a delay of about 30 days in flowering when planted in April compared with September. At Ibadan yields up to 2400 kg ha^{-1} or 11 kg ha^{-1} d^{-1} were obtained, but soybean outyielded winged bean. At Onne winged bean was the most promising among six species of grain legumes with respect to nodulation, pest and disease, resistance to field weathering and yield.

8. Stephenson, R.A.; Kesavan, V.; Claydon, A.; Bala, A.A. and Kaiulo, J.V. Preliminary studies on tuber production in winged bean (*Psophocarpus tetragonolobus* (L.) DC.). Presented at the 5th Symposium on Tropical Root Crops, Manila, Philippines, 17-21 September, 1979.

Preliminary work including a dietary survey, regional variety tuber trials, and the effects of pruning, mulching and temperature on, and the genetic control of, tuber production has indicated the potential which exists for the development of winged bean as a valuable, high protein tuber-producing crop for the tropics. Yields of 11 tonnes of fresh tubers per hectare with protein contents of up to 10.9 percent of fresh weight have been obtained. Evidence suggests that there is considerable scope for increasing winged bean tuber yields beyond this level.

B. GENETICS AND PLANT BREEDING

9. Eagleton, G.E.; Halim, A.H. and Chai, N.F. Towards the effective utilisation of winged bean germplasm. Proceedings of the International Symposium on Legumes in the Tropics, U.P.M., Serdang, Malaysia, 1980.

In this review of literature and ongoing research, a framework is drawn up for evaluating the commercial potential of the winged bean. Four production possibilities are considered, deficiencies in existing genotypes are identified and germplasm is described whereby the deficiencies might be overcome.

For commercial vegetable purposes, existing Malaysian varieties mature too slowly (68 days to first flower), have low harvest index (34% pods as percentage of plant tops), and produce pods with poor storage qualities. There is germplasm available, particularly from Papua New Guinea, to upgrade these characteristics.

As a grain legume the winged bean is a distant prospect, pod-shattering, low shelling percentage (40 to 60%), unsuitable plant architecture and deficiencies in processing characters require long-term research programmes.

The tuber potential of the winged bean is greater than previously believed. Experimental yields in the order of 1500 g/m^2 have been obtained from lines of Northern Thai and Burmese origin.

For forage purposes, Indonesian varieties with perenniality, vegetative vigour and resistance of *Synchytrium psophocarpi* (Rac.) Gaumann warrant investigation. The tuberous roots serve as regenerative bases allowing recovery after defoliation.

10. Hildebrand, D.F.; Hymowitz, T.; Newell, C.A. and Bryan, H.H. Variation in growth habit, determinancy and shattering of the winged bean - *Psophocarpus tetragonolobus* (L.) DC.

One hundred and eighty-nine accessions of winged beans and three accessions of *P. scandens* (Endl.) Verdc. obtained from cooperators in 16 countries were planted at Homestead, Florida (25.5 N latitude) in May, 1978. Observations were made on determinancy and growth habit from May 1978 to July, 1979. Shattering was determined by leaving pods on the plants of each accession at least one month after harvest maturity.

Growth habits varied from genotypes with many months of prostrate growth before climbing up the supporting stakes (IL 4, IL 23) to genotypes

which soon after germination climbed up the supporting stakes (IL 61-A, IL 23). The accessions evaluated displayed four determinancy classes: 1) plants with one reproductive period during their life cycle (IL 11-B, IL 87); 2) plants with regrowth from the roots after producing a seed crop (IL 13, IL 117); 3) plants with regrowth from the stems after producing a seed crop (IL 79, IL 147); and 4) plants with continuous growth during the entire study (IL 80, IL 112). One accession (IL 226) showed no shattering in the field.

The variation seen in the three characteristics indicates that winged bean lines could probably be developed compatible with a diversity of cropping systems. However, an upright bush genotype amenable to combine harvesting was not found in the accessions evaluated.

11. Pickersgill, B. (1980). Cytology of two species of winged bean, *Psophocarpus tetragonolobus* (L.) DC. and *P. scandens* (Endl.) Verdc. (Leguminosae). *Botanical Journal of the Linnean Society* 80:279-91.

Karyotype morphology of *Psophocarpus tetragonolobus* and *P. scandens* is described and the behaviour of chromosomes at meiosis discussed. Both species have a chromosome number of 2n = 18 and similar karyotypes of a sort unusual within the Phaseolinae. Differences between the species in detailed morphology of the chromosomes agree with data from external morphology, palynology and crossability in indicating that *P. scandens* cannot be the immediate wild ancestor of domesticated *P. tetragonolobus*. Study of meiotic chromosomes and analysis of qualitative and quantitative variation in Papua New Guinean *P. tetragonolobus* suggest that there are few restrictions to recombination other than those imposed by predominant self-pollination. The bearing of these data on the taxonomic relationships of *Psophocarpus* and on chromosomal evolution within the Phaseolinae is discussed.

C. PHYSIOLOGY

12. BaSamba, S. and Rüegg, J. The performance of winged bean in the field and in controlled environment - a comparative study. A monograph from Nestle Foundation, Kpouebo, Ivory Coast and Department of Crop Science, Swiss Federal Institute of Technology (ETH), Zürich.

Winged beans, accessions Kade 1-26, UPS-32, UPS-122 and TPT-8 were sown on the 21st of May 1980 (main rainy season March to June) in the rain forest zone of the Ivory Coast some 200 km northeast of Abidjan

(7°N latitude) where the annual rainfall is 1778 mm. Each accession was represented by 60 plants (3 replicates with 20 plants). Plants were spaced by one metre between and within the lines and staked individually to two metres. On the 16th of December (209 days after sowing) seed harvest was completed and on the 27th of January 1981 (294 days after sowing) plants were dug up for the tuber harvest.

The same accessions, represented by 10 plants each (5 replicates with 2 plants) were grown in 6-litre pots to a height of one metre in growth chambers set to a 12 hour photoperiod and day/night air temperatures of 27/23°C. Kade 1-26 and UPS-32 were harvested after 140 days, UPS-122 and TPT-8 after 172 days.

The *seed yields* (g/plant) of the field grown plants were 119, 133, 141 and 217 for Kade 1-26, UPS-32, UPS-122 and TPT-8 respectively. Clearly, TPT-8 was the top yielder and there was no significant difference between the three other accessions. The number of pods/plants were 40, 47, 41 and 68 (order as above). The seed yield of the plants grown in the growth chambers were eightfold lower than in the field but the ranking of the accessions was the same. The results confirmed TPT-8 as top seed yielder and underlined that the number of pods/plant was by far the single most important component of seed yield. Other yield components such as pod length, number of seeds/pod and single seed weight were very similar in absolute terms for field and growth chamber grown plants.

Days to the first open flower were 42, 48, 59 and 51 in the field and 42, 45, 54 and 46 in the growth chambers for Kade 1-26, UPS-32 UPS-122 and TPT-8, respectively. In the field TPT-8 produced an average of 3320 flowers/plant of which 88% were shed. In the growth chambers the respective values were 51 and 87%.

Leaf size was estimated after two months of growth by measuring the maximal length of the centre leaflet of fully expanded trifoliate leaves. Values (in cm) were in the field: 9.7, 8.7, 13.3, and 10.3 and in the growth chambers 9.5, 9.0, 12.3 and 10.9 for Kade 1-26, UPS-32, UPS-122 and TPT-8 respectively.

Both Kade 1-26 and UPS-32 failed to produce any significant tuber yields in the field as well as in the growth chambers. However, modest tuber growth was observed in the field on 33% and 43% of the plants of UPS-122 and TPT-8 respectively. Average tuber yields (g/plant, fresh weight basis) were 131 (Range 70-210) for UPS-122 and 147 (70-265) for TPT-8. In the growth chambers the respective values were 57 (32-81) and 52 (0-115).

An additional treatment in the growth chamber experiment revealed that when the average temperature was lowered to 22/18°C, as it is similarly encountered in the highlands of PNG (Wau Ecology Institute), the

tuber yield of UPS-122 and TPT-8 was about doubled while the seed yield was about halved. These results suggest that the prevalent temperatures near Kpouebo, which are approximately comparable to 27/23°C, may be an important factor preventing satisfactory tuber production, at least with the genotypes tested so far. Reproductive pruning (picking all flowers daily or all young pods weekly) in the field had a stimulative effect on tuber growth which was also confirmed by similar results in the growth chambers.

13. Ikram, A. and Broughton, W.J. (1980). Rhizobia in tropical legumes - VII. Effectiveness of different isolates on *Psophocarpus tetragonolobus* (L.) DC. *Soil Biol. Biochem.* 12:77-82.

Rhizobia isolated from fourteen different genera of legumes were tested for their N-fixing effectiveness with *Psophocarpus tetragonolobus* in standard Leonard jar trials. Isolates from all plants except *Pithecellobium jiringa* were able to form nodules with *P. tetragonolobus* although a wide range of effectiveness amongst the different rhizobia was demonstrated. Thus *P. tetragonolobus* may be considered promiscuous with respect to its rhizobial requirements. Based on this experiment, a group of rhizobia comprising three elite strains (RRIM 56 from *P. tetragonolobus*, UMKL 36 from *Lablab purpureus* and CB 756 from *Macrotyloma africanum*, a moderately effective strain (NGR 258 from *P. tetragonolobus*), and two strains of low effectivity (RRIM 968 from *Centrosema pubescens* and UMKL 12 from *Phaseolus angularis*) were selected for further study. When these were used to inoculate *P. tetragonolobus* growing in soil taken from virgin jungle (less than 1.54 rhizobia g^{-1} soil); RRIM 56 and UMKL 36 again performed well, but NGR 258 outperformed CB 756.

14. Ikram, A. and Broughton, W.J. (1980). Rhizobia in tropical legumes - VIII. Serological characteristics of *Psophocarpus tetragonolobus* (L.) DC. isolates. *Soil Biol. Biochem.* 12:83-7.

Antisera were prepared against six inoculant strains of rhizobia for *Psophocarpus tetragonolobus*, and used to react with 62 different strains in both agglutination and immunodiffusion systems. A wide array of reactions occurred, indicating the extent of heterogenecity amongst strains capable of nodulating the same host. In agglutination reactions, the heat-stable somatic antigens could be arranged in 25 serogroups. In gel diffusion, antigens which produced strong precipitin bands usually showed agglutination relationships, but the corollary was not true. The immunodiffusion technique easily distinguished homologous and cross - reacting reactions and could be reliably used in field experiments with *P. tetragonolobus*.

15. Ikram, A. and Broughton, W.J. (1980). Rhizobia in tropical legumes IX. Pot and field trials with inoculants for *Psophocarpus tetragonolobus* (L.) DC. *Soil Biol. Biochem.* 12:203-9

Antigenically identifiable inoculants for *Psophocarpus tetragonolobus* were evaluated in three non-sterile soils contained in pots (sandy-clay, Renggam series; a loamy sand, Sungei Buloh series; silty-clay, Munchong series). Most-probable-numbers of indigenous rhizobia ranged from 4 (Renggam series) to 13 (Munchong series) g^{-1}. Only two (RRIM 56 and 968) of the eight rhizobia tested formed > 50% of the nodules in all soils. Recovery of two strains (RRIM 968 and UMKL 12) was significantly poorer from the Munchong series soil which had the most indigenous rhizobia and the highest silt plus clay content. In a field trial using a Sungei Buloh series soil containing 700 rhizobia g^{-1} capable of nodulating *P. tetragonolobus*, none of the applied strains formed > 18% of the nodules; two formed no nodules. There were no significant increases in plant yield in response to inoculation in the field trial and in two soils in the pot trials. In Sungei Buloh series soil, RRIM 56 formed 90% of the nodules when the indigenous rhizobia were 5 cells g^{-1}, and 14% when the population was 700 g^{-1}. This raises the question of the need to inoculate seed sown into soils with high indigenous rhizobial populations, but there were some indication of increasing representation of inoculant strains in nodules with time.

16. Faizah, A.W.; Broughton, W.J. and John, C.K. (1980). Rhizobia in tropical legumes - XI. Survival in the seed environment. *Soil Biol. Biochem.* 12:219-27.

Factors affecting rhizobia in the seed environment of the legumes *Cajanus cajan*, *Centrosema pubescens*, *Glycine max*, and *Psophocarpus tetragonolobus* were investigated. These included the effects of fungicides, insecticides, and herbicides on the survival and growth of rhizobia on agar and in liquid cultures. The pesticides used varied in their toxicity towards rhizobia but many fungicides and insecticides could be used in the vicinity of inoculated seeds. Certain fungicides and insecticides were shown to have little or no effect on the Rhizobium-legume symbiosis of *C. cajan*, *C. pubescens*, *G. max*, and *P. tetragonolobus* when added directly to inoculated seed. Various protective pelleting procedures were investigated including preparation of coating materials containing rock phosphates from different localities, talc, and bonemeal. These were applied to the seed in mixtures suspended in aqueous solutions of substituted celluloses, or gum arabic. Talc and Christmas Island rock phosphate both proved satisfactory, while "Cellofas" is recommended as the adhesive in this formulation. Soaking seeds before pelleting in an effort to remove anti-rhizobial substances from *G. max* seeds was beneficial in the case of soyabean cultivar KS 437, but harmful when applied to Palmetto seeds.

17. Rüegg, J. Flowering of winged bean under long day conditions. Monograph.

Thirteen accessions of winged bean from Papua New Guinea, Ghana and the Ivory Coast (supplied seed was called P-0 seed) were grown in 6 - litre pots to 1.6 m height in a glasshouse near Zürich where daylength was extended to 16 hours throughout the year by artificial lighting. Day/night growth temperatures were:

27.7 ± 2.7/22.5 ± 1.0°C (warm) and

23.4 ± 2.5/18.0 ± 1.0°C (cool).

In the warm environment reproductive growth was absent, but in the cool environment 6 plants, representing the accessions UPS-62, UPS-99 and TPT-8, out of a total of 210 plants, flowered and set seeds (called P-1 seed). P-1 seed was resown in both temperatures. All plants of UPS-62, UPS-99 and TPT-8 cultivated from P-1 seed flowered and set seeds (P-2 seed) in the cool environment. In the warm environment, 80% of the plants of TPT-8 flowered and set seeds (P-2 seed), all other plants remained vegetative. P-2 seeds of UPS-62, UPS-99 and TPT-8 were then resown in both temperatures and compared with P-1 seed of TPT-8 and P-0 seed of the accessions TPT-8, Kade 1-26, UPS-32 and UPS-122.

The cool environment combined with the 16-hour photoperiod was more inducive to flowering than the warm. Out of 8 tested winged bean types (4 unselected and 4 selected), 2 flowered in the warm and 7 in the cool environment. Potential for pod and seed production was determined on P-0 of Kade 1-26, P-2 of UPS-99 and P-2 of TPT-8 in the cool environment, and on P-2 of TPT-8 in the warm environment. In the cool, P-0 of Kade 1-26 and P-2 of UPS-99 began flowering 101 days after sowing.

The population P-2 selected within accession TPT-8 was particularly interesting since it showed potential for pod and seed production in both temperatures. In the warm and in the cool environment, respectively, flowering of this selected type began 58 days (range 55-67) and 71 days (63-85) after sowing. Seeds were harvested 169 days and 190 days after sowing and seed yields per pot were 27.4 (17.4-35.4) grams and 19.2 g (17.4-37.2), respectively, in the warm and cool temperature. These results may indicate potential for the selection of day-neutral winged bean types.

18. Rüegg, J. Potential for a day-neutral winged bean types.

Seeds of population P-2 (see previous abstract) were resown in the 16-hour photoperiod and the warm temperature. Out of 24 plants 20 flowered within 55 to 97 days after sowing. All plants which had begun

flowering within 70 days after sowing were selected arbitrarily and referred to as ETH-selection I. All other plants were discarded.

In a comparative test including both plants grown from seeds of the original accession TPT-8 and from seeds of ETH-selection I, we recorded the days to first flowers as follows:

Photoperiod	8 hours[1]	12 hours[1]	16 hours[2]
Accession TPT-8	56 (54-60)	57 (49-68)	--[3]
ETH-selection I	62 (59-65)	58 (54-62)	61 (55-69)

Day/night temperature was approximately 28/23°C for all photoperiods. 1: in growth chambers, 2: in glasshouse, 3: an average of only 6% of all plants flowered and there were very few flowers per plant

In addition, ETH-selection I was being tested in the 16 hour photoperiod and the cool temperature. Compared to the warm temperature the low temperature delayed the beginning of flowering by two weeks which confirmed our earlier results.

Although for technical reasons the tests could not include all combinations of three photoperiods and two temperatures, and growing conditions in the glasshouse and in the growth chambers were not strictly comparable, the results suggest that ETH-selection I is very likely to represent a day-neutral type within a temperature range of about 20 - 30°C.

In the glasshouse (16 hours, 28/23°C) seeds of ETH-selection I were propagated by means of a miniature plantation which covered 4 m^2. Sixty plants staked to 1.3 m were grown for seven months. The final seed yield was 128 g/m^2 or 8.5 g/plant. Immature green pods were harvested as well, the average fresh weight per plant was 16.5 g. Tuber production was insignificant.

In a qualitative test winged beans (accessions UPS-99, Kade 1-26, TPT-8 and ETH-selection I) were sown in the field in southern Switzerland (46°10'N latitude) on the 20th of May 1981. The mean temperature between sowing and 90 days after sowing was 17.5°C with a mean maximum of 23.0°C and a mean minimum of 11.6°C. The average daylength was approximately 15 hours. Clearly the temperatures were too low for optimal growth, however it was interesting to note that about half of the plants grew to 1.5 m (staking height supplied) and between 85 and 100 days after sowing flowers opened on some plants of ETH-selection I and on fewer plants of accession TPT-8. The first young pods were observed by the end of August. Kade 1-26 and UPS-99 produced only small flower buds.

The results suggest that winged bean types exist which can flower under fairly high latitudes with prevailing long-day conditions during summer. The cultivation of winged bean under truly subtropical conditions, e.g. in the central and southern mediterranean area, may become feasible.

19. Wong, K.C. and Schwabe, W.W. (1980). Effects of daylength and day/night temperature on the growth, flowering and tuber formation of winged bean (*Psophocarpus tetragonolobus*) (L.) DC.) Proceedings of the International Symposium on Legumes in the Tropics, Serdang, Malaysia, 1980.

The growth, flowering and tuberization responses of winged bean to daylength and day/night temperature regimes were studied in controlled-environment cabinets using a Malaysian selection M 14/4. Plants grown under 16-h daylength failed to flower altogether and produced no tuber. Less chlorophyll was produced by the leaves of the long-day-grown plants. Flowering in plants given 8-h daylength was markedly affected by day/night temperatures, whereas, tuberization occurred irrespective of temperature. Under this short daylength, flowering was inhibited when day temperatures were extreme at a high 32°C and a low 18°C. In a day temperature of 26°C, flowering occurred readily at a high night temperature (26°C) but was inhibited when this was low (14°C). There was no evidence from the present study of a thermoperiodic response.

D. DISEASES

20. Abdullah, H. (1980). A disease of winged bean caused by *Pseudomonas solanacearum* in Malaysia. *Plant Disease*. 64(8):798-9.

P. tetragonolobus was infected with *Pseudomonas solanacearum* in Malaysia. Although the pathogen occurs world wide, this is the first report of this pathogen on this host in Malaysia or elsewhere.

21. Khan, A.Z.M. Nowsher A. and Rahman, M.M. (1980). A study on some *Colletotrichum* species from three leguminous crop plants. In Abstract of Section II (Supplementary issue), Fourth and Fifth Annual Science Conference of Bangladesh Association for the Advancement of Science. pp. 3-4.

The present account includes the results of a study on five isolates of *Colletotrichum* species, found on three leguminous crop plants, with special reference to their cultural growth characters and conidiospore morphology. The hose plants were grown either in the Botanical garden of

the University of Dacca, or in vegetable gardens in certain localities of Dacca City. Those dealt with in the straight-spore group are *C. lindemuthianum* (Sacc. & Magn.) Bri. & Cav. on hyacinth bean (*Lablab niger* Medik) and *C. gloeosporioides* (Penz.) Sacc. (perfect state - *Glomerella cingulata* (Stonem) Spauld & Schr.) on soya bean (*Glycine max* (L.) Merr.) and winged bean (*Psophocarpus tetragonolobus*) (L.) DC.) and in the curved-spore group *C. truncatum* (Schw.) Andrus & Moore on soya bean and winged bean.

The isolates of the straight-spore group of *Colletotrichum* spp. produced oblong, 1-celled hyaline conidiospores with rounded ends. The conidiospore of the hyacinth bean isolate of *C. lindemuthianum* measured 12-19.2 x 3.65-5 µm while the range of conidiospore measurement for the soya bean and winged bean isolates of *C. gloeosporioides* was 11.6-18 x 3.2-5.6 µm. The lone isolate of *C. lindemuthianum* showed a slower growth on potato dextrose agar (pH 6) at 25°C than the isolates of *C. gloeosporioides*. Both the isolates of *C. gloesoporioides* unlike the isolate of *C. lindemuthianum*, produced ascigerous state on several occasions, at room temperatures (21.5-24.5°C) which resembled *Glomerella cingulata*.

As for the curved-spore group, soya bean and winged bean isolates of *C. truncatum* produced falcate, 1-celled, hyaline conidiospore with rounded ends but tapered towards the apex. The conidiospore measurement of the soya bean isolate was 13.2-24.4 x 2.4-3.6 µm while that of the winged bean isolate was 24-26 x 2.8-4. um. The soya bean isolate of *C. truncatum* showed comparatively a slower growth on potato dextrose agar (pH 6) at 25°C than the winged bean isolate of the same species.

The effect of the above discussed isolates of *Colletotrichum* spp. were tested on the detached leaves of the host plants by cross inoculation. The hyacinth bean isolate of *C. lindemuthianum* and the winged bean isolate of *C. gloesporioides* infected the detached leaves of hyacinth bean, soya bean and winged bean. The soya bean isolate of *C. gloeosporioides* readily infected the detached leaves of hyacinth bean and soya bean but failed to establish on the detached leaves of the winged bean. As regards the soya bean and winged bean isolates of *C. truncatum* cross inoculations were successful on the detached leaves of soya bean and winged bean

22. Khan, A.Z.M. Nowsher A. and Nahar, K. (1978). *Cercospora canescens*, associated with a leaf spot disease of the winged bean plants (*Psophocarpus tetragonolobus*) in Bangladesh. *Bangladesh J. Bot.* 7(2):10-2.

In the months of August and October, 1976, several varieties of winged bean were planted in the Botanical garden of the University of Dacca, Bangladesh. A large number of these plants were found to suffer from a leaf spot disease in winter, 1977. The spots were circular to

sub-circular, up to 0.5 mm in extent, whitish-grey, surrounded by a reddish brown border.

The fungus associated with these disease leaf spots was *Cercospora canescens* Ellis & Martin, which is most frequently encountered in tropics and sub-tropics on a wide range of the Leguminosae, but has not been reported earlier on winged bean. Other species of *Cercospora*, so far reported on the winged bean are *C. aranetae* Borlaza & Roldan, *C. psophocarpi* Yen, and *C. psophocarpicola* Yen, *C. psophocarpi* has been recently transferred to *Pseudocercospora* Speg. by Deighton (1976).

The specimen cited is deposited at C.M.I., Kew, England, U.K.

23. Khan, A.Z.M. Nowsher A.; Rahman, M. Mizanur and Banu, Lulu Bilquis. (1980). Fungi causing anthracnose of soya bean in Dacca City, Bangladesh. *Bangladesh J. Bot.* 9(2):157-63.

Soya bean plants (*Glycine max* (L.) Merr.) grown at the Botanical Garden of the University of Dacca, Bangladesh, during 1976-1978, suffered from anthracnose disease caused by either *Colletotrichum truncatum* (Schw.) Andrus & Moore or *Glomerella cingulata* (Stonem) Spauld. & V. Schr. (imperfect state: *C. gloeosporioides* (Penz.) Sacc.). The pathogens were isolated on potato dextrose agar, described and illustrated. Parasitic effects of these species were tested by artificial inoculation of their original host plant, i.e. soya bean and two other leguminous crop plants, winged bean (*Psophocarpus tetragonolobus* (L.) DC.) and hyacinth bean (*Lablab niger* Medik). *C. truncatum* produced grayish to brownish necrotic lesions on the artificially inoculated plants of soya bean, winged bean and hyacinth bean. *G. cingulata* when inoculated on soya bean and hyacinth bean plants induced yellowing and premature withering of the leaves followed by the drying up of the plants. As for winged bean, *G. cingulata* did not produce any visible sign of infection on the inoculated plants but the pathogen was found successful in establishing itself as an endophyte in the symptom-less plant parts like green leaves.

24. Krishnappa, K.; Gururaja Rao, M.R. and Shirashankar, G. Screening of winged bean cultivars against root-knot nematode. Monograph.

Preliminary field investigations carried out during 1980-81 at the University of Agricultural Sciences, Bangalore, India, indicated that out of 25 lines of winged bean 23 showed varying degrees of host reaction against root-knot nematode (*Meloidogyne incognita*) (Kofoid and White) Chitwood) at a soil population of 22 larvae/100 g of soil. Varieties IC 17005-A and LB NC3 were completely free from nematode infection (immune). Trivandrum local showed fairly resistant type of reaction, whereas varieties LB NC1 and IC 27884 were highly susceptible. Further work

regarding screening of these varieties in nematode sick plots, identifying the resistant material and incorporation of the resistance into popular local varieties is in progress.

25. Lordello, Rubens R.A. and de Almeida, Luiz D'Artagnan. (1979). *Meloidogyne javanica*. *Revista de Agricultura*, Piracicaba 54(3):136 (São Paulo, Brazil).

Winged bean, a legume introduced into Brazil in 1976, was very heavily injured by a Javanese root-knot nematode, *Meloidogyne javanica* (Treub. 1885) Chitwood, 1949. Symptoms shown by plants are described.

26. Parman and Thompson, A.E. (1981). Resistance to false rust in winged beans. *Hort Science*. 16(1):63-5.

An inoculation technique was developed to test seedling plants of winged beans for resistance to false rust disease incited by the fungus *Synchytrium psophocarpi* (Rac.) Gaumann. Sporangia were collected in distilled water by washing or scrapping from infected, sporulating winged bean leaves. Inoculum was applied by brushing the sporangial suspension onto the 1st or 2nd true leaves of seedling plants, and holding the inoculated plants under high humidity conditions for 24 hours. Intensity of infection can be scored 10 days after inoculation. Resistance appears to result from a hypersensitive reaction.

E. CHEMICAL COMPOSITION AND NUTRITION

27. Garcia, V.V. (1980). Carbohydrates of winged beans. *Journal of Food Technology*. 15(5):477-84.

Five varieties of winged beans were analyzed and found to contain 9.8 to 13.8% soluble sugars. Verbascose was present at a level of 0.2 to 0.9%; stachyose 2.2 to 3.6%, raffinose 1.1 to 2.0%, and sucrose 5.6 to 8.2%. Starch could not be detected in the mature beans of the five varieties analyzed.

28. Garcia, V.V. (1980). Proximate analysis of five varieties of winged beans. *Journal of Food Technology*. 15(5):469-76.

Varieties TPT-2, HIMBO, WB-19, Selections 10 and 12 were investigated. The results showed that the varieties analyzed had a high protein and fat content; which was similar to soybeans.

29. Hettiarachchy, N.S. (1980). Folic acid conjugase from leafy vegetables. Proc. 36th. Ann. Sessions Sri Lanka Assoc. Advmt. Sci. 36(1):3.

Naturally occurring folates in foods are mainly in the form of polyglutamates. These polyglutamates are cleaved in the intestine by conjugase to monoglutamate, prior to absorption. The present communication deals with a study of conjugase from leafy vegetables and the finding is that winged bean and sweet potato leaves released food folates from conjugated forms at pH 4.5 (0.1 M, acetate buffer). The food folate values obtained by using rat liver and chicken pancreas conjugase was in close agreement with the values obtained by using winged bean leaves conjugase. The folic acid released after the action of conjugase was determined by the radio-isotopic protein binding assay method. Folic acid conjugase from winged bean and sweet potato leaves can therefore be used for the estimation of total folates in foods.

The prevalence of folic acid deficiency among pregnant mothers and among women using oral contraceptives in Sri Lanka may be due to the low folic acid content in their food and the losses incurred due to overcooking. Conjugase from winged bean or sweet potato leaves can be used to determine the exact amount of folate available in food before and after cooking.

30. Hettiarachchy, N.S. and Sri Kantha, S. (1980). Nutritive value of winged bean, *Psophocarpus tetragonolobus*. Presented at 8th International Congress of Dietetics and 6th Latin American Congress of Nutritionists, São Paulo, Brazil, Aug. 25-31, 1980.

Edible portions of 20 cultivars of winged bean grown in Sri Lanka have been analysed for the proximate composition (AOAC method), and their anti-nutritional factor, trypsin-inhibitor (Kakade *et al* method). The protein content in seeds was 29.8 - 42.5% (36.0 ± 0.97, means + S.E.) and trypsin inhibitor present was 4.89×10^4 - 2.35×10^5 TUI/g of protein. The oil content was 11.0 - 23.0% (17.8 ± 0.98). The protein content in tubers was 2.27 - 8.05% (5.56 ± 0.43) on wet weight basis. The trypsin inhibitor present in the edible portions could be inactivated or destroyed by boiling. Analysis of fatty acid composition of six cultivars showed a high percentage of unsaturated fatty acids (75-80%). Winged bean thus appears to be a promising source to alleviate protein deficiency seen mainly in the Tropics.

31. Hildebrand, D.F.; Hymowitz, T.; Chaven, C.; Bryan, H.H. and Duncan, A.A. Yield, protein and oil data from the 1978-1979 International Winged Bean Trials, Homestead, Florida.

A replicated performance trial for seed yield in winged bean strains was conducted at Homestead, Florida (25.5 N latitude) in 1978-1979. This trial was part of the international winged bean cooperative test which was conducted in many locations throughout the world.

Oolite limestone deposits were mechanically pulverized and tilled to form the "soil" upon which the winged beans were grown. These deposits have low levels of clay and organic matter. The pH of the soil was about 7.8.

The field received a basal application of 448 kg/ha of 7-6-12-2 (N-P-K-Mg) fertilizer prior to planting. The winged bean seeds were planted directly in the field through holes in white on black plastic mulch strips with a trickle irrigation line under each strip. The seeds were inoculated with inoculum provided for the international trials. The strains were planted in a randomized complete block with 4 replications. The plots consisted of 2 rows of 9 plants planted 30 cm apart on either side of the plastic covered beds with 60 cm between each plot. There was 30 cm between twin rows. Both rows of the double row plots were provided with a 2 m trellis with the poles for the two rows joined at the top.

Several harvests were made for each entry by hand. The harvested pods were thrashed mechanically. The cumulative harvests were pooled for each strain. Duplicate random seed samples were taken from the cumulative harvest of each strain and the protein and oil was determined by an infrared grain analyzer (Hildebrand *et al* (1981)).

There was a significant effect of strain on yield (5% level), a highly significant effect of strain on % protein level (1% level), and no significant effect of strain on % oil. The variation for both protein and oil is not large, but these strains were selected because of their yielding ability and most of the strains originated in Papua New Guinea.

In this experiment the coefficient of variation was 26.2% for yield, 2.7% for % protein and 5.5% for % oil. The correlation between protein and oil was 0.04; oil and yield 0.08, protein and yield 0.16; and protein plus oil and yield of 0.21.

32. Hildebrand, D.F.; Chaven, C. and Hymowitz, T. Winged bean seed protein and oil.

In a recent study we reported on the range of protein and oil in mature bean seeds from a large, heterogeneous germplasm collection grown in a single environment using infrared light reflectance analysis (Hildebrand *et al*, 1981). In this note we report on the frequency distribution of protein and oil of the accessions evaluated.

The frequency distribution for protein shows a near normal distribution with the mode being between 37 to 38% protein (Figure 1). The frequency distribution for oil is roughly bell shaped but skewed to the left in the low oil range (Figure 2). The mode is between 19 to 20% oil. The correlation between protein and oil content was 0.075 (n = 227).

Reference

HILDEBRAND, D.F.; CHAVEN, D.; HYMOWITZ, T.; BRYAN, H.H. and DUNCAN, A.A. 1981. Variation in protein and oil content of winged bean seeds as measured by near infrared light reflectance. *Agronomy J.* 73: (In press).

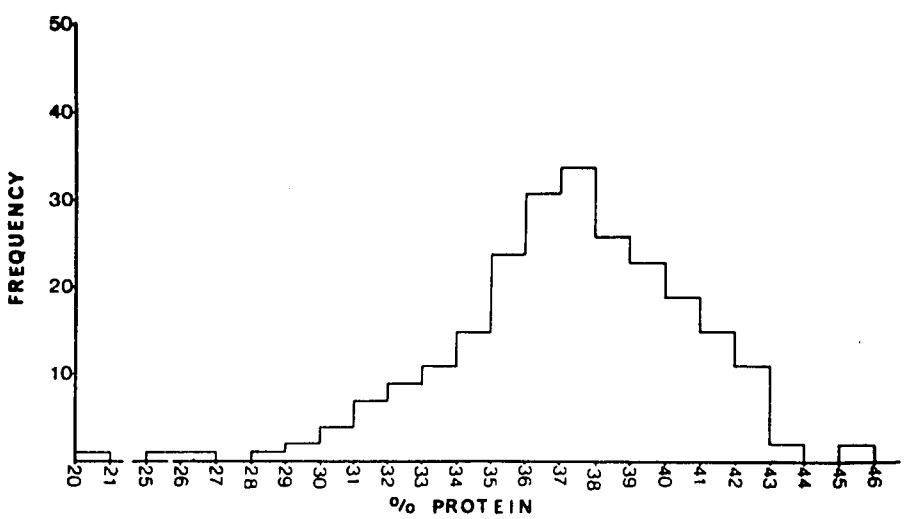

Figure 1. Frequency distribution for protein content in winged bean seeds.

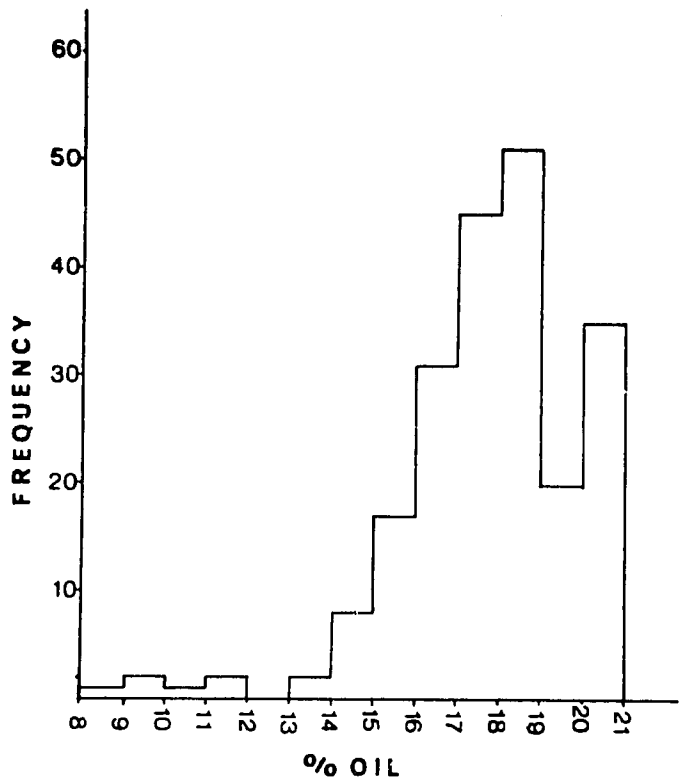

Figure 2. Frequency distribution for oil content in winged bean seeds.

33. Khor, H.T.; Tan, N.H. and Wong, K.C. (1980). Winged bean seed: a potential food source of the tropics. Proceedings of the 6th Annual Conference of the Malaysian Biochemistry Society, Kuala Lumpur, Malaysia.

Protein, trypsin inhibitor and oil contents of several varieties of winged bean seeds were investigated. The seed protein content varied from 32 to 42.4% of the wet weight of the seeds and trypsin inhibitor content varied from 2.77 to 6.29 million inhibitor units per 100 g of seeds. The winged bean seed oil content varied from 16.5 to 24.8% of the wet weight of the seeds. Analysis of the fatty acid composition by gas chromatograph shows that most of the fatty acids are unsaturated in nature. There appears to be no major qualitative difference in fatty acid components among the varieties but quantitative differences are fairly obvious. The potential of winged bean seeds as a source of plant protein and edible oil is discussed.

34. Kortt, A.A. (1979). Isolation and characterization of the trypsin inhibitors from winged bean seed (*Psophocarpus tetragonolobus* (L.) DC. *Biochimica et Biophysica Acta*, 577:371-382.

The trypsin inhibitors from winged bean seed were isolated by affinity chromatography on trypsin-Sepharose 4B and the components fractionated by chromatography on SP-Sephadex C-25 and Sephadex G-100. The major components, inhibitors 2 and 3 were found to be homogeneous proteins with molecular weight of about 20 000. The inhibitors stoichiometrically inhibited bovine trypsin in the molar ratio of 1:1 whereas the inhibition of bovine α-chymotrypsin was weak and non-stoichiometric. Amino acid analysis indicated that both the inhibitors contain four cysteine residues and are rich in aspartic acid, glutamic acid, glycine, valine and leucine; however, inhibitor 3 lacks histidine and methionine while inhibitor 2 contains one histidine and three methionines. A minor trypsin inhibitor fraction was also isolated which contained at least three proteins with a molecular weight of about 10 000 and a high content of half-cystine.

35. Kortt, A.A. (1980). Isolation and properties of a chymotrypsin inhibitor from winged bean seed (*Psophocarpus tetragonolobus* (L.) DC.) *Biochimica et Biophysica Acta*, 624:237-48.

A new inhibitor of bovine α-chymotrypsin has been isolated from winged bean seed. The inhibitor was purified to homogeneity by affinity chromatography on chymotrypsin-Sepharose, following the removal of the trypsin inhibitors on trypsin-Sepharose. The inhibitor has a molecular weight of approx. 21 000 and amino acid analysis showed that it contains four half-cystine residues, lacks methionine, and is rich in aspartic acid, glutamic acid, valine and leucine. The inhibitor does not inhibit bovine trypsin in the standard inhibitor assay and does not bind to trypsin-Sepharose at pH 8.0. Inhibition data show that 1 mol of inhibitor inhibits 2 mil of α-chymotrypsin to form a 1:2 complex. The inhibition, however, is characterized by substrate induced dissociation of the complex

and complete inhibition, even at high inhibitor concentration, is not attained. The inhibitor-chymotrypsin complex is stable at pH 8.0 and was isolated by gel-filtration on Sephadex G-100. An apparent molecular weight of approx. 70 000 was obtained for the complex, measured by gel filtration and ultracentrifugal analysis, consistent with a 1:2 molar stoichiometry.

36. de Lumen, B.O. and Gerpacio, A.L. Report on the use of winged beans as a chicken feed component.

The potential of winged bean as a substitute for soybean oil meal in chicken feed was evaluated. Soybean oil meal is expensive and often not always available in developing countries, making it imperative to utilize other locally available plant protein sources, among them the winged bean.

Winged beans are high in protein and fats, but not much is known on their overall nutritive value as chicken feed. Some toxic effects resulting in depressed growth have been observed when fed to chickens over a period of time. It was concluded that whole winged bean properly heat treated can be used to replace soybean meal up to about 50%. There were adverse effects on broiler performance at higher levels of replacement. The latter may have been caused by the seed coat, suggesting that dehulled winged bean seeds may be superior. The economics of this will have to be studied.

The possible use of red flower beetle larvae (*Trifolium castaneum*) to evaluate the selective nutritional values of several varieties of winged bean has been assessed. The method may be useful in screening the good from the poorer quality winged bean varieties.

This work was designed to determine the *in-vitro* digestibilities, crude protein, cellulose, hemicellulose, lignin, cutin and ash content of various parts of the winged bean plant and its possible nutritive value as a ruminant feed.

37. N'Zi, G.; Sylla, B.S. and Ravelli, G.P. Introduction of the winged bean (*Psophocarpus tetragonolobus*) into traditional dishes of a rural population in the Ivory Coast. *Cahiers de nutrition et de diététique.*

The winged bean is a legume indigenous to the humid tropics (Papua New Guinea). The plant has a great potential for improving the human diet that has as yet been underexploited. All parts of the plant are edible and rich in proteins and vitamins: the leaves, the green pods, the seeds and the tuberous roots. The seeds have a composition very

similar to that of soya seeds (37% protein and 17% oil). This article presents a project undertaken by the Nestle Foundation in the forest zone of the Ivory Coast with the aim of increasing the nutritional value of the local diet through the introduction of the winged bean culture in family gardens and the consumption of its products by the villagers. Results of composition analysis of the various parts of the plant are given. Traditional recipes used by the housewife in the village are presented. Examples are given of how the introduction of the winged bean in local recipes improves the nutritional value of traditional dishes. The villagers' reactions to the new plant and to its consumption are discussed.

38. Sri Kantha, S.S. and Hettiarachchy, N.S. (1980). Phytohaemagglutinins in the winged bean. Proc. 36th Ann. Sessions Sri Lanka Assoc. Advmt. Sci. 36(1):11-12.

Though the presence of phytohaemagglutinin in the winged bean has been recorded by some workers, the varying levels in the different cultivars have yet to be reported.

This study reports the phytohaemagglutinin levels in some different edible portions of the winged bean - namely the seeds, tubers and leaves Phytohaemagglutinin activity was studied in the winged bean extracts, with washed human erythrocytes, by a modification of the serial dilution technique of Liner & Hill (1953). Phytohaemagglutinin activity in the raw mature seeds ranged from 3,200 - 25,600 haemagglutination units/g sample, in the eleven cultivars tested. On the contrary, the dried leaves (at 60°C) and fresh tubers showed comparatively low values of 800 HU/g and 100 HU/g respectively. These phytohaemagglutinins were found to be thermo-labile, and were inactivated considerably by the normal moist-heat cooking methods.

39. Yap, T.N. (1979). Composition and *in-vitro* digestibility of the winged bean and possible utilization of the whole plant in ruminant feed. *Malaysian Applied Biology*, 8(2):119-23.

The composition and nutritive value of winged bean plant parts were evaluated. The crude protein (CP) content was highest in the seeds (42.02%) followed by young leaves (33.93%), old leaves (23.63%), green pods (22.61%) and tubers (20.57%). The dry pods (seeds removed) and old stems had the lowest CP, 9.75 and 11.51%, respectively.

The neutral detergent soluble fraction, representing the soluble carbohydrates and proteins available to the ruminants, was highest in the seeds (76.89%), tubers (72.43%) and young leaves (68.65%).

Lignin was highest in the old stems (16.98%), dry pods (15.0%) and young stems (13.51%). Since cutin, ash and lignin bound proteins (ADFN) were low, lignin content was the most important factor which depressed *in-vitro* digestibility. Low *in-vitro* digestibility was observed in young stems (64.50%), dry pods (61.88%) and old stems (58.15%) while the seeds and tubers had high *in-vitro* digestibilities (91.70 and 95.28%, respectively).

True cutin was determined only in the seeds (2.96%). "Cutin" in the other parts (compounds insoluble in neutral detergent) was about 2%.

Results indicated that the winged bean plant parts would make an excellent supplement for ruminants.

VII. THESES ABSTRACTS

1. Sri Kantha, S.S. Nutritive value of winged bean, *Psophocarpus tetragonolobus* (L.) DC. Unpublished thesis for the Degree of Master of Science in Biochemistry, University of Peradeniya, Sri Lanka, August, 1980.

Thirty two cultivars of the winged bean grown in Sri Lanka have been analysed. Weight of a seed ranged from 0.18 - 0.42 g with a mean value of 0.28 g while the weight of a full mature tuber ranged from 7.1 - 53.3 g with a mean value of 34.7 g. The average weight of edible portion in tuber ranged from 4.6 - 42.3 g/tuber with a mean value of 25.4 g. Around 65 percent of the weight of the tuber forms the edible portion.

Proximate chemical analysis shows that the protein content of seeds ranged from 29.8 - 42.9 g/100 g fresh weight with a mean of 36.7 g/100 g. The protein content of fresh tubers ranged from 2.3 to 8.1 g/100 g, with a mean of 5.5 g/100 g. The range of protein values exhibited by fresh leaves falls between 4.6 and 11.8 g/100 g with a mean of 7.4 g/100 g. The protein contents of fresh immature pods and flowers range from 1.3 - 2.7 percent (mean 2.1 percent), and 1.3 - 2.7 percent (mean 2.1 percent) respectively. The oil content of the seeds ranged from 11.0 - 24.0 g/100 g with a mean of 17.8 g/100 g.

Detailed chemical analysis shows that the winged bean seed protein is rich in lysine which is the limiting amino acid in the Sri Lankan staple diet of rice. Sulphur containing amino acids and tryptophan seem to be the first and second limiting amino acids in this protein. The fatty acid profile of the seed oil shows that oleic and linoleic acid fractions formed the major fatty acid components with mean values of 40.2 and 31.6 percent respectively.

The levels of two anti-nutritional factors, trypsin inhibitors and phytohaemagglutinins were determined in the seeds, tubers and leaves. The range of trypsin inhibitor content in the raw mature seed, tuber and leaf were 10.6-49.5, 0.2-33.1 and 0.2-1.9 mg TI/g sample respectively. Phytohaemagglutinin content in the raw mature seeds ranged from 3,200 - 25,600 haemagglutinin units/g sample.

Soaking the seeds for 10 hours at room temperature (28 ± 2°C) resulted in hydration of the seed and is recommended as an initial processing step. Maximum tenderisation and complete inactivation of the two anti-nutritional factors, trypsin inhibitor and phytohaemagglutinin, resulted when the seeds soaked in tap water or in $NaHCO_3$ (0.5 percent) solution, and boiled in $NaHCO_3$ (0.5 percent) or NaCl (0.5 percent) solutions. Tenderisation of the seeds occurred in soaking as well as boiling steps, but to a greater extent during boiling. Inactivation of trypsin inhibitors and phytohaemagglutinins resulted only during boiling. Depending on the individual preferences, either $NaHCO_3$ or NaCl may be used for tenderisation of the seed during cooking while this study prefers the usage of NaCl since it is easily accessible at village consumer level in comparison to sodium bicarbonate.

Winged bean food preparations (winged bean "rotti", winged bean "thosai", winged bean-butter cake, winged bean bread and winged bean milk) were made from the processed winged bean flour. Supplementation of winged bean flour at 10 percent levels to wheat flour resulted in acceptable food items. Of the preparations, all except the winged bean bread were found to be acceptable to the taste panel. Winged bean milk is suggested as a substitute for coconut "milk", in traditional food preparations. Initial processing of winged bean flour and winged bean tuber for food items with longer shelf-life is suggested.

2. Truong, Van den. Lipoxygenase isoenzymes of winged bean, *Psophocarpus tetragonolobus* (L.) DC. Unpublished Ph.D. thesis, University of the Philippines at Los Baños, Philippines, 1980.

Lipoxygenase (Linoleate: oxygen oxidoreductase EC 1.13.11.12) in winged bean and cowpea seeds were studied using various spectrophotometric assay, isolation and purification procedures. Winged bean lipoxygenase specific activity (14-30 units/mg protein) was comparable

to that of soybeans (11-48 units/mg protein) while cowpea had the highest specific activity (205-316 units/mg protein).

Winged bean has high protein and fat content which are similar to that of soybeans, ranging from 30 to 38.5% and 16.9 to 20.5%, respectively. Lipoxygenase activity and fat content decreased during seed germination. The fatty acid composition of five native winged bean lines determined by gas liquid chromatography (GLC) was similar to peanut oil. Parinaric acid was not present in the samples analyzed. Lignocenic acid and behenic acid had the range of 1.02-2.05% and 5.04-11.62%, respectively. The major unsaturated fatty acids were oleic and linoleic acid. Linoleic acid values ranged from 21 to 36% of the oil by both GLC and enzymatic methods. At least with the lines studied, there was no correlation between the lipoxygenase activity and the polyunsaturated fatty acid content of winged bean seeds.

Winged bean and cowpea lipoxygenase activities were located in 30-50% and 40-60% $(NH_4)_2SO_4$ precipitates, respectively. Disc gel electrophoresis followed by specific enzyme staining revealed at least 2 and 4 isoenzymes for winged bean and cowpea lipoxygenase with a major isoenzyme at Rf = 0.21-0.27.

Purification of winged bean lipoxygenase on CM-Sephadex column had a poorer performance compared to DEAE-Sephadex column. A purification procedure of winged bean lipoxygenase using $(NH_4)_2SO_4$ fractionation and sequential Sephadex G-150, DEAE-Sephadex and hydroxyapatite chromatography revealed two major isoenzymes, F1 and F11, with 104- and 171-fold purification respectively compared to the crude extract. Both isoenzymes possess carbonyl-producing activity. They had similar electrophoretic mobility (Rf = 0.25) on polyacrylamide gel and molecular weights of 78,000 and 82,000 by gel filtration and SDS-PAGE, respectively. Optimum pH of 6.0 and 5.8, Km values of 0.44×10^{-3}M and 0.37×10^{-3}M for linoleic acid, the best substrate of winged bean lipoxygenase, were obtained for F1 and F11, respectively. Ca^{++}, CN^{-}, Fe^{+++}, Mg^{++}, Mn^{++} and ethanol inhibited the enzyme but Fe^{++}, Zn^{++}, Co^{++} at 1 mM concentration enhanced the activity. Among the antioxidants tested, butylated hydroxyanisol and butylated hydroxytoluene were the most effective inhibitors of winged bean lipoxygenase. Sulfhydryl reagents such as idoacetamide and dithiothreitol has little effect on the lipoxygenase isoenzyme activity.

In solution, winged bean lipoxygenase was stable up to 60°C. Increasing the temperature to 70°C rapidly denatured the enzyme. In whole seed, the enzyme was more resistant to heat than soybean lipoxygenase. The heat inactivation followed first order reaction. Winged bean lipoxygenase had optimal activity at 30°C and an activation energy of 4.5 Kcal/mole.

The chromatogram of volatiles produced by purified winged bean lipoxygenase using linoleic acid indicated that the system produced some components which are present in the flavour profile of raw winged bean homogenate. This study showed that lipoxygenase is responsible for the formation of flavor components in winged bean seeds.

VIII. COUNTRY REPORTS

AUSTRALIA

Khan, T.N. Winged bean (*Psophocarpus tetragonolobus*): a report and hints for growing in the South West of Western Australia. Monograph produced by the Western Australian Department of Agriculture: 3 September, 1980.

Over 900 seeds packets were distributed to people in Perth and in country areas. In most cases, results were disappointing indicating that plants failed to establish, and although some grew well, flowering did not take place.

The winged bean is essentially a plant suited to the hot and humid regions of the equatorial region. The Mediterranean climate of Perth and the surrounding countryside presents many problems in trying to grow this plant in the summer months. These problems are:

1. Equatorial regions are hot but the temperature seldom exceeds 32°C and humidity is always high. Temperatures above 35°C with dry conditions, as are experienced in Perth during summer, are not suitable to its growth.

2. Winged bean requires short day conditions for flowering. Long day conditions delay flowering.

3. As flowering does not take place until summer/early autumn, the period in which pod setting takes place is considerably reduced, giving low pod yield. This is due to the fact that temperatures in late autumn and winter are too low to allow pod setting.

Work has shown that different varieties vary in their flowering habit and in their ability to thrive in hot and dry summers. Through cross breeding it should be possible to develop a more suitable variety.

BELIZE

Benya, E.G. The winged bean (*Psophocarpus tetragonolobus*) in Belize, Central America: Three case studies (St. Paul's Bank, Belize; Santa Elena, Cayo; and San Antonio, Toledo). A report to the International Council for the Development of Underutilized Plants, 1979.

At St. Paul's Bank, a region less than 150 m above sea level, winged bean was grown in a mixed cropping, shifting agriculture, (slash and burn) situation on a heavy clay loam soil. Germination was slow but once growth began, it was prolific. Some support stakes were easily broken by the weight of the vines. No pests were noted. Yields were reported to occur in waves, although exact figures were not available. Pod production continued from a high level in October/November 1978 to lower levels in April 1979. The edible roots were not used for food since new sprouting started from these. The flavour and general palatability of the bean was considered very good but the hardness of the seed had an effect on the uses. Before eating, seed was boiled, ground into a flour and strained. The beans were extensively used in soup.

The Benedictine Monastery near Santa Elena was also used for trials (60-90 m above sea level). Tpt-1 was grown on a silt loam soil high in iron and provided with irrigation and fertilizer. There was no problem with seed hardness or germination. Beans were used in the green pod stage at the monastery. Harvesting began about 7 weeks after the February planting.

Mixed winged bean seed of the Tpt-1 and Chimbu varieties was planted in the shallow sandy loam soils of San Antonio (88.5 m above sea level) in September, 1978. No fertilizer or pesticide was provided. Pods were produced over a 2-month period although yields were unsatisfactory. Adverse effects of the dry season resulting in high moisture loss from the shallow soil probably contributed to this. Parasol ants (*Atta* spp) were a major pest which attacked the plants when they were at the peak of growth and stripped them of green tissue. Pods were used for food in the green pod stage only. They were boiled and found to be very palatable. No attempt was made to eat the fleshy roots.

BRAZIL

Lam-Sánchez, A. Introduction and cultivation of winged bean in the region of Jaboticabal, São Paulo, Brazil. (A monograph with 3 tables).

Two varieties of winged bean, UPS-31 and UPS-122 were introduced from Papua New Guinea and submitted to a date of planting experiment in Jabotica al (21°15'18" S Latitude 48°15'18" W; 610 m altitude). Dates of planting were spaced by 15 days, starting in 10/16/78 and ending 12/15/78. Plants were planted in rows 1.5 m apart and 0.6 m between plants, they were tutored by bamboo poles 1.7 m high. Observations on the general biology of the plant were made in the rows, and specifically for flowering and fructification observations were made on individual flowers. Plant characteristics and yield components were obtained from 8 competitive plants and submitted to statistical analysis.

By the results obtained it can be concluded that this crop can be cultivated in the region, and date of planting had some effects where the earlier ones promoted a higher plant development and also as a consequence higher values for the studied characteristics. Variety UPS-122 showed a greater plant development and consequently a higher yield.

GUATEMALA

Tiberghien, J.; Bahlinger, D.G. and Benya, E.G. Some production and palatability factors concerning the winged bean (*Psophocarpus tetragonolobus*) in San Jacinto, Chiquimula, Guatemala. A report to the International Council for the Development of Underutilized Plants, 20 January 1981.

Seeds of both Chimbu and Tpt-1 were sown on 9 July, 1979 and germinated in 12 days. Vegetative growth was profuse and the first green pods were harvested in early October. Irrigation was provided from November when the dry season set in. Where plants were not staked, growth was poor. The yield of green pods began declining in February. Chimbu plants produced an average of 7 pods each. Production from Tpt-1 was less.

Generally, insects were not a serious problem but, in some cases, plants were defoliated.

IX. WINGED BEAN FLYER SUBSCRIPTIONS (AND BACK ISSUES)

The International Council for Development of Underutilized Plants has arranged for a financial grant to produce Volume 3 of *The Winged Bean Flyer* on the condition that, thereafter, the publication become financially self supporting. This means, of course, that subscriptions must be levied. The high quality of *The Winged Bean Flyer* will be maintained, and where possible improved at minimal costs. Much of the work involved in the production of this newsletter is honorary, the major cost being that of postage and printing.

Beginning with Volume 4, the annual subscription rate for two issues will be:

US$6.00

PLUS US$2.50 for SURFACE MAIL costs

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To ensure continuity of production of *The Winged Bean Flyer*, we would appreciate receiving your completed subscription form (below), indicating that you wish to continue receiving *The Winged Bean Flyer*, together with your cheque for Volume IV as soon as possible. Cheques should be made out to: The Winged Bean Flyer/ICDUP.

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The second (1981) edition of the Winged Bean Bibliography, edited by Verona R. Aterrado, has been published by the International Documentation Centre for the Winged Bean. The current edition contains 420 entries, over three times the number in the first edition and is complete with keyword, author and geographic indexes. This valuable book is available for a nominal US$10.00 plus postage. Copies of documents cited in the bibliography may be obtained from the Centre in either hard copy or microfiche for nominal fees to cover reproduction and mailing costs. Requests should be sent to:

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