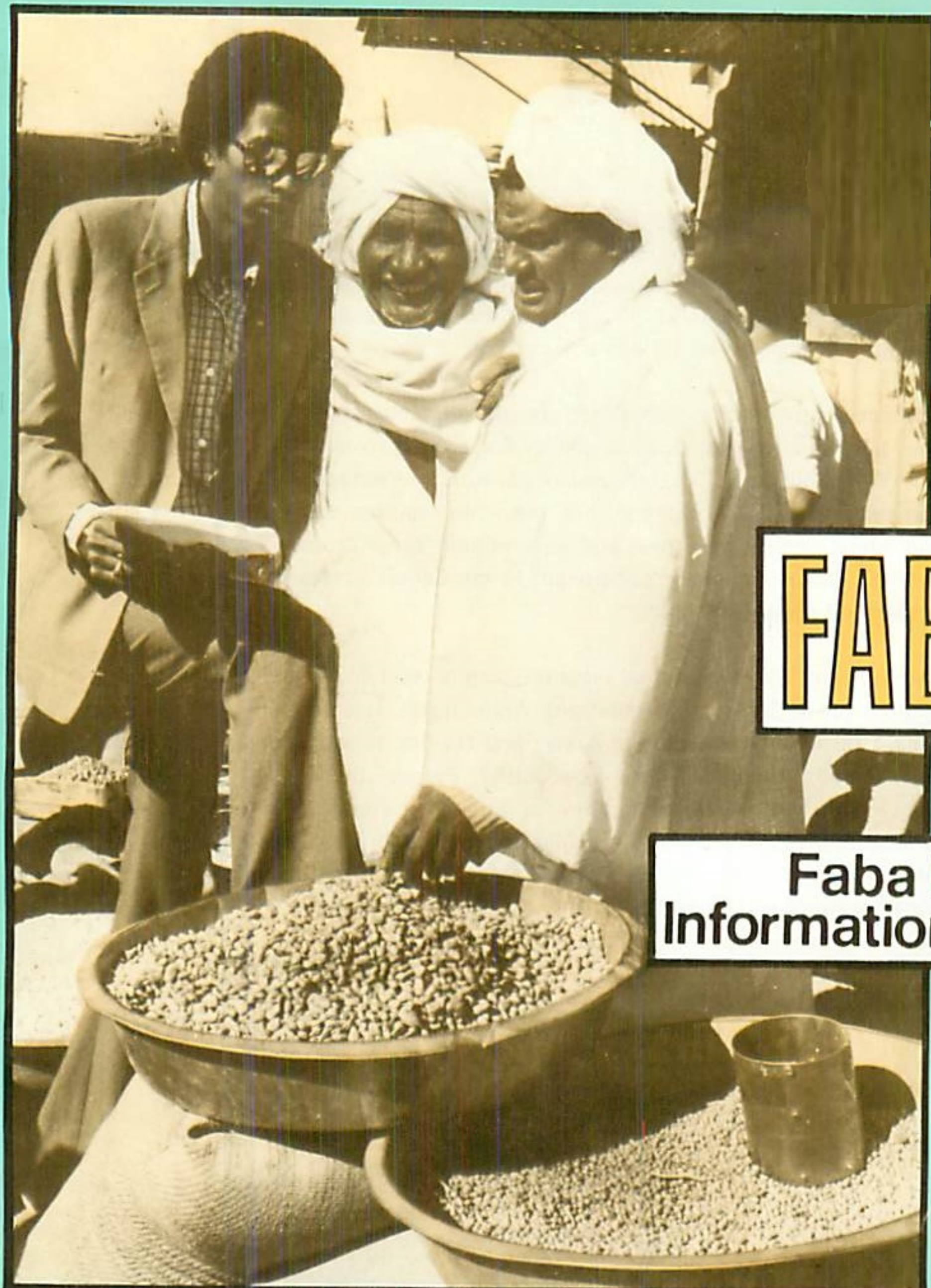


FABIS

Faba Bean Information Service

NEWSLETTER
No. 8
APRIL 1984

INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS
(ICARDA)

The Center and its Mission

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 to undertake research relevant to the needs of developing countries and specifically for the agricultural systems in West Asia and North Africa. The overall objective of the Center is to contribute towards increased agricultural productivity, thereby increasing the availability of food in both rural and urban areas, and thus improving the economic and social well-being of people.

Though devoted mainly to winter-rainfed agriculture in areas with 200-600 mm rainfall per annum, ICARDA has world responsibility for the improvement of barley, lentil, and faba bean. Where logical, ICARDA's area of concern thus extends into environments with monsoon rainfall or with irrigation. In the winter-rainfed areas, research is also carried out on wheat, kabuli chickpea, and pasture and forage crops. Development of improved farming systems is a major component in the Center's research program. The Center undertakes and supports training.

ICARDA is one of 13 international research centers receiving support from donors through the Consultative Group on International Agricultural Research (CGIAR). Donors to ICARDA have included Australia, the Arab Fund for Social and Economic Development, Belgium, Canada, Denmark, Ford Foundation, France, the Federal Republic of Germany, the World Bank, Italy, International Fund for Agricultural Development, International Development Research Centre, Mexico, the Netherlands, Norway, Organization of Petroleum Exporting Countries, Saudi Arabia, Spain, United Kingdom, Sweden, United Nations Development Programme, and United States Agency for International Development.

Cover photo: a Sudanese scientist conducts a faba bean price survey in Khartoum, Sudan.

FABIS

Faba Bean Information Service

NEWSLETTER No.8

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS
(ICARDA)

CONTENTS

Seed Quality and Nutrition

Seasonal changes in faba bean consumption in the Khartoum area: survey results from 1982 and 1983

Abdallah El Mubarak Ali[1], Asma Mohamed Ali[1] and Thomas L. Nordblom[2]
[1] *Food Research Center, ARC, P.O.Box 213, Shambat, SUDAN*
[2] *ICARDA, P.O.Box 5466, Aleppo, SYRIA*

The objective of this study was to estimate responses to price and season in the consumption of faba beans by the population of the Khartoum, Omdurman and Khartoum North urban areas. The study was justified by the need for more complete information to guide research and policy.

Methods

A questionnaire, in Arabic (Ali *et al.* 1983b), was administered by personal interview to 209 households sampled from the urban population in January and February 1983. Sampling was carried out in two stages: (1) identification and random selection of residential areas, and (2) systematic choice of households within the selected residential areas. In the first stage, all residential areas associated with the three towns were listed by name and a number assigned to each, and within each town 10 residential areas were randomly selected.

The second stage of sampling was carried out in the selected residential areas by the interviewers. To ensure that households would be chosen at uniform intervals across the length and breadth of a residential area, the interviewers would first locate and determine the size of an area and its number of streets. Then, starting on the south side of the area, for example, they would interview the third household in the third street, the fourth house in the fifth street, the fifth house in the seventh street, and so on, until the desired sub-sample size was obtained. In cases where nobody in a selected house could be interviewed, adjacent houses were selected.

An indication of the composition of the sample is given by the occupations of the heads of households: 40% were government workers, 29% merchants, 23% laborers, 6% pensioners, and 2% farmers. Most (90%) of the sampled households contained more than five people and 31% had 10 or more persons. Responses on monthly household consumption of faba beans were divided by the number of persons in each household to estimate per capita consumption.

Seasonal differences in faba bean consumption

Interviewees were questioned on whether more faba beans are consumed in winter than in summer. About 31% said there is no difference, but the rest said they consume more in winter. However, only 45% of those interviewed provided quantitative estimates, and the increase on average was 40% . Based on the above figures, the overall average increase in consumption from summer to winter could be estimated at between 18% and 28% . The lower figure is obtained by assuming a zero increase for those not giving a quantitative estimate of increase. These estimates are consistent with the notion that appetites for heavy meals are depressed in hot weather.

Faba bean prices in Khartoum, and consumer opinions about them relative to other food prices, are presented in Table 1 for a harvest-time period (March-April 1982), and a winter period (January-February 1983). Consumers in the harvest-time survey mostly considered faba beans to be reasonably priced or cheap, and their per capita consumption was estimated to be 1.54 kg per month (Ali *et al.* 1983a). By the time of the winter survey, prices had increased to more than threefold. Consumers mostly considered faba beans expensive and per capita monthly consumption was estimated to have fallen to 1.16 kg. This picture seems contradictory to that drawn earlier which suggested winter consumption levels to be higher than in hot weather.

That consumption of faba beans is lowest in late winter due to high prices is supported by answers given to a second set of questions. People were asked to estimate their household's monthly consumption of faba beans at the time of the interview (January-February 1983) and to estimate how much would be consumed if 1) there were a 50% decrease in faba bean prices with all other prices unchanged, and 2) its price were doubled while other prices remained constant.

In response to the hypothetical price decrease of 50%, increased consumption (averaging 28%) was indicated by 37% of the households. The remaining households

Table 1. Khartoum faba bean prices and consumption levels at harvest time and in winter.

	Harvest time (March-April) 1982 [1]	Winter (January - February) 1983
Khartoum faba bean price (LS/kg)[2]	0.75	2.39
Consumer opinions on the price of faba beans compared to other foods:		
a) Expensive (% of consumers)	26	84
b) Reasonable or cheap (% of consumers)	74	16
Per capita consumption of faba beans (kg/month)	1.54	1.16
S.D.	1.40	0.66

[1] See Ali *et al.* 1983a.

[2] Both prices are in constant March-April 1982 Sudanese Pounds (LS).

indicated no change. Confronted with a hypothetical doubling of faba bean prices, however, 58% of the households indicated that consumption would decrease. The average decrease was 35% among these, while the remaining households indicated no change. Of the majority who said consumption would decrease, many suggested they would consume no faba beans if the price were doubled. Only one household (a merchant's) of the 209 interviewed said they would increase consumption if prices were doubled.

To compute estimates of aggregate change, the many "no-change" answers were weighted in proportion to the numbers of people responding this way. The aggregate estimates of consumption shifts at halved and doubled prices were +10.4% and −20.3%, respectively.

Price elasticity of demand (the proportional change in quantity given a proportional change in price, i.e., $(dQ/Q)(P/dP)$) is thus very low, approximately −0.2 for faba beans in this case. That is, per capita consumption is expected to change little in response to large price increases or decreases. These relationships are consistent with our earlier comparison of estimated per capita consumption at harvest-time (Table 1).

The decline in monthly consumption of faba beans, from 1.54 to 1.16 kg per capita, may be explained as the result of a large price increase interacting with an increase in demand from hot to cool seasons (Fig. 1). The survey responses suggested that cool season demand for faba beans may be as much as 28% greater than hot season demand. That is, at any given price level, the amount purchased in cool weather could be 128% of the amount purchased in hot weather.

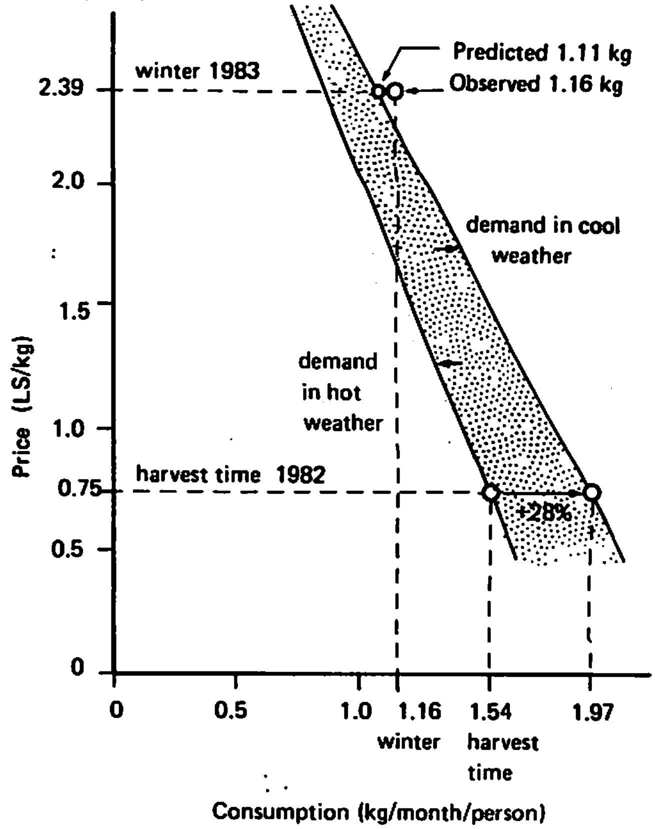


Fig. 1. Shifts in faba bean consumption in response to seasonal demand and price, Khartoum area. The prices are in constant (March/ April 1982) Sudanese Pounds (LS).

Presumably, therefore, if prices had remained unchanged at the harvest-time level of LS 0.75/kg, per capita consumption would have increased from 1.54 to 1.97 kg (i.e., 128% of 1.54) by the time of the January-February survey. However, prices had climbed to LS 2.39/kg (corrected for inflation), more than three times the harvest-time price. Survey responses to the hypothetical price increase and decrease questions now allow an independent prediction of consumption response to *this* large price increase.

By placing the initial quantity and price levels with the elasticity estimate in the elasticity equation as follows:

$$-0.2 = (dQ/1.97)\ (0.75/(2.39-0.75)) = dQ\ (0.2321),$$

the change in quantity due to the price increase (dQ) is calculated as:

$$dQ = (-0.2)/(0.2321) = -0.86 \text{ kg}$$

The prediction that consumption would fall by 0.86 kg in response to the price *rise*, after accounting for enhanced winter appetites, points to a monthly consumption level of 1.11 kg (i.e., 1.97–0.86). This is sufficiently close to the directly estimated consumption level of 1.16 kg to give credence to the notion that people preferred to eat more faba beans in the cool season, but actually ate less due to high prices. Thus, the consumption shifts in response to seasonal levels of appetite and prices form a consistent picture.

It should also be noted that consumption levels, estimated in both the 1982 and 1983 surveys of the Khartoum area, are well within the range of faba bean consumption levels (0.81 to 3.0 kg/capita/month) estimated in a recent survey in Egypt (Hussein 1983).

Lentils, and lentils combined with other foods such as meat, salad, eggs, and cheese, were mentioned frequently in the 1983 survey as substitutes for faba beans in the Khartoum area. This is consistent with interview answers in the 1982 survey. However, in the 1982 survey, when the question was posed in terms of equal preference, about one fourth of the respondents said there is no substitute for faba beans. In contrast, all respondents in the 1983 survey mentioned some food items as substitutes when the question was posed for a hypothetical situation where no faba beans are available.

At the time of the pre-harvest 1983 survey, faba bean supplies were short and prices were high and nearly equal in both Khartoum and the production areas in the north. When the large 1983 crop was harvested, faba bean prices in the main growing areas almost immediately plunged to about one third of the price of the previous month. Faba bean prices in Khartoum fell to about two thirds of their pre-harvest level, a much less drastic drop in price than that facing the farmers. It is very clear that only a fraction of the 1983 harvest had reached the retail market. The bulk of the crop was being stored some place between the farm gate and the consumers.

The merchants who buy faba beans from farmers before or during harvest, transport and store the commodity, and release it gradually to the markets throughout the year, are providing extremely valuable services to consumers in the urban areas. While the profits earned by these middlemen are unknown, we are certain that they also face many costs and risks.

There can be little doubt that experienced merchants carry out most of the marketing operations for this crop with far greater efficiency and lower costs than could an isolated farmer. However, farmers may have certain advantages in being able to store faba beans with fewer losses and better maintenance of quality by closer monitoring of smaller stocks. Most importantly, of course, by storing his crop the farmer would also have the opportunity to sell it at higher prices later in the year. Farmers have had to sell their crops to merchants prior to harvest due to their need for cash and in the absence of other sources of credit. Farmers and consumers would benefit the most from on-farm storage while the more efficient merchants would still have many vital and profitable roles to play in the marketing process.

Simple and cost effective on-farm storage methods that protect the quality of faba beans are clearly needed. Credit facilities for the producers may be necessary precursor to on-farm storage. The economic gains available to farmers through increased production are almost dwarfed by those that would be possible if means for high-quality, low-cost on-farm storage can be developed and implemented. Merchants spread their retail sales over the whole year to take advantage of the inelastic consumer demand for faba beans. Farmers also can be helped to take advantage of these facts.

Further research is needed on the marketing aspects of faba beans in Sudan, in particular, means for providing credit to small farmers and on-farm storage techniques.

Acknowledgments

While the authors retain responsibility for any errors which remain, they are grateful to Drs. Hamid Fakki, Habib Amamou and David Nygaard for their criticisms of earlier drafts.

References

Ali, A. El M., Ali, A.M., Salkini, A.B., and Nordblom, T.L. 1983a. Consumer preferences for faba beans in selected urban and farming areas of Sudan. FABIS No. 6: 4-6.

Ali, A. El M., Ali, A.M., and Nordblom, T.L. 1983b. A faba bean and lentil consumption survey in the Khartoum area, January-Feburary 1983. A paper presented at the Annual Coordination Meeting of the ICARDA/IFAD Nile Valley Project, 10-14 Sept. 1983, Khartoum, Sudan.

Hussein, L. 1983. Nutrition Studies in Egypt. Pages 134-140 *in* Faba Bean in the Nile Valley (Saxena, M.C. and Stewart, R.A., eds.) Martinus Nijhoff Publishers, The Hague, The Netherlands.

Breeding and Genetics

Inheritance of seed dormancy in *Vicia faba* L.

Dhirendra Khare and C.B. Singh
Department of Plant Breeding and Genetics,
Jawaharlal Nehru Agricultural University,
Jabalpur, M.P. INDIA

Seed dormancy is an important character in leguminous crops. It has been reported as being dependent on the extent of seed maturity (Zenari 1929), air temperature and humidity (Nakamura 1961), length of storage (Bagoury and Niyazi 1973) and heredity (Bennett 1959; Pel'cih 1962; and Khare 1983). However, Altkin (1939), in *Trifolium incarnatum*, Forbes and Wells (1968), in blue lupin, and Donnelly *et al.* (1972), working on *Vicia faba*, reported seed dormancy control by both environmental and genetic factors.

Materials and Methods

Crosses were made between six genotypes of *V. faba* differing in seed dormancy. The genotypes included in the study were JV-2, JV-3, JV-5 and JV-6 with dormant character and JV-7 and JV-8 with nondormant character. The progenies obtained in the F_2 population were analyzed for seed dormancy by placing them on moist blotters in petri dishes. Data were recorded on germinated and ungerminated seeds up to 15 days. The seeds which did not germinate were considered dormant.

The testa of 10 seeds from each of the progenies of the crosses was removed by rubbing with sand paper, and the same germination test applied. Data were analysed by goodness of fit (X^2 test).

Results and Discussion

The data on the segregation of crosses between dormant and nondormant genotypes are presented in Table 1. It is evident from the data that all the crosses with JV-7 and JV-8 genotypes segregated in a typical monohybrid ratio indicating dormancy to be dominant over nondormancy. The progenies of other crosses did not follow the monohybrid ratio. The removal of the testa influenced dormancy in most of the progenies by allowing the seeds to germinate, but in some progenies the dormancy was not broken.

Table 1. Segregation of crosses between dormant and non-dormant genotypes, with and without testa.

Crosses	Segregation in F_2 intact testa		X^2 3:1	Segregation in F_2 without testa	
	Dormant	Non-dormant		Dormant	Non-dormant
JV-2 x JV-3	178	0	–	151	27
JV-2 x JV-5	63	1	–	57	7
JV-2 x JV-6	67	0	–	59	8
JV-2 x JV-7	45	8	2.77	32	21
JV-2 x JV-8	58	14	1.18	41	24
JV-3 x JV-5	82	0	–	72	10
JV-3 x JV-6	61	1	–	54	8
JV-3 x JV-7	54	10	3.00	43	21
JV-3 x JV-8	46	12	0.56	30	28
JV-5 x JV-6	53	0	–	48	5
JV-5 x JV-7	71	31	1.58	53	49
JV-5 x JV-8	43	22	2.71	34	31
JV-6 x JV-7	44	7	3.45	36	15
JV-6 x JV-8	56	15	0.56	42	29
JV-7 x JV-8	6	62	–	0	68

Therefore it is concluded that the dormancy in *V. faba* is controlled by both physical and genetic factors and that dormancy is governed by a dominant gene.

Acknowledgements

The authors are grateful to Dr. S.P. Singh, Professor and Head of the Department of Plant Breeding and Genetics, J.N. Agricultural University, Jabalpur, M.P., India for providing facilities and encouragement during the course of the investigation.

References

Altkin, Y. 1939. The problem of hard seed in subterranean clover. Proceedings of the Royal Society of Victoria, 51: 187.

Bagoury, O.H. and Niyazi, N.A. 1973. Effect of different fertilizers on germination and hard seed percentage of Egyptian clover *Trifolium alexandrinum* seeds. Seed Science and Technology 1: 773-779.

Bennett, H.W. 1959. The effectiveness of selection for hard seeded character in crimson clover. Agronomy Journal 51: 15-16.

Donnelly, E.D., Watson, J.E., John, A. and McGivre. 1972. Inheritance of hard seeds in *Vicia faba*. Journal of Heredity 63: 361-365.

Forbes and Wells, 1968. Hard and soft seededness in blue lupin *Lupinus angustifolius* L. Inheritance and phenotypic classification. Crop Science 8: 195-197.

Khare, D. 1983. Study of induced genetic variability in M_3 generation and inheritance of qualitative traits in *Vicia faba* L. M.Sc. Ag. Thesis. J.N. Agricultural University, Jabalpur, M.P., India. pp.95.

Nakamura, S. 1961. Germination of legume seeds. Proceedings of the International Seed Testing Association 27: 694-710.

Pel'cih, L.A. 1962. Hard seed in *V. villosa.* Agrobiologiya, 932-934.

Zenari, J. 1929. The character hard seed in relation to heredity and environment. Annals of Botany 18: 174-215.

EEC Joint Faba Bean and Pea Trials

The results of trials of faba beans and peas at nine locations in north-west Europe for the three years 1980-82, were presented at the EEC seminar at Nottingham University, UK, on 14 September 1983. The full reports will be published as part of the Proceedings of the EEC Faba Bean Seminar, Nottingham, 1983. The following are abstracts of the two papers presented.

Results of the Joint Faba Bean and Pea Trials for the years 1980-1982

E. Ebmeyer
Institute of Agronomy and Plant Breeding, Gottingen, German Federal Republic

During the years 1980-1982 a second series of the EEC Joint Faba Bean Test was carried out. Eight faba bean varieties, representing different plant types, and three pea varieties were tested at nine locations in western Europe. Averaged over all environments involved, the highest yielding bean variety was 'Minica', which also had a higher harvest index as compared to the other varieties. The latter indicates a more efficient distribution of dry matter between reproductive and vegetative parts of the plant. Yield data of faba beans and peas indicate that some locations are more suitable for growing peas than beans.

Yield stability of faba beans and peas in EEC Joint Trials 1980-1982

D.A. Bond
Plant Breeding Institute, Maris Lane, Trumpington, Cambridge, UK

Eight faba bean varieties (G) in 27 environments (E) (comprising 9 locations in 3 years) showed highly significant G x E interaction, some of which was attributable to heterogeneity of regression of varieties on environmental means. As in the 1977-79 series of trials, the large-seeded (*major*) varieties gave high mean yields, due to greater responsiveness to favorable environments, as compared with the more stable but lower yields of the *minor* types. The variety 'Strubes,' an *equina* type not tested in 1977-79, responded in the same way as the *major* types. 'Minica' had a high mean yield but made a large contribution to the environment x variety interaction.

In a combined analysis of the 8 faba bean and 3 pea varieties over 24 environments, regressions did not account for a significant proportion of the G x E interaction but the pea variety 'Finale' had a greater mean yield and a lower coefficient of variation than the *major*-type bean, 'Wierboon.' In both mean yield and yield stability there were greater differences among bean or pea varieties than between the means of beans and of peas. Regressions of pea varieties on to environmental means of peas accounted for a much higher proportion of the variance than on to environmental means composed mainly of beans; i.e., one crop was not a satisfactory index of the environment suited to the other.

Faba bean cultivars in Spain

J.I. Cubero
Escuela Tecnica Superior de Ingenieros Agrónomos, Departmento de Genetica, Apartado 3048, Cordoba, Spain

Cv. Alameda.

Origin and method of maintenance

Obtained by selecting for auto-fertility in a landrace from Cadiz Province, Spain. The cultivar is maintained by cycles of two consecutive generations under insect-proof cages, followed by one generation under open pollination. Selection of the best plants is performed during the second year under the cages, and during the generation under open pollination.

Morphological traits

a) Height and tillering: 75-100 cm tall, 3-5 tillers/plant.
b) Leaves: 5 leaflets/leaf, eliptical/lanceolate, medium-small (4.5 x 10 cm). Leaves are light green, upper surface is matt.

c) Flowers: 3-4 node, first flower in the 5th or 6th node. Color standard. Seventy to 80% of flowers set pods.
d) Podding characteristics: Indehiscent, short and erect, up to 3/node. Three to four seeds/pod.
e) Seed characteristics: 950-1000 g/1000 seeds. Seed length ±1.7 cm, ±0.6 cm thick, ±1.3 cm wide.
Protein content 25%.
Seed coat beige, hilum black.

Agronomic characteristics

Semi-early with short flowering-maturity period. Well adapted to areas receiving 450-600 mm annual rainfall, with mild to moderate cold winters.

Resistant to rust and ascochyta blight, and moderately tolerant to *Orobanche* sp.

Cv. Palacio
Origin and method of maintenace

Obtained by selecting for auto-fertility in a landrace from Morocco, probably of Hungarian origin. Maintenance as for cv Alameda.

Morphological characteristics

a) Height: 70-90 cm.
b) Leaves: leaflets slightly larger than cv Alameda, 5 x 10 cm.
c) Flowers: 3-4/node, 70-90% set pods. Average of 3.3 ovules/ovary, 75-85% fertile.
d) Podding characteristics: up to 3 pods/node, erect/semi-erect, straight, sharp apex. Seeds/pod, 2.4-3 (2.6 average).
e) Seed characteristics: 850-950 g/1000 seeds. Seeds 1.6 cm long, 0.6 cm thick, 1.1 cm wide. Protein content 25%.

Agronomic characteristics

Early maturing. Susceptible to *Orobanche* sp., but otherwise similar to cv Alameda.

Physiology and Microbiology

Dry matter production and efficiency of solar energy utilization of faba bean in Japan

Kiyoshi Kogure and Kenji Watanabe
Faculty of Agriculture, Kagawa University, 2393 Ikenobe, Miki-tyo, Kagawa-ken 761-07, JAPAN.

Faba beans have been widely cultivated as a winter crop in the multiple cropping of the paddy field system in Japan (Kogure 1979). This crop shows no remarkable top growth except for vigorous branching under low temperatures in December to February (Cooper 1970). More than 10 stems per plant have been recorded, the number being closely related to planting density (Tamaki *et al.* 1973), and cultivar (Kogure, unpublished observations). The dry matter production and efficiency of solar energy utilization during March to May is very important for this crop in Japan. The incident solar energy of 325-450 cal/cm^2/day during this period contrasts with that of 178-218 cal/cm^2/day during the winter, (December-February) period.

Materials and Methods

The small-seeded cultivar Boshu-wase was planted in a field trial. Row width was 36 cm, with 36 cm between hills and two plants per hill. Stem elongation was slow in early March, but accelerated in late March with the onset of flowering. The increase in dry weight of the vegetative organs began in late March, and ended in mid-May. The dry seed yield was 440 g/m^2. The harvest index was 39.9% .

Plants were sampled throughout the growing season and the calorific values of the plant organs were determined using an autocombustion calorimeter. Figure 1 shows the variation in calorific value of the different organs through the growing season. The calorific values of the individual organs were summed to give the total plant calorific value for each sampling date.

The solar energy utilization efficiency, Eu, was calculated with the following equation:

$$Eu = \frac{\Delta T}{S} \times 100\ \%$$

where ΔT is the total energy produced on a unit field area during a given period (total calorific value at t_2 − total calorific value at t_1), and S is the total short-wave radiation incident on the plants during the same period.

Results

The efficiency of solar energy utilization was 1.50% during the early flowering period, 30 March to 16 April, increasing gradually to the end of flowering, and reached a peak of 2.27% during the period 29 April to 15 May, the highest value recorded in this experiment. It then declined to 0.83% at harvest.

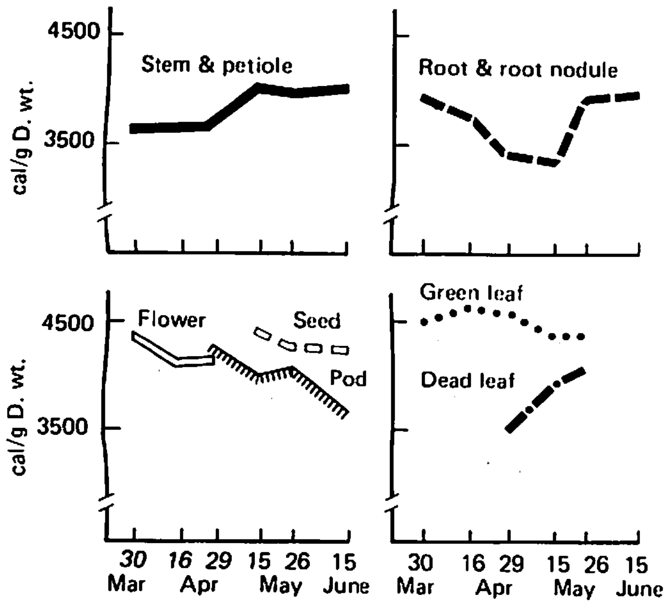


Fig. 1. The variations in calorific value of each organ (cal/ g dry weight).

Murata (1981) reported figures for solar energy utilization efficiency, Eu, of 3.95 ± 0.43% for C_4 plants, and 2.89 ± 0.48% for C_3 plants, considerably higher than those found in this experiment. Despite this relatively low figure for Eu, faba bean is one of the crops best adapted to growing during the winter and spring months in Japan.

References

Cooper, J.P. 1970. Potential production and energy conversion in temperate and tropical grasses. Herbage Abstracts 40: 1-15.

Kogure, K. 1979. Broad beans in Japan: origin and development. FABIS 1: 11-14.

Murata, Y. 1981. Dependence of potential productivity and efficiency for solar energy utilization on leaf photosynthetic capacity in crop species. Japanese Journal of Crop Science 50:223-232.

Tamaki, K., Asanuma, K., and Naka, J. 1973. Physiological studies of the growing process of broad bean plants. VII. Effects of plant density on the growth and the seed production. Technical Bulletin of the Faculty of Agriculture, Kagawa University 25: 1-11.

Agronomy and Mechanisation

The effect of sowing time on the seed yield of faba beans

O. Tosun, D. Eser, H.H. Gecit, and H.Y. Emeklier
Department of Field Crops, Faculty of Agriculture, University of Ankara, TURKEY

Introduction

In Turkey, approximately 8 million out of 25 million hectares of arable land are being left fallow every year. Some 80% of agriculture in Turkey is rainfed and fallow-winter cereal rotations (particularly winter wheat) predominate. Cold tolerant and annual winter legumes could replace the fallow phase of these rotations. In view of this, some faba bean lines were evaluated for cold tolerance by sowing in autumn and spring.

Materials and Methods

Twenty five faba bean genotypes (23 from ICARDA and 2 from Turkey) were sown on two dates, 29 November 1980 and 5 March 1981, at Ankara. The previous crop had been wheat. Diammonium phosphate was broadcast at a rate of 150 kg/ha before sowing. The genotypes were sown in a randomized block design with four replications. Plots were 2 m long by 4 rows wide. Interrow distance was 50 cm and planting density was 20 seeds/m^2.

Emergence of the seedlings was observed on 18-20 January and 2-4 April 1981 in autumn and spring sown plots, respectively. Flowering occurred on 18-22 April and 20-25 May in autumn and spring sown plots, respectively. The lowest temperature recorded was −11.4°C, during February, at which time the plants were under 2-3 cm of snow. Plots were harvested on 29-30 June and 2-3 July, 1981, for autumn and spring sown crops, respectively. All observations were made from 1.5 m lengths of the two middle rows of each plot.

Results and Discussion

In most of the genotypes, seed yield, biological yield, harvest index, yield per plant, and 1000 seed weight were signficantly higher in the autumn sown that in the spring sown crop (Table 1). Many factors were responsible for these differences. Soil conditions in the autumn were more favorable for root growth and penetration. The autumn sown crop had particularly good root growth in spite of poor shoot growth early in the season. This was probably due to soil temperature being higher than air temperature during the winter. Thus the autumn sown crop was less affected by drought in the spring and summer.

Table 1. Seed and biological yield, number of plants/m^2, yield per plant, plant height and 1000-seed weight in autumn and spring sowings of 25 faba bean genotypes.

Genotype	Origin	Seed yield (g/m^2)		Biological yield (g/m^2)		Plant numbers per m^2		Plant yield (g)		Plant height (cm)		1000 seed weight (g)	
		Autumn Sowing	Spring Sowing	Autumn Sowing	Spring Sowing	Autumn Sowing	Spring Sowing	Autumn Sowing	Spring Sowing	Autumn Sowing	Spring Sowing	Autumn Sowing	Spring Sowing
74TA12	Cyprus	275.7	228.0	500.5	467.5	16.2	18.2	16.9	12.4	38.3	64.5	995.0	780.8
74TA22	China	247.7	198.7	453.3	396.7	16.5	16.5	15.0	11.7	35.8	62.1	1113.8	855.9
77Ms88252	Syria	227.2	239.0	411.0	493.3	11.2	18.5	20.2	13.5	34.3	63.3	1178.2	803.1
77TA80023	Syria	276.7	209.7	537.9	425.8	17.7	16.5	15.6	12.6	39.3	67.2	906.0	716.5
75TA26062	Iraq	267.0	205.5	486.7	412.5	15.5	17.2	17.2	11.9	36.7	65.7	1138.7	953.4
74TA85	Iraq	259.2	183.3	467.5	371.7	15.2	17.5	17.0	10.4	37.7	62.9	921.1	766.6
74TA87	Iraq	295.3	229.4	524.2	468.3	14.5	17.0	20.3	13.4	37.5	66.1	1058.7	796.3
69VI	Turkey	119.7	102.0	366.7	365.8	13.7	18.2	8.7	5.6	32.8	59.6	522.6	370.8
74TA133	England	269.5	207.7	496.7	416.7	13.0	14.0	20.7	14.7	37.4	56.7	839.2	665.2
75TA26332	Turkey	288.5	187.3	531.9	380.0	15.7	16.2	18.3	11.5	36.1	60.8	916.9	647.4
74TA367	Spain	232.8	204.0	436.6	413.3	15.0	18.0	15.5	11.2	36.5	65.7	787.3	640.0
74TA374	Lebanon	293.4	182.3	542.7	388.1	13.7	17.5	21.3	10.3	36.8	63.0	1037.3	867.6
77Ms88323	Lebanon	283.8	197.5	488.3	413.3	15.5	16.0	18.3	12.3	38.3	61.7	680.5	532.0
77Ms88218	Spain	202.0	179.8	392.5	395.8	16.2	18.7	12.4	9.5	33.6	64.4	833.5	619.0
77Ms88158	Egypt	305.3	212.7	560.6	426.8	14.0	16.7	21.8	12.7	36.1	71.2	826.6	608.9
76TA56202	Egypt	238.0	208.4	442.3	433.6	12.5	16.2	19.0	12.0	36.7	67.9	852.6	615.3
69V2	Turkey	91.5	88.8	312.2	381.3	7.7	17.5	11.8	5.1	36.7	57.5	448.4	373.5
74TA498	Egypt	233.5	143.3	439.7	323.3	13.2	15.7	17.6	9.0	35.5	60.3	924.4	659.6
78Ms88362	Algeria	205.5	163.7	422.0	352.4	14.2	16.5	14.4	9.7	35.0	67.0	847.7	672.8
Hudeiba 72	Sudan	68.2	112.2	164.2	289.7	7.7	13.5	8.2	8.2	34.4	59.5	636.0	461.1
78S49172	England	213.2	191.3	404.2	377.2	14.0	15.2	15.2	12.5	39.7	63.6	1060.3	897.8
Local	Syria	241.0	196.7	467.2	379.2	13.7	15.7	17.6	12.3	37.2	60.9	1200.9	976.6
78S49892	Lebanon	221.0	121.5	444.2	292.2	12.5	14.2	17.8	8.5	38.4	59.1	866.7	796.8
Giza 3	Egypt	114.6	170.9	220.8	360.9	7.5	13.2	15.3	12.8	32.3	51.6	755.2	576.5
78S 33011	Cross line	253.4	212.8	487.6	446.8	13.0	15.5	19.5	13.7	36.4	62.0	901.3	750.8
Mean		228.9	183.1	440.0	394.5	13.6	16.4	16.6	11.1	36.4	62.7	890.0	697.4
LSD 5%		44.34	67.996	75.023	123.63	2.199	3.178	1.599	3.081	2.421	13.288	44.358	37.949

In addition, many faba bean varieties are known to require a low temperature ($<5^oC$) period of 30-40 days for vernalization for good generative development, although the magnitude of response varies between ecotypes (Saxena and Wasimi 1979). Autumn sown lines would have their vernalization requirements met to a greater extent than spring sown lines. The autumn sown faba beans started to flower 20-25 days earlier than spring sown lines, but reached maturity only 2-3 days earlier. Thus, the reproductive growth phase was longer in autumn sown lines.

The number of the plants/m^2 was less in autumn sown than in spring sown plots due to injury to, and death of some plants from low temperature. Plant height was also reduced by autumn sowing, possibly due to reduced inter-plant competition in the thinner stand of the autumn sown crop.

In view of the fact that the minimum temperature of -11.4^oC could be tolerated by several of the genotypes under autumn sowing it is hoped that cold tolerant faba bean varieties can be developed. Although autumn sowing of faba bean cannot be done at the present time in our region, early spring sowing may be recommended. Autumn sowing may be feasible in some of the coastal areas in Turkey.

Reference

Saxena, M., and Wasimi, N. 1979. A preliminary study of the response of some bean (*Vicia faba*) genotypes to vernalization. FABIS 1: 20-21.

Effect of sowing date on yield of faba bean (*Vicia faba major*) at Valdivia, Chile

Aage Krarup H.
Instituto de Produccion y Sanidad Vegetal, Facultad de Ciencias Agrarias , Universidad Austral de Chile, Casilla 567, Valdivia, CHILE.

Chile grows only the *major* variety of faba bean (*Vicia faba major*) for human consumption. Beans are consumed mainly as green beans, but also in lesser quantities as green pods. The area devoted to the crop is around 5,000 hectares, concentrated in central Chile, near the largest cities, and in southern Chile, near Temuco and Valdivia. Planting in southern Chile can only be done in winter at the end of the rainy season, and in early spring, due to the normally heavy winter rainfall and low temperatures. The crop is usually sown as early as possible, as it is generally known that late sowings yield less. However, information on the effect of sowing date on yield is scarce.

Some preliminary trials have been run at our institute to gain more information on this crop. Results from the trial on the effect of sowing date upon yield are reported here.

Materials and Methods

Six planting dates, at 15-day intervals from 30 July to 15 October, 1982 were studied at the Santa Rosa Experiment Station, Valdivia. Plots of two rows, 4.2 m long with 60 cm interrow separation, were planted with two seeds per hill at 10 cm intervals. Guard rows were used at either side of the plots. A Windsor type cultivar was used.

One plot row was harvested for the green yield determination, and the second for dry seed yield.

The trial was fertilized with 150 kg P_2O_5/ha, as triple superphosphate, and 100 kg K_2O/ha as potassium sulphate, placed in bands under the seeds. Application of nitrogen at sowing and flowering time was also investigated, but no response was observed to either. Soils of the area have 15-20% organic matter.

Results and Discussion

Green and dry matter yields, and grain yield are presented in Table 1. Green and dry matter yields were evaluated when the pods were ready for harvest as green pods.

The results clearly indicate that the date of sowing has a strong effect on both green and dry matter yields. Early sown crops have substantially higher yields, as has been found previously by Ageeb (1979), Baldwin (1980), and Pandey (1981). Total dry matter yield from the first two planting dates is more than double those of the later planting dates, as is also the case with dry grain yield. Late sowing shortens the growing period from 146 days from planting to harvest in the earliest planted crop, to 89 days in the latest planted crop. Baldwin (1980) found that yield was reduced by about 50% with each four-week delay in sowing. Pandey (1981) concluded that the delay in planting reduced the number of days to flowering and maturity, sharply reducing yield, and was associated with a reduced number of fruiting nodes and pods per plant.

The total dry matter (DM) percentage ranged from 18.8 to 26.6 % . Leaf and stem DM ranged from 20.6 to 32.7% , and pod DM from 14.5 to 18.8% . Green beans represented, on average, 37.1% of the pod green matter by weight.

Table 1. Total green and dry matter yields and grain yield of faba beans, as affected by planting date at Valdivia, Chile (1982/83).

Date of sowing		Green yield (t/ha)			Total dry matter yield	Dry grain yield
		Total	Foliage	Pods	(t/ha)	(kg/ha)
July	30	45.18a	30.56a	14.62a	8.49a	2595a
Aug	15	33.58ab	19.57ab	14.01a	8.92a	2749a
Aug	30	25.06bc	13.21bc	11.85ab	5.34b	2258ab
Sept	15	26.42bc	14.33bc	12.09ab	5.11b	2339ab
Sept	30	17.53c	11.48bc	6.05bc	3.55b	1065c
Oct	15	13.04c	8.36c	4.68c	2.71b	757c
DHS	5%	12.70	8.81	5.23	2.51	1068
DHS	1%	15.20	10.29	6.25	3.00	1279

Data followed by the same letter do not differ significantly $P < 0.05$.

The trial indicates the need for early sowing of faba beans. For maximum yields planting should not be delayed beyond 15 September.

References

Ageeb, O.A.A. 1979. The effect of sowing date and watering interval on the grain yield of broad bean. FABIS 1: 22-23.

Baldwin, B. 1980. Time of sowing - a major factor influencing the yields of *Vicia faba* in South Australia. FABIS 2: 39.

Pandey, R.K. 1981. Time of sowing - a major factor for higher yields of faba bean in Northern India. FABIS 3: 43-46.

Spring beans: is early sowing an advantage ?

J.B. Lee, L. Allen-Williams, and N.A. Hamon
Bayfordbury Research Laboratories, Lower Hatfield Road, Hertford, England, SG13 8LD.

A majority of growers in Britain sow faba beans in early March, although April sowings are not unknown. The official view is that late sown crops tend to yield less per hectare (Anon 1978), and it is indeed clear that very dry summers lead to low yields, late sown crops being more vulnerable (Hebblethwaite *et al.* 1979). In other countries late sowing has been shown to improve yields in some cases (Salih and Ageeb 1983), although other reports show the opposite effect (Pandey 1981), and climatic differences are clearly involved.

The large variability of yields of faba beans in Britain makes a clear-cut assessment of the effect of planting date difficult. Never-the-less, if results over a long period are examined, it is possible to discern a definite trend in yield which suggests that, other things being equal, higher yields are obtained from later planted crops. Table 1 gives an analysis of the published yields of faba beans from Rothamsted Experimental Station (Hertfordshire, England) for the period 1953 - 1980, grouped into four fortnightly planting periods.

Over the ten year period 1971-80 the mean yield from late April sown crops was almost 46% greater than that from early March sown crops, and similar trends are evident in the less extensive data for 1953-1970. In 1982 we examined the effect of late planting of faba beans (*Vicia faba major*, and *Vicia faba minor*), icluding delaying sowing into early May. The results are summarized in Table 2. The data confirm the trend to increased yield from later sowing. Whilst problems could arise in a slow growing season with late harvests interfering with preparation for succeeding crops, in this instance all crops were cleared by late August.

Table 1. Mean yield of *Vicia faba minor* beans (tonnes/ha) from untreated plots against sowing date over the period 1953 - 1980.

Sowing date	Mean yield (t/ha)			
	1953-60	1961-70	1971-80	1953-1980
1-15 March	1.88 ± 0.25	2.86 ± 0.35	2.33 ± 0.29	2.39 ± 0.30
16-30 March	2.01 ± 0.25	3.13 ± 0.49	2.49 ± 0.54	2.58 ± 0.43
31 March - 14 April		3.08 ± 0.81	2.96 ± 0.76	3.02 ± 0.79
15-29 April			3.40 ± 0.53	3.40 ± 0.53

Table 2. Mean yields (tonnes/ha) of *Vicia faba major* and *minor* beans sown at different dates, 1982.

Crop	Yield (t/ha)		
	18 April	26 April	9 May
V. faba major	1.64±0.24	2.74±0.38	2.85±0.27
V. faba minor	1.30±0.37	2.03±0.33	3.01±0.23

We have also noted that yield differences with date of sowing are more marked in isolated crops than in those which border earlier sown crops. Among many factors which may influence yield in this way we may consider attack by the weevil *Sitona lineatus*, the pest status of which has been disputed (George *et al.* 1962, Bardner and Fletcher 1979). Our own results (Hamon 1983, Lee, unpublished observations) tend to confirm that significant yield increases may result from treatments which *inter alia* control the weevil.

The weevil is a reasonably strong flier and shows a regular spring flight onto crops, beginning in late March and peaking in mid-April, so that crops above ground by this time are vulnerable to attack. In Britain the normal seasonal temperature rise ensures that later sown crops germinate more quickly and to a considerable extent make up the growth gap with earlier crops (Hamon 1983). Attack by adult *S. lineatus* is readily monitored by the notching which is caused by feeding upon the bean leaves. Larvae, which attack the root nodules, can be monitored by sampling of roots plus the surrounding soil. Table 3 records the mean number of notches per plant, for crops sown on the dates indicated, as measured on the dates indicated, together with the peak larval numbers per root for each sowing date. It will be seen that both adult and larval infestations are less on the later sown crops. This is largely due to the general build-up of population numbers being overtaken by the increasing mortality of the spring generation of adults; the total populations of the adult weevil reach quite low levels in mid-season until recruitment of newly emerged adults begins in July - August (Hamon 1983).

Table 3. Mean number of feeding notches per plant, and maximal larval numbers of *Sitona* sp. per root, on *V. faba minor* beans sown on four different dates.

Sowing date	Notches / plant					Larval No.
	27 April	4 May	19 May	2 June	22 June	
8 March	16.3	26.4	44.3	31.3*	21.1*	5.62 ± 0.45
24 March	14.1	21.6	39.5	64.2	56.6*	3.59 ± 0.43
13 April			16.8	40.9	51.3	1.05 ± 0.34
27 April			1.7	21.4	28.3	0.39 ± 0.24

* Lower leaves senescent.

Variations in crop yield losses due to the weevil would thus appear to be a possible factor in the yield differences noted above. This is supported by the results of insecticide treatment on crops infested to different levels by *S. lineatus*. Table 4a presents some figures for 1982, for plots where control levels of infestation differed widely. It can be seen that yield increases from treatment of heavily infested crops were much greater. Table 4b gives an analysis of the published yields for insecticide treated crops over the 10-year period 1971-80, which should be compared with those of the untreated crops in Table 1. It will be seen that treatment of early sown crops gives economic yield increases, while treatment of later sown crops does not, again consistent with reduction of insect (mainly *Sitona* sp.) damage on later crops. A plot of log of larval numbers of *Sitona* sp. against log of mean yield gives a linear relationship (Fig. 1) and is consistent with damage by the weevil larvae being a factor in the yield variations noted.

Table 4 (a). Comparison of yields from untreated (control) and bromophos treated (treated) plots for crops showing different infestation levels with *Sitona lineatus*.

Crop	Notching per plant*	Yield (tonnes/ha) Control	Treated	Yield icrease over control (%)
V. faba major	1.2	2.88 ± 0.18	2.96 ± 0.53	2.8
	18.8	2.82 ± 0.22	3.08 ± 0.31	9.2
V. faba minor	19.7	2.05 ± 0.24	2.37 ± 0.22	15.6
	38.5	2.63 ± 0.36	3.19 ± 0.28	21.3

* Provides an estimate of the numbers of adults present.

Table 4 (b). Mean yields (tonnes/ha) of *V. faba minor* from insecticide treated crops sown at different dates over the period 1971-80.

Sowing date	Mean yield (tonnes/ha)	Increase over control (%)
1-15 March	2.68 ± 0.44	15
16-30 March	2.89 ± 0.56	16
15-29 April	3.39 ± 0.57	0

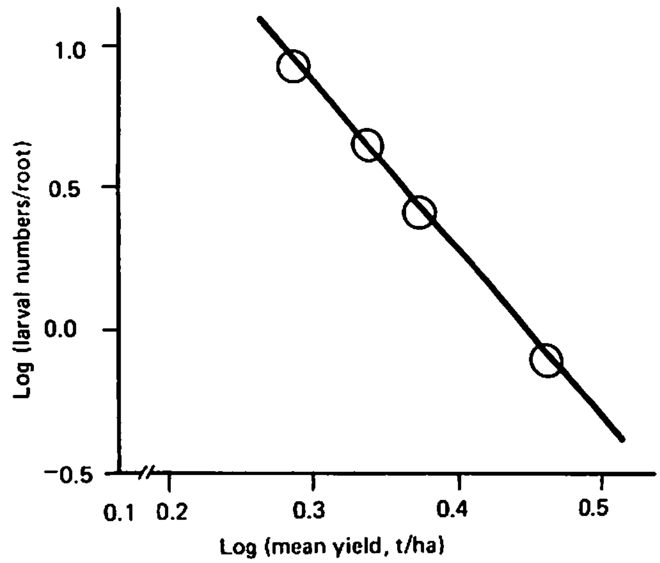


Fig. 1. Plot of log (larval numbers /root) of *Sitona lineatus* against log (mean yield/hectare) for *V. faba minor* crops, Hertford, 1981 and 1982.

References

Anon. 1978. Pea, bean and clover weevils. Ministry of Agriculture, Fisheries and Food, Advisory leaflet HVD 56.

Bardner, R., and Fletcher, K.E. 1979. Larvae of the pea and bean weevil *Sitona lineatus*, and the yield of field beans. Journal of Agricultural Science, UK 97: 109-112.

George, G.S., Light, W.I., and Gair, R. 1962. The effect of artificial defoliation of pea plants on the yield of shelled peas. Plant Pathology 11: 73-80.

Hamon, N. 1983. Studies in the population dynamics and control of the pea and bean weevil, *Sitona lineatus*. Ph.D. Thesis, The Hatfield Polytechnic, England.

Hebblethwaite, P.L., Ingrams, J., Scott, R.K., and Elliot J. 1979. Some factors influencing yield variation in field beans (*Vicia faba* L.). Scottish Horticultural Research Institute Bulletin 15: 20-27.

Pandey, R.K. 1981. Time of sowing - a major factor for higher seed yields of faba bean in northern India. FABIS 3: 43.

Salih, F.A., Ageeb, O.A.A. 1983. Effect of sowing date, watering regime and mulching, on yield of faba bean. FABIS 6: 13-15.

Searching for tolerance to drought in *Vicia faba*

R.J. Heringa, A. van Norel, and J. Post
Foundation for Agricultural Plant Breeding, P.O.Box 117, 6700 AC Wageningen, THE NETHERLANDS.

Introduction

Yield variability in faba bean (*Vicia faba* L.) between years is well known. One reason for this variability may be the crop's susceptibility to drought.

The Foundation for Agricultural Plant Breeding is trying to find material which shows drought tolerance, i.e. maintenance of yield potential under dry conditions. In 1982 an experiment with a limited number of cultivars and lines grown under different watering regimes gave some indication of genetic variability for drought tolerance. This experiment was repeated in 1983 on a larger scale.

Weather conditions in 1983 were very variable, with periods of drought during the pod-setting and pod-filling phases. Despite planting of selection and yield trials in the first week of March under ideal conditions, yields were about 30% lower than in 1982. It is thus necessary to determine the influence of environmental conditions on yield, and to identify drought tolerant material for use in breeding programs. This trial was carried out for that purpose.

Materials and Methods

Two pits 7x11x0.3 m were made in normal sandy soil, and lined with polythene sheet (Fig. 1). On the bottom of each pit, three drain pipes were installed, attached to a collector drain. The pipes were bedded in a gravel layer about 10 cm deep, and covered with nylon gauze to prevent sand seepage. A 20 cm deep layer of a mixture of the original soil, peat, fertilizer, and dry cattle manure was placed on the gauze. The pits were surrounded by a small sand wall to prevent loss of sand.

Both pits were planted with 35 lines and cultivars of faba bean in three replications, and in the same layout. Planting was in 1 m rows, 45 cm apart, with 10 cm interplant spacing within the rows.

When the plants were about 10 cm tall, the soil between the rows and, as far as possible, between the plants, was covered with polythene sheet to exclude rain water (Fig. 1). The soil moisture level was controlled with tensiometers.

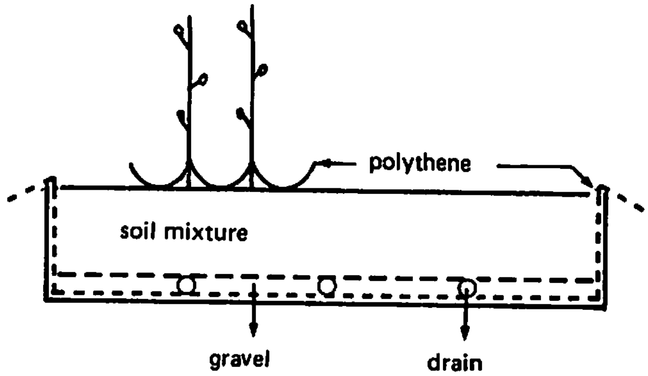


Fig. 1. Transverse section of the pit.

One of the pits was kept under a non-stressed water regime throughout the growing season. During the extreme drought period, water was applied three times through the drain pipes. The second pit was kept dry during the whole season. Both pits received sufficient water after planting to insure good emergence and growth during the first three weeks.

At harvest the seed yield, 1000 seed weight, and the harvest index were measured.

Results

Data in Table 1 show the large variability in yield loss due to drought stress. Lines 4, 5, 6, 12, 19, and 21 show less than 30% yield loss. Lines 5 and 21 also have fairly high yields under normal conditions, and could therefore be used as parental lines in breeding for drought tolerance.

Harvest index was found to be negatively correlated with the percentage loss in yield (Table 2).

Lines/cultivars which are late ripening were more affected by drought (Table 1, Fig. 2). As can be seen from Figure 2, the early inbred line has the lowest yield under normal conditions (A+B), but also the lowest loss of yield due to drought stress (A). The late cultivar, Colomba, has an intermediate yield under normal conditions but shows the greatest loss. The medium-early cultivar, Alfred, has both the highest yield under favorable conditions and under stressed conditions.

Conclusions

It is difficult to establish, under more-or-less practical circumstances, the influence of drought on yield. It is clear that there are great differences in drought tolerance even among this limited number of lines and cultivars. Thus there is genetic variability for drought tolerance available to the plant breeder.

A dry period during the pod-setting and pod-filling phases has a great effect on the yield of faba beans. An early dry period can affect the development of the flowers. Far more detailed work still needs to be done to more fully understand the influence of drought stress on the yield of faba beans.

Table 1. Yield (stressed and non-stressed) per meter row, yield loss due to drought stress (%), harvest index (HI), and earliness, for 35 cultivars and lines at Wageningen, 1983.

Entry no.	Yield (g) non-stress	Yield (g) stress	Yield loss (%)	HI	Earliness
1	1493	800	46	64	6
2	1769	670	62	52	6
3	1981	833	58	59	8
4	1130	833	26	62	8
5	1382	1132	18	67	8
6	904	667	26	60	8
7	801	533	33	63	6
8	1659	1131	32	61	6
9	1636	957	42	57	6
10	1980	1101	44	64	8
11	1447	945	35	63	8
12	1097	918	16	64	8
13	1869	1160	38	60	6
14	1989	934	53	58	8
15	1932	824	57	58	6
16	1881	879	56	58	8
17	2174	1092	59	58	4
18	1661	896	46	63	8
19	1294	951	27	68	8
20	1260	737	42	64	8
21	1322	1003	24	68	8
22	1681	1092	35	60	8
23	1911	844	56	58	2
24	2319	896	61	54	4
25	1742	946	46	59	4
26	2287	826	64	58	4
27	1905	813	57	60	4
28	1604	667	58	60	4
29	2042	927	55	54	4
30	1577	683	57	56	4
31	1268	688	46	52	4
32	1412	554	61	54	2
33	2031	575	72	59	4
34	1726	299	83	52	2
35	1705	310	82	52	2

Earliness on a scale of 1-9; 9= earliest, 1= latest. Yield is the average of three replications.

Table 2. Correlation matrix.

	Yield (g) non-stress	Yield (g) stress	Yield loss (%)	HI (%)
Yield (g) stressed	0.208	1.000		
Yield loss (%)	0.627	−0.611	1.000	
HI (%)	−0.414	0.509	−0.753	1.000
Earliness	0.344	−0.527	0.713	0.694

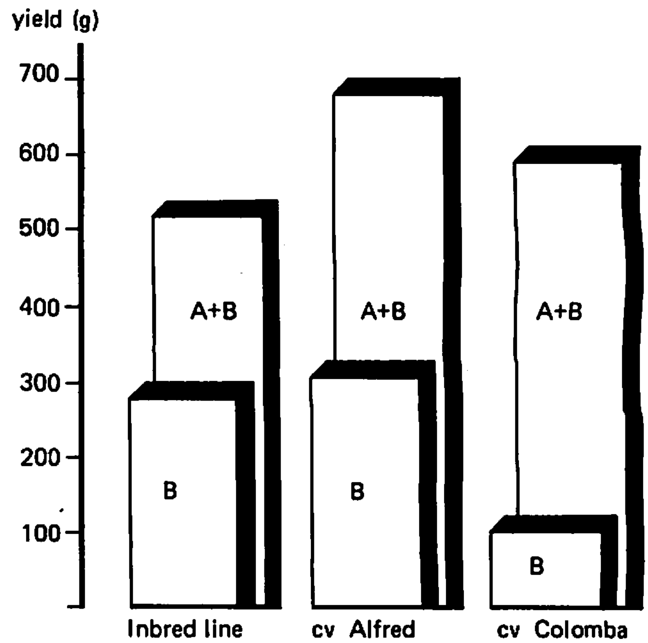


Fig. 2. Yield (unstressed = A + B, stressed = B) as affected by earliness for three faba bean lines.
1 = Inbred line from Minica; early (7).
2 = cv Alfred; medium-early (6).
3 = cv Columba; late (3).

Seed Quality and Nutrition

Effects of vicine and convicine on human erythrocytes deficient in glucose-6-phosphate dehydrogenase

Semra Sardas and Nevin Vural
Department of Toxicology, Faculty of Pharmacy, Gazi University, Ankara, TURKEY

Introduction

Favism is an acute hemolytic anemia disease occurring in susceptible individuals after eating faba beans. It is characterized by rapid development of anemia, accompanied by jaundice and hemoglobinemia. The disease is usually associated with metabolic abnormalities in the erythrocyte, e.g., defects in glucose-6-phosphate dehydrogenase (G-6-PD) and instability of glutathione (Kattamis *et al.* 1969). These abnormalities are not the only factors causing favism, and are not characteristic of that disease alone, since they occur in other forms of drug-induced hemolytic anemia. The incidence of the enzymatic defect varies widely between racial groups, and is particularly high in the Mediterranean peoples, notably Greeks, Sicilians, and Arabs. A nationwide survey of the incidence of G-6-PD deficiency in Turkey has been reported (Say *et al.* 1965). Faba beans are cultivated and eaten a lot in Turkey and have become a valuable food item in view of its substantial and fairly balanced protein content. The defects are genetically transmitted, and are probably sex linked, in that the gene responsible is located on the X-chromosome (Wintrobe 1967).

It has been suggested that the pyrimidine derivatives, isouramil (2, 4, 5 trihydroxy-6-amino pyrimidine) and divicine (2, 6-diamino 4, 5 dihydroxy pyrimidine), occurring in faba beans as the aglycone moieties of their corresponding -glycosides (vicine and convicine, respectively), or the glycosides themselves may be responsible for the induction of favism (Mager *et al.* 1965).

In this study we isolated vicine and convicine from faba beans, and tested their oxidizing capacities on reduced glutathione (GSH) in human red blood corpuscles.

Materials and Methods

Fresh and dry samples of the faba bean cultivar Midas were obtained from the Mediterranean Institute of Agricultural Research, Antalya, Turkey. Vicine was isolated according to the methods of Lin *et al.* (1962). The yield of vicine was 1 g/kg of fresh beans.

For convicine, ground fresh beans were soaked in 95% ethanol at room temperature for three days. Convicine was extracted from the alcohol with ether, and concentrated under vacuum at 40°C. The solution was then placed in the refrigerator, and the convicine crystalized out of solution. Yield of convicine was 0.6 g/kg of fresh beans.

Physical and chemical properties (microscopic observations, melting point, solubility, chromatographic characteristics, UV, IR and NMR spectra, and elementary analysis) were determined (Vural and Sardas 1983).

Blood specimens were obtained from known favism susceptible subjects with the help of the Hematology Research Laboratories of the Hacettepe Children's Hospital. Blood samples were collected in acid-citrate-dextrose (ACD) solution, in which enzyme activities do not change for several days (Dacie and Lewis 1970). The samples were refrigerated promptly. The erythrocytes were tested for a deficiency in reduced glutathione (GSH), and abnormal glutathione stability. These tests were conducted according to the methods of Beutler *et al.* (1963). Glucose-6-phosphate dehydrogenase was determined by the specific procedures of Beutler (1968). Biochemical reagents used were obtained from Sigma or Merck.

Solutions of vicine and convicine in phosphate buffered physiological saline were prepared and incubated with erythrocytes from 10 sensitive and 10 non-sensitive subjects.

Results and Discussion

In non-susceptible subjects, blood GSH levels were reduced by 33 and 19% by vicine and convicine, respectively. In susceptible subjects, the respective reductions were 99 and 81% (Table 1). It should also be noted that the initial levels of GSH were much lower in the susceptible than in the non-susceptible group. Even after incubation, the levels of GSH in the non-susceptible group were still higher than the pre-incubation level of the susceptible subjects.

These results confirm the findings of Mager *et al.* (1965). The overall pattern of metabolic disturbance resulting from the incubation of red blood corpuscles deficient in G-6-PD with vicine and convicine is essentially similar to that caused by treatment with acetylphenylhydrazine (APH). The powerful capacity for oxidizing GSH exhibited by vicine and convicine *in vitro* is consistent with a possible causative role for these two compounds in the development of favism.

Table 1. Effects of vicine and convicine on GSH levels in blood from susceptible and non-susceptible individuals.

Group	Sample size	Treatment	Mean GSH*	
			before incubation	after incubation
Non-susceptible	10	vicine	81.250 ± 24.848	54.310 ± 23.248
Non-susceptible	10	convicine	81.250 ± 24.848	65.930 ± 25.481
Susceptible	10	vicine	46.970 ± 21.858	2.090 ± 3.497
Susceptible	10	convicine	46.970 ± 21.858	8.730 ± 4.819

GSH in mg/100 ml red blood corpuscles ± standard deviation.

References

Beutler, E.A. 1968. Series of new screening procedures for G-6-PD deficiency and glutathione reductase deficiency. Blood 32:816.

Beutler, E.A., Duron, O., Kelly, B.M. 1963. Improved method for determination of blood glutathione. Journal of Laboratory and Clinical Medicine 61:882.

Dacie, J.V., and Lewis, S.M. 1970. Practical Haematology. 4th edition. J.A. Churchill, London.

Kattamis, C.A., Kyriazakov, M., and Chaidas, S. 1969. Favism. Journal of Medical Genetics 6(1): 34-41.

Lin, J.Y., Ling, K.H. 1962. Isolation of an active principle from faba beans (*Vicia faba*). Journal of the Formosan Medical Association 61: 484.

Mager, J., Glaser, G., Razin, A., Izac, G., Bien, S., and Noam, M. 1965. Metabolic effects of pyrimidines derived from faba bean glycosides on human erythrocytes deficient in G-6-PD. Biochemical and Biophysical Research Communications 20:235.

Vural, N., and Sardas, S. 1983. Biological activities of broad bean (*Vicia faba*) extracts grown in South Anatolia in favism sensitive subjects and detection of the causative toxins. (in press).

Wintrobe, M.M. 1967. Clinical hematology. 6th edition. Lea and Febiger, Philadelphia.

Liver protein synthesis in male rats fed a faba bean (*Vicia faba* L.) diet

Mercedes Goena, Santiago Santidrian, Fernando Cuevillas and Jesus Larralde
Department of Physiology, Division of Nutrition, University of Navarra, Pamplona, SPAIN

Faba bean (*Vicia faba* L.) is extensively cultivated throughout the Mediterranean region, including Spain. Its relatively high protein content makes this legume nutritionally important both for humans and domestic animals.

However, despite the importance of the nutritional value of faba bean, there is still little published information on its effects on protein metabolism. Results from our laboratory (Cenarruzabeitia *et al.* 1979, Santidrian 1981, Santidrian *et al.* 1981, Sobrini *et al.*, 1982) have shown that feeding growing animals on diets containing raw faba beans as the main source of protein brings about a significant reduction in the rate of growth, negative nitrogen balances, changes in the composition of the skeletal musculature, inhibition of intestinal absorption of sugars and amino acids, and other effects. Similar results have been reported by other investigators (Jaffe and Vega 1968, Marquardt *et al.* 1975, 1977, Jamalian *et al.* 1977, Liener 1980).

Previously reported data from this Department (Cenarruzabeitia *et al.* 1979) showed that feeding growing rats and chickens on a faba bean diet for experimental periods of two weeks or longer caused a reduction in liver protein. This was accompanied by increases in the activities of several enzymes related to the catabolism of amino acids, such as arginase, alanine aminotransferase, argininosuccinate synthetase, and guanidinoacetate methyltransferase. This paper reports on the effects on the rate of liver protein synthesis of feeding rats on diets containing raw faba bean as the only protein source.

Materials and Methods

Fourteen Wistar male rats, weighing about 80-90 g, were randomly divided in two groups of seven animals each and housed in metabolic cages. One group was fed a control casein diet. The second group was fed a diet containing raw faba bean as the only source of protein. Both diets were isocaloric and contained about 20% protein (Nx6.25). The food intake of the legume-fed rats was matched to that of the casein-fed group. Compositions of the diets are given in Table 1. The experiment lasted for 10 days. Body weight changes and food intake were monitored daily.

Table 1. Diet compositionss (g/100 g diet).

Components	Diets	
	Control	*Vicia faba*
Casein	23.0	–
Vicia faba	–	79.7
Olive oil	5.0	3.6
Mineral mixture[1]	4.4	2.6
Vitamin mixture[2]	1.7	1.7
Cellulose	5.0	–
Sucrose	32.0	6.2
Starch	32.0	6.2
Total protein (N x 6.25)	20.0	20.0

[1] The mineral mixture contained (%): NaCl, 13.93; KI, 0.079; KH_2PO_4, 38.91; $MgSO_4 7H_2O$, 5.73; $CaCO_3$, 38.14; $FeSO_4 7H_2O$, 2.7; $MnSO_4 H_2O$, 0.4; $ZnSO_4 7H_2O$, 0.055; $CuSO_4 5H_2O$, 0.048; $CoCl_2 6H_2O$, 0.002.

[2] The vitamin mixture contained (mg/g): vitamin K_1, 0.15; choline, 200; niacin, 4; calcium pantothenate, 4; riboflavin, 0.8; thiamin hydrochloride, 0.5; folic acid, 0.2; biotin, 0.04; and (in IU): vitamin A, 2,000; vitamin D, 200; vitamin E, 10.

On the last day of the experiment, the rats were fasted overnight, and the rates of liver protein synthesis were measured following the methodology of Garlick and Marshall (1972). Briefly, U-(^{14}C)-tyrosine was infused through the tail vein of the rats for 6 h. At the end of the infusion, rats were killed by decapitation and the livers were rapidly removed and weighed. Liver protein was determined according to the method of Lowry *et al.* (1951). To determine the fractional synthetic rate of liver protein, a piece of liver was homogenized in trichloroacetic acid; the radiospecific activity of the tyrosine, which had previously been converted into tyramine by the enzyme L-tyramine decarboxylase (Sigma Chemical Co., St. Louis, Mo., USA) was determined in both the precipitate (i.e., bound to liver protein, S_B) and in the supernatant (i.e., free in the intracellular pool, S_i), and the fractional synthetic rate of liver protein, k_s (i.e., the percentage of protein that is synthesized in 24 h) calculated. Statistical analysis was carried out by the Student's t-test.

Results

The results are summarized in Table 2. A significant reduction ($P < 0.01$) in the rate of growth, and a significant increase ($P < 0.05$) in liver S_B/S_i ratio, and therefore in liver protein synthesis, was found in faba bean-fed animals, as compared to the control group. No significant differences were found in either food intake or liver weight. A slight reduction, though not significant, in liver protein content was displayed by the legume-fed rats, as compared to the control animals.

Table 2. Body weight gain, food intake, liver weight, liver protein, S_B/S_i ratio and k_s in liver of male rats (80 g initial weight) fed for 10 days on diets containing either casein (control) or raw faba bean. Entries are mean values (± SEM) of seven rats in each group.

Determinations	Groups[1]	
	Control	*Vicia faba*
Body weight gain (g/day)	7.5 ± 0.5	4.5 ± 0.4*
Food intake (g/100 g body weight)	12.0 ± 0.5	11.8 ± 0.6
Liver weight (g/100 g body weight)	3.8 ± 0.2	3.6 ± 0.2
Liver protein (g/100 g of liver weight)	17.8 ± 0.8	16.0 ± 0.8
S_B/S_i (x 10^3)[a]	122 ± 11	145 ± 10*
k_s[a]	53.4 ± 0.1	64.2 ± 0.1*

[1] Legume-fed rats were pair-fed to the food intake of casein-fed rats.

[a] According to Garlick and Marshall (1972).

* Significant difference at the 5% level (Student's *t*-test) as compared to the control.

Discussion

Two points must be considered when interpreting these results. Firstly, the increase in liver protein synthesis may be related to the increase in the activity of a number of hepatic amino acid-degrading enzymes, as has been found earlier (Cenarruzabeitia *et al.* 1979, Santidrian *et al.* 1981). Secondly, it is well known that protein synthesis or breakdown in the liver is the cause, rather than the effect, of increased hepatic uptake or output of amino acids from non-hepatic tissues. In a recent paper (Goena *et al.* 1983), we have shown that muscle protein synthesis remained significantly reduced in young rats fed a raw faba bean diet, and therefore it is possible that as a consequence, a flux of amino acids coming from the skeletal musculature may go to the liver, and consequently increase the rate of liver protein synthesis.

In any case, the intrinsic mechanism by which the raw faba bean produces all these effects remains unclear. It is possible that both sulfur amino acid deficiency, characteristic of legume proteins (Bello *et al.* 1972, Boulter *et al.* 1976), and the action of the antinutritive factors contained in raw legume seeds (Liener 1980) may account for the effects reported in this paper.

References

Bello, J., Cenarruzabeitia, M.N. and Larralde, J. 1972. Antinutritive substances contained in seeds of field bean (*Vicia faba*). 3. Changes in the sarcoplasmic and myofibrillar fractions of muscle proteins in growing rats. Revue de Nutrition Animal 10: 225-236.

Boulter, D., Evans, I.M. and Thompson, A. 1976. Screening for protein quality in legumes. Qualitas Plantarum 26: 107-119.

Cenarruzabeitia, M.N., Santidrian, S., Bello, J. and Larralde, J. 1979. Effect of raw field bean (*Vicia faba* L.) on the amino-acid-degrading enzymes in rats and chickens. Nutritional Metabolism 23:203-210.

Garlick, P.J. and Marshall, I. 1972. A technique for measuring brain protein synthesis. Journal of Neurochemistry 19: 577-583.

Goena, M., Santidrian, S., Cuevillas, F. and Larralde, J. 1983. Rate of muscle protein synthesis in field bean (*Vicia faba* L.) fed growing rats. Revista Espanola de Fisiologia (in press).

Jaffe, W.G. and Vega, C.L. 1968. Heat-labile growth inhibiting factors in beans (*Phaseolus vulgaris*). Journal of Nutrition 94:203-210.

Jamalian, J., Aylward, F. and Hudson, B.J.F. 1977. Favism-inducing toxins in broad beans (*Vicia faba*): estimation of the vicine contents of broad bean and other legume samples. Qualitas Plantarum 27:207-211.

Liener, I.E. 1980. In: Toxic Constituents of Plant Foodstuffs (Liener, I.E., ed.). Academic Press. New York, USA.

Lowry, O.H., Rosebrough, F.L. and Randall, R.J. 1951. Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry 193:265-275.

Marquardt, R.R., McKirdy, J.A., Ward, T. and Campbell, L.D. 1975. Amino acid, hemagglutinin and trypsin inhibitor levels, and proximate analyses of faba beans (*Vicia faba*) and faba bean fractions. Canadian Journal of Animal Science 55:421-429.

Marquardt, R.R., Ward, T., Campbell, L.D. and Cansfield, P.E. 1977. Purification, identification and characterization of a growth inhibitor in faba beans. Journal of Nutrition 107: 1313-1324.

Santidrian, S. 1981. Intestinal absorption of D-glucose, D-galactose and L-leucine in male growing rats fed a raw field bean (*Vicia faba* L.) diet. Journal of Animal Science 53: 414-419.

Santidrian, S., Sobrini, F.J., Bello, J. and Larralde, J. 1981. Guanidinoacetate methyltransferase activity in growing male rats fed on a raw field bean (*Vicia faba* L.) diet. Enzyme 26: 103-106.

Sobrini, F.J., Santidrian, S. and Larralde, J. 1982. Nutritive value and effect of tannin content of *Vicia faba equina* and *minor* seeds on the rate of growth in growing rats. FABIS 5: 32-35.

Faba beans as a potential protein rich feedstuff for poultry

Ronald R. Marquardt
Department of Animal Science, University of Manitoba Winnipeg, R3T 2N2, CANADA

Protein feedstuffs continue to be in short supply on a world scale. The relatively high yield potential of faba beans, its high content of protein and its wide adaptability to different climatic zones would suggest that it should not only be considered as a food for humans but as a feedstuff for livestock. During the past several years considerable research has been carried out on factors affecting faba bean utilization by poultry. Some of this information is discussed in this presentation.

Composition and general nutritive value

Improved varieties of faba beans contain about 24-28% protein (Table 1), although the composition varies with type, variety, and growing conditions.

A common feed replacement scheme involves two units of faba beans replacing one unit of soybean meal (44% protein) plus one unit of barley. The basis for this scheme can be seen in Table 1, the soy/barley mixture being similar to faba beans in nutrient content.

Table 1. Average percent composition and nutritive value of faba beans in comparison with soybean meal and barley, air-dry basis.

	Canadian faba beans[1]	UK faba beans[2]	Soybean meal[2]	Barley[2]
Moisture	13	13	11	11
Protein (Nx6.25)	27.7	24	44	11.3
Ether extract (fat)	0.8	1.2	0.9	1.9
Fiber	7.4	6.7	7.0	5.0
Available carbohydrate		39.5	12.6	54.6
ME poultry, kcal/kg		2, 300	2,220	2,660
ME swine, kcal/kg		3, 080	3,375	2,915
Essential amino acids				
Arginine	2.77	2.04	3.76	0.68
Glycine	1.25	1.08	1.94	0.48
Histidine	0.77	0.55	1.16	0.24
Isoleucine	1.25	0.98	2.02	0.42
Leucine	2.13	1.83	3.61	0.78
Lysine	1.94	1.52	2.90	0.46
Methionine and cystine	0.47	0.28	1.34	0.42
Phenylalanine and tyrosine	2.13	1.93	2.16	0.44
Threonine	1.02	0.95	1.89	0.42
Tryptophan	——	0.23	0.51	0.15
Valine	1.44	1.13	2.1	0.56
Minerals				
Calcium	0.09	0.11	0.22	0.04
Phosphorus (available)	——	0.15	0.3	0.2
Fatty acids				
Linoleic	——	0.65	0.4	0.9

[1] Campbell and Marquardt (1977).
[2] Blair (1977).

Faba bean protein is relatively high in lysine, low in *methionine* and reasonably well balanced with regards to the other amino acids (Table 1 and NRC 1977). The true digestibility of faba bean protein has been reported to be 83% (Waring 1969), with individual values ranging from a high of 92% for arginine to a low of 70% for the sulfur amino acids. The fat content of faba beans is only 0.8 to 1.2% , while the fiber content is approximately 7%, which partly accounts for its low energy value. Edwards and Duthie (1971) reported mean ME and MEn (metabolizable energy, nitrogen corrected) values (90% DM) of 11 samples of beans to be 2.40 and 2.26 kcal/g, respectively, when beans were given to 3- to 4-week-old chicks. Corresponding values for Canadian grown faba beans (Shannon and Clandinin 1977) were 2.57 and 2.20 kcal/g at 90% dry matter. Waring and Shannon (1969) reported average ME values of two cultivars of faba beans when fed to colostomized hens to be 2.43 kcal/g.

The carbohydrates were investigated by Pritchard *et al.* (1973), who reported that the various fractions contained in winter and spring beans were, respectively: an available carbohydrate fraction (dextrin, starches and ethanol soluble sugars) 46 to 48% and 30 to 42% ; and a lignin, cellulose, hemicellulose and water-soluble polysaccharide fraction, 19 to 20% and 22 to 37%.

The composition of milled fractions of beans is shown in Table 2. The seed coat or testa accounts for about 12% of the weight and contains approximately 84% of the fiber. More than 97% of the fat and protein are contained in the dehulled kernel. Separation of the bean into these two fractions would provide a practical way in which the crop could be upgraded. This would have the further advantage of removing most or all of the condensed tannins.

Table 2. Composition (%) of milled fractions of faba beans (dry matter basis).

	Whole seed	Testa (12% of seed)	Cotyledon (88% of seed)
Protein	31.8	5.9	36.3
Ether extract	0.9	0.3	1.1
Fiber	8.5	53.5	1.4
Calcium	0.11	0.38	0.05
Phosphorus	0.57	0.08	0.64
ME, poultry (kcal/kg)*	2,300(2,729)	500	3033

* Values on an air-dry basis. Numbers in brackets represent value calculated from testa and cotyledon values. ME values are from Blair (1977). Other values are from Marquardt *et al.* (1975).

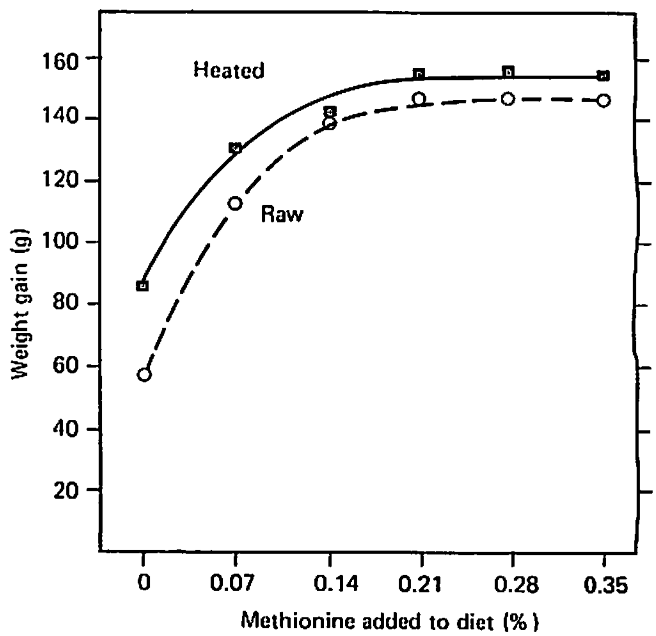
Influence of sulfur amino acid supplementation

Results in Figure 1 demonstrate that Leghorn chick growth is poor when they are fed diets that contain faba beans as the principal source of protein. The addition, however, of relatively low levels of methionine (0.21%) to the diet dramatically improved growth rates (110%). Feed intake increased by 33% and feed: gain ratio by 38%.

Autoclaved (heated), as compared with raw faba bean diets, also improved weight gains (10%) and feed : gain ratios (10%), with autoclaving being most effective when the levels of sulfur amino acids were most limiting. Similar results were also obtained with broiler chicks (Marquardt and Campbell 1975). In this study it was observed that methionine supplementation (0.24%) of a diet containing faba beans as the sole source of protein improved growth rate by 370% . In contrast, an equivalent addition of sulfur as K_2SO_4 resulted in only a slight improvement in chick performance.

The results of these studies and those by Wilson and McNab (1972) clearly demonstrate the necessity of adding methionine, which is relatively inexpensive, to diets that contain a high proportion of their total dietary protein in the form of faba bean protein. The amount of methionine required to achieve optimal performance under practical conditions would vary considerably depending on the nature of other dietary ingredients. The use of feedstuffs such as fishmeal, and to a lesser degree cereals, would provide a source of methionine that would tend to complement that in faba beans.

Fig. 1. Growth response of chicks fed a basal diet containing faba beans as the major source of protein and varying levels (%) of methionine (Marquardt and Campbell 1974).



Influence of processing on the nutritive value of faba beans

Processed faba beans have been shown by several researchers to be nutritionally superior to raw faba beans. Campbell and Marquardt (1977) carried out a series of four experiments with young broiler chicks to determine the influence on growth performance of feeding diets containing various levels of raw or autoclaved (121°C for 20 minutes) faba beans. Chicks responded to increasing levels of raw faba beans in the diet by a marked increase in feed consumption, but this increase in consumption was not sufficient to maintain a constant body weight. Autoclaving markedly altered this response which also indicated that a heat labile antinutritional factor present in faba beans was largely responsible for the less than optimal performance by broiler chicks fed diets containing faba bean. A summary of results from one trial illustrates the magnitude of these effects (Table 3). Subsequent studies (Ward *et al.* 1977) established that faba bean hulls had a much higher concentration of a growth inhibitory substance than the cotyledon portion of the bean. This is demonstrated by the fact that heat treatment of dehulled beans increased weight gain and feed efficiency by 8%, whereas the corresponding increases were 31 and 25%, respectively, when whole beans were heat treated.

Table 3. Influence of different dietary levels of heated and raw faba beans on broiler chick performance[1].

Faba bean level (%)	Feed intake Raw	Feed intake Heated[2]	Weight gain Raw	Weight gain Heated[2]	Feed efficiency Raw	Feed efficiency Heated[2]
0	100(1,014)		100(672)		100(0.66)	
28	104	102	98	100	93	97
56	112	107	96	100	85	93
84	113	109	92	96	81	88

[1] Values represent a percent of those fed the control diet (zero faba beans). Values in brackets represent feed intake (g/bird), weight gain (g/bird) and feed efficiency (g gain/g feed).

[2] Heat treated faba beans were autoclaved at 121°C for 20 minutes. Data from Campbell and Marquardt (1977).

These results are consistent with studies by other researchers. Edwards and Duthie (1971) found that autoclaving faba beans for 30 minutes at 108°C improved classical ME values from 2350 to 2440 kcal/kg; a 12% increase. Shannon and Clandinin (1977) reported increases in MEn content of 15% when faba beans were autoclaved for 45 and 60 minutes, while McNab and Wilson (1974) obtained increases of 10% in ME of faba beans subjected to infrared radiation. The findings of these groups are in fairly close agreement and demonstrate that a significant improvement in available energy content can be obtained by heat treating faba beans.

Edwards and Duthie (1973) further found that the MEn value of a sample of hulled beans was 2280 kcal/kg, while the cotyledons had values of 3033 kcal/kg. The increase in metabolizable energy obtained, about 30%, was more than expected. Apart from the large increase in metabolizable energy obtained by removing the indigestible seed coat (approximately 12 to 14% of the seed), the results would indicate that some seed coat factor may limit energy utilization. As discussed subsequently, this factor is probably condensed tannins. Heat treatment of the dehulled beans (cotyledons) in a commercial maize flaking plant further improved ME values from 3070 to 3330 kcal/kg, an increase of 10%.

In addition to improving ME values of faba beans, heat treatment also improves the retention of other nutrients. Marquardt and Ward (1979) reported that the retention of dry matter, amino acids, and ether extract were increased by 32, 17, and 5% , respectively, when tannin-containing cultivars were heat treated. These results demonstrate that heat treatment of faba beans improves its nutritional value by improving the availability or digestibility of several nutrients including carbohydrates and proteins. This effect is mainly associated with the destruction of a thermolabile factor present in the hull (testa) of the bean.

Influence of condensed tannins on the nutritive value of faba beans

Studies by Marquardt *et al.* (1977) and Martin-Tanguy *et al.* (1977) have shown that the thermolabile growth depressing factor present in the testae of faba beans was a condensed tannin (condensed proanthrocyanidins). Feeding trial studies have demonstrated that purified condensed tannins from faba beans when incorporated into a chick diet markedly reduced feed intake, weight gains, efficiency of feed utilization, and dry matter and amino acid retention (Marquardt *et al.* 1977, Marquardt and Ward 1979). These results are similar to those observed when faba bean testae were added to chick diets (Ward *et al.* 1977).

Several studies have compared results obtained with tannin-free and tannin-containing cultivars of faba beans. The testae of tannin-free cultivars also have a much lower concentration of lignin than tannin-containing cultivars (Marquardt *et al.* 1978). Nutritional studies have demonstrated that weight gains, efficiency of feed utilization, and the retention of dry matter and amino acids were improved by 8, 9, 13 and 14% , respectively, when tannin-free cultivars replaced tannin-containing cultivars of faba beans in chick diets. The results also demonstrated that the retention of all amino acids was lower in tannin-containing cultivars of faba beans. Heat treatment of tannin-free cultivars improved dry matter and amino acid retention by 13 and 8% , respectively, whereas the corresponding improvement with tannin-containing cultivars was considerably higher, being 23 and 14%. A combination of both heat treatment and the use of tannin-free cultivars improved dry matter and amino acid retention by 39 and

24% , respectively. These results clearly demonstrate that the nutritional value of faba beans can be considerably improved by both heat treatment and the use of tannin-free cultivars of faba beans. The results would also suggest that approximately one-half of the total response to heat treatment is associated with the destruction of condensed tannins.

Laying hens

Wilson and Teague (1974) found that 20% faba bean in laying hen diets had no effects on egg production or feed consumption, but resulted in a significant decrease in egg size. In contrast, Davidson (1973) found that the productive performance of laying hens was reduced when faba beans were fed at levels higher than 15%; the depression in performance was only partially corrected by supplementing the diets with methionine. Studies by Robblee *et al.* (1977) demonstrated that egg weight declined whereas Haugh unit values increased as the level of faba beans in diets increased. It was also observed that when the faba bean content in the diet exceeded 30% there was decreased egg production and feed conversion efficiency. More recent studies by Campbell *et al.* (1980) reported that when diets adequately supplemented with methionine were used, egg production rates of hens fed faba beans were similar to those of controls, except for high dietary levels of faba beans (in excess of 25%) where a depression was indicated. Mortality rates were not influenced by faba beans in the diet. Hens fed faba beans consistently laid smaller eggs than the controls and the extent of egg size depression was related to the level of faba beans in the diet. The egg-size depressing effect of faba beans was not related to dietary levels of protein or energy and was not influenced by heat treatment of faba beans or removal of hulls from the faba beans. These studies demonstrated that faba beans can be effectively used as a protein source in the diet of laying hens up to a level of 20 to 30% but that the effect on egg size should be considered when the choice to use faba beans is made.

Limitations on energy and protein availabilities however, would be the same as for the broiler type chick. Condensed tannins would be a factor that would reduce these values which could be partially overcome as described above. In addition we have demonstrated that faba beans also cause other adverse effects in the laying hen and that these effects are attributable to two thermostable compounds (vicine and convicine) which are present in the cotyledon portion of the bean (Olaboro *et al.* 1981a, b). Muduuli *et al.* (1981, 1982) have demonstrated that vicine and convicine when incorporated into the diet of the laying hen depressed egg and yolk weight, reduced the number of developing ova, and the fertility and hatchability of eggs. Yolks from vicine-fed birds were more fragile and had an increased incidence of blood spots. Vicine consumption also elevated plasma lipid and lipid peroxide levels, increased erythrocyte hemolyses, and depressed the ratio of plasma vitamin E: lipid. Vitamin E supplementation of the diet markedly improved fertility and hatchability of eggs but did not affect the other factors examined. Chicks fed on diets that contained vicine had similar growth rates but slightly higher levels of spontaneous hemolysis of erythrocytes than birds fed a control diet.

It may be concluded that vicine which was isolated from faba beans has a marked influence on the metabolism of the laying hen and only a slight effect on the growing chick. Vicine or its metabolites probably causes peroxidation of cellular components, which interferes with normal lipid transport or synthesis, or both, increases fragility of erythrocytes and yolk, and reduces fertility. These effects are overcome to varying extents by supplemental vitamin E.

References

Blair, R. 1977. Feedingstuffs 49(29): 15-16.

Campbell, L.D. and Marquardt, R.R. 1977. Poultry Science 56: 442-448.

Campbell, L.D., Olaboro, G., Marquardt, R.R. and Waddell, D. 1980. Canadian Journal of Animal Science 60: 395-405.

Davidson, J. 1973. British Poultry Science 14:557-567.

Edwards, D.G. and Duthie, I.F. 1971. Journal of Agricultural Science, UK 76: 257-259.

Edwards, D.G. and Duthie, I.F. 1973. Journal of the Science of Food and Agriculture 24: 496-497.

Marquardt, R.R. and Campbell, L.D. 1974. Canadian Journal of Animal Science 54: 437-442.

Marquardt, R.R. and Campbell, L.D. 1975. Canadian Journal of Animal Science 55: 213-218.

Marquardt, R.R., McKirdy, J.A., Ward, T. and Campbell L.D. 1975. Canadian Journal of Animal Science 55: 421-429.

Marquardt, R.R., McKirdy, J.A. and Ward, A.T. 1978. Canadian Journal of Animal Science 58:775-781.

Marquardt, R.R. and Ward, A.T. 1979. Canadian Journal of Animal Science 59: 781-789.

Marquardt, R.R., Ward, A.T., Campbell, L.D. and Cansfield, P.E. 1977. Journal of Nutrition 107: 1313-1323.

Martin-Tanguy, J., Guillaume, J. and Kossa, A. 1977. Journal of the Science of Food and Agriculture 28: 757-765.

McNab, J.M. and Wilson, B.J. 1974. Journal of the Science of Food and Agriculture 25: 395-400.

Muduuli, D.S., Marquardt, R.R. and Guenter, W. 1981. British Journal of Nutrition 47: 53-59.

Muduuli, D.S., Marquardt, R.R. and Guenter, W. 1982. Canadian Journal of Animal Science 61: 757-764.

National Research Council 1977. Nutrient Requirements of Poultry. No.1. 7th rev. ed. National Academy of Science, Washington, D.C.

Olaboro, G., Marquardt, R.R. and Campbell, L.D. 1981a. Journal of the Science of Food and Agriculture 32: 1074-1080.

Olaboro, G., Marquardt, R.R., Campbell, L.D. and Frohlich A.A. 1981b. Journal of the Science of Food and Agriculture 32: 1163-1171.

Pritchard, P.J., Dryburgh, E.A. and Wilson, B.J. 1973. Journal of the Science of Food and Agriculture 24: 663-668.

Robblee, A.R., Clandinin, D.R., Hardin, R.T., Milne, G.R. and Darlington, K. 1977. Canadian Journal of Animal Science 57: 421-425.

Shannon, D.W.F. and Clandinin, D.R. 1977. Canadian Journal of Animal Science 57: 499-507.

Ward, A.T., Marquardt, R.R. and Campbell, L.D. 1977. Journal of Nutrition 107: 1325-1334.

Waring, J.J. 1969. British Poultry Science 10: 155-163.

Waring, J.J. and Shannon, D.W.F. 1969. British Poultry Science 10:331-336.

Wilson, B.J., and McNab, J.M. 1972. British Poultry Science 13: 67-73.

Wilson, B.J. and Teague, P.W. 1974. Journal of Agricultural Science 83: 231-235.

Chick performance as affected by autoclave treatment of tannin-containing and tannin-free faba beans

Ronald R. Marquardt and A. Thomas Ward
Department of Animal Science, University of Manitoba Winnipeg, R3T 2N2, CANADA

Introduction

Previous studies in our laboratory have shown that processing improved the utilization of faba beans by chicks through its effects on components associated with both the testa and a protein fraction prepared from the cotyledon (Ward *et al.* 1977). A subsequent study demonstrated that the active component in the testa was a condensed tannin, condensed proanthrocyanidin (Marquardt *et al.* 1977). Condensed tannins were shown to reduce chick growth rate, efficency of feed utilization, and retention of certain nutrients, particularly amino acids. Martin-Tanguy *et al.* (1977), using different methods, also came to similar conclusions.

Picard (1975) and Bond (1976) reported that the whole grain of white-flowered faba beans were tannin-free. Bond (1976) and Marquardt *et al.* (1978) demonstrated that the *in vitro* digestibility of the testae of tannin-free cultivars was considerably greater than those from tannin-containing cultivars. Marquardt *et al.* (1978) showed that the testae of the tannin-free cultivars had a lower concentration of lignin and a corresponding higher concentration of cellulose than the tannin-containing cultivars. Tannin-free cultivars also tended to have a smaller portion of their total weight as testae as compared to tannin-containing cultivars. One of the objectives of this study was to establish the relative effects on the nutritive value of faba beans of condensed tannins and other factors. A comparison of the performance of chicks fed raw or autoclaved (heat-treated) faba beans which were either tannin-free or tannin-containing provided the basis for establishing these effects. A second objective was to establish the influence of increasing levels of dietary condensed tannins isolated from faba beans on chick performance.

Materials and Methods

The materials, methods, and details of the experiments were as described by Marquardt and Ward (1979). In experiment 1 the influence of autoclave treatment of three cultivars of tannin-free, and two cultivars of tannin-containing faba beans was studied in a 2 (raw vs autoclaved) x 2(tannin-free vs tannin-containing) factorial experiment. Experiment 2 was designed to compare nutrient utilization in chicks fed dehulled faba beans which contained five levels of condensed tannins.

Results and Discussion

A summary of results for experiment 1 are given in Table 1. The average weight gain and feed: gain ratios were improved 29% and 18% , respectively, when faba beans were heat-treated, or 9% and 8% , respectively, when birds were fed the tannin-free cultivars, as compared to those fed the tannin-containing cultivars. The interaction of tannin level x processing method for the retention of dry matter and amino acids were significant and may be partially attributed to a difference in tannin levels among cultivars, as there was a higher retention of nutrients in birds fed raw tannin-free, as compared to those fed raw tannin-containing, cultivars; and in part to an effect on factors other than condensed tannins, as autoclave treatment of tannin-free cultivars also improved faba bean utilization in all cultivars. The relative improvements in retention of nutrients in birds fed diets that contained raw tannin-free cultivars as compared to those fed raw tannin-containing cultivars were

Table 1. Comparative performance of broiler chicks fed different cultivars of raw and autoclaved faba beans (experiment 1).

Treatments	Response criteria			Dry matter retention (%)	Amino acid retention (% of total)	Ether extract retention (%)
	Feed intake (g)	Wt. gain (g)	Feed:gain ratio			
Tannin-free cultivars						
Raw	137	80	1.72	47.9	83.7	75.6
Autoclaved	141	100	1.41	58.7	90.7	83.0
Tannin-containing cultivars						
Raw	140	74	1.88	42.3	73.2	79.0
Autoclaved	154	99	1.52	56.2	85.4	83.2
SEM	2.4	2	0.02	1.1	1.1	3.0

13% for dry matter and 14% for total amino acids. The corresponding improvements in the relative retention of nutrients following the destruction of the non-tannin factor by autoclaving were 23% for dry matter and 8% for total amino acids. The combined effects of both factors can be estimated by comparing results with the autoclaved tannin-free and the raw tannin-containing cultivars. The overall effect on dry matter and total amino acid retentions were 39% and 24%, respectively. These results would suggest that condensed tannins more effectively depressed amino acid retention than did the non-tannin heat-sensitive factor (14% vs 8%). This latter factor, however, had a greater depressing effect on dry matter retention compared to the condensed tannins (23% vs 13%).

Table 2. The percentage retention of individual amino acids by chicks fed five cultivars of raw and autoclaved faba beans (experiment 2).

Amino acids	Percentage retention of amino acids				SE±
	Tannin-free cvs.		Tannin-containing cvs.		
	Raw	Autoclaved	Raw	Autoclaved	
Alanine	80.3	88.7	71.9	83.8	1.1
Arginine	89.4	94.7	77.2	88.8	1.2
Asparagine	84.0	85.8	73.2	81.1	1.2
Glutamic acid	87.6	92.3	79.3	88.8	1.0
Histidine	88.4	93.3	78.7	86.8	0.8
Isoleucine	79.4	91.2	68.8	86.0	1.5
Leucine	82.4	92.9	71.7	87.2	1.3
Lysine	82.7	87.8	70.2	83.2	1.4
Phenylalanine	84.6	94.3	76.2	88.8	1.3
Proline	80.5	90.6	68.5	83.1	2.2
Serine	82.5	88.8	69.6	82.2	1.8
Threonine	78.8	85.0	65.5	79.5	0.9
Tyrosine	87.7	93.1	73.7	86.7	2.1
Valine	80.5	90.7	68.4	84.8	1.2

In general the response to heat treatment and cultivar for each of the individual amino acids (Table 2) was similar to that for all amino acids. This would suggest that condensed tannins and the second, thermolabile, factor (possibly a protein) do not specifically affect a single amino acid or a group of amino acids. These results would suggest that the overall effects of these factors could be readily monitored by following the availabilities of only one or two amino acids.

Graded levels of condensed tannins isolated as a water extract from faba bean testae were added to chick diets containing raw dehulled faba beans (experiment 2). The coefficients of correlation (r) between amount of condensed tannins added to the diet and chick performance were: 0.70 ($P < 0.05$) for feed intake, –0.90 ($P < 0.05$) for weight gain, +0.97 ($P < 0.01$) for feed: gain ratio, –0.98 ($P < 0.01$) for dry matter retention, –0.99 ($P < 0.01$) for protein retention, +0.96 ($P < 0.05$) for fat retention, and –0.81 ($P < 0.05$) for ash retention. These results clearly demonstrate that, except for fat retention, there is a negative correlation between the level of condensed tannin in the diet and chick performance.

The results of these studies have demonstrated that improvements in nutritional value of faba beans following heat treatment can be attributed to the destruction of condensed tannins and to an improvement in the digestibility of the non-tannin components in the bean.

In conclusion, it may be stated that the development of faba bean cultivars that have a zero level of condensed tannins would result in a signficant improvement in the utilization by chicks of most nutrients, particularly amino acids. Also, heat treatment of these cultivars would further improve their nutritional value.

References

Bond, D.A. 1976. Journal of Agricultural Scinece, UK 86: 561-566.

Marquardt, R.R., Ward, A.T., Campbell, L.D. and Cansfield, P.E. 1977. Journal of Nutrition 107: 1313-1323.

Marquardt, R.R., McKirdy, J.A. and Ward, A.T. 1978. Canadian Journal of Animal Science 58: 775-781.

Marquardt, R.R. and Ward, A.T. 1979. Canadian Journal of Animal Science 59: 781-789.

Martin-Tanguy, J., Guillaume, J. and Kossa, A. 1977. Journal of the Science of Food and Agriculture 28: 757-765.

Picard, J. 1975. Annales d'Amelioration des Plantes Plant (Paris) 26: 101-106.

Ward, A.T., Marquardt, R.R. and Campbell, L.D. 1977. Journal of Nutrition 107: 1325-1334.

Purification and some properties of vicine and convicine isolated from faba bean protein concentrate

Ronald R. Marquardt, David S. Muduuli and Andrzej A. Frohlich
Department of Animal Science, University of Manitoba Winnipeg, R3T 2N2, CANADA

Introduction

Faba beans (*Vicia faba* L.) contain both thermolabile (Marquardt and Ward 1979, Cansfield *et al.* 1980) and thermostable anti-nutritional compounds (Olaboro *et al.* 1981a, b). Recent studies by Olaboro *et al.* (1981a, b, c) and Muduuli *et al.* (1981, 1982) have demonstrated that the thermostable chicken egg-size-depressing factors in faba beans were vicine and convicine. Vicine and convicine and their respective aglycones have also been implicated as causative agents of favism (Mager *et al.* 1980).

Detailed studies on the metabolic effects of vicine and convicine have been hampered by the absence of an isolation procedure that yields large quantities of the glycosides. The objective of this study was to develop a simplified procedure for the simultaneous isolation of vicine and convicine from faba bean protein concentrate, a fraction that has an enriched concentration of vicine and convicine relative to whole faba beans. Information on the stability and solubility of these compounds at different pH levels was also established in order to facilitate the development of the procedure.

Materials and Methods

Most of the experimental procedures are given in Marquardt *et al.* 1983. The procedure for isolation of vicine and convicine is as follows:

Water (6.2 l), or water (5.75 l) and 3 N NaOH (0.45 l) were added to faba bean protein concentrate (FBPC, 2.5 kg), in the ratio of 1:5 (weight/volume). The mixture was homogenized for 5 minutes (Tekmar, SD45N homogenizer, Cincinnati, OH), an additional 5 volumes (12.5 l) of acetone were added, and the suspension was mixed for an additional 15 minutes with a propeller type mixer (Ohmite Mfg. Co., Skokie, IL). After standing for 30 to 60 minutes at room temperature, the clear supernatant was siphoned off and the remaining slurry was transferred into cotton bags and squeezed in a 9 liter mechanical press (F. Dick, Sausage-extruder). Antifoam B (6 ml, Fisher Scientific Co.) was added to the filtered extract and the extract was concentrated in a cyclone (steam) evaporator at reduced pressure to approximately 0.08 to 0.12 volumes

(200-300 ml). The pH of the concentrated extract was lowered to approximately 7.2 with 8 N HC l and the preparation was allowed to stand for 24 to 96 h at 1-4°C until crystallization was complete. The crystalline suspension was harvested by centrifugation (13,000 *g* for 30 minutes), and was washed successively with 150 ml and 100 ml distilled water, and 200 ml of acetone with centrifugation for 20, 20 and 30 minutes, respectively, at 13,000 *g* after each wash. The mixed vicine and convicine crystals were dried overnight at 60°C.

The mixed crystals were resuspended in water (10 ml/g) and the pH was adjusted to 1.0 using 8 N HC l. The suspension was mixed for 15 minutes at 24°C and was centrifuged at 13,000 *g* for 30 minutes. The pellet was washed successively with 2.5 ml of 0.2 N HC l and 10 ml water/g wet pellet. The supernatant and the first washings were pooled and the pH was immediately raised to 7.2 with 8 N NaOH. The crystalline suspension was allowed to stand overnight at 1-4°C. Vicine crystals were harvested by centrifugation at 13,000 g for 30 minutes, and were washed twice with water (2.5 ml/g wet weight) and finally acetone (4 ml/g wet weight). This fraction (vicine, first crystallization)was dried overnight at 50-60°C.

The first vicine crystals were recrystallized. They were suspended in water (10 ml/g), and the pH was adjusted to approximately 10.5 - 11 with 8 N NaOH until all of the sample was dissolved. The mixture was centrifuged at 13,000 *g* for 20 minutes, the pH of the supernatant was lowered with 8 N HC l over a 30 minute period to 9.0 and the suspension was allowed to stand overnight at 1-4°C during which time crystallization was completed. The pure vicine (second crystallization)was harvested, washed and dried as described above except that the volumes of water, water and acetone wash solutions were 5, 5 and 10 ml/g dry vicine (first crystallization), respectively.

The washed convicine-rich pellet from the mixed crystals was suspended in water (4 ml/g wet weight), the pH was adjusted to 11 with 8 N NaOH, and the mixture was centrifuged at 13,000 *g* for 20 minutes. The pH of the supernatant was lowered to 7.2 with 4 N HC l and the preparation was allowed to crystallize overnight at 4°C. Convicine (first crystallization) was harvested, washed and dried in a manner similar to that described for vicine (first crystallization). The convicine was recrystallized using the same procedures as used in the first crystallization except the volumes of water, water and acetone wash solutions were 10, 10 and 20 ml/g dry convicine (first crystallization).

Results and Discussion

Stability studies have demonstrated that vicine and convicine are stable in neutral or basic solutions for long periods (at least 7 days) but that they should not be stored at a low pH over a similar time period. These compounds, however, are relatively stable in the presence of dilute acids (i.e., 0.1 N HC l) and low temperatures (2°C) for 24 h. At elevated temperatures and low pH these compounds are rapidly hydrolyzed, with convicine being more sensitive.

The solubility of vicine and convicine was markedly influenced by pH (Figure 1). Convicine was minimally soluble at pH levels between 1.0 and 8.0, the values being 0.4±0.1 and 1.2±0.1 mg/ml, respectively. Vicine was minimally soluble at pH levels between 4.0 and 9.0, the corresponding values being 3.0±0.2 and 3.6±0.2 mg/ml, respectively. Vicine, however, was highly soluble at pH values of less than 1 or greater than 10.5. Convicine was also highly soluble in high pH solutions but, in contrast to

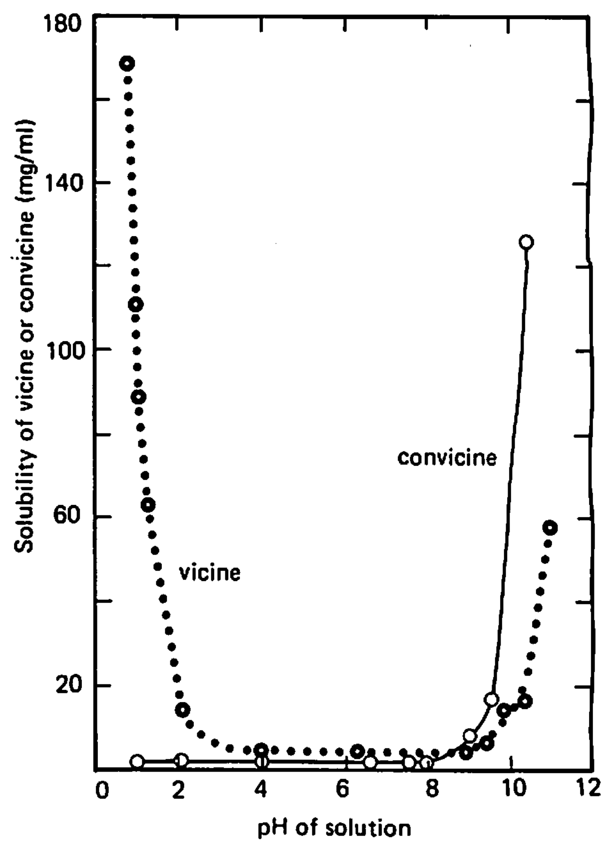


Fig. 1. Influence of pH on the solubility of vicine and convicine. Values represent averages of 2-3 samples. SE values are not shown as they were less than 5% of man values.

Table 1. Purification of vicine and convicine from faba bean protein concentrate (FBPC)[1].

Fraction[2]	Percent recovery[3]		Fold purification[3]	
	Vicine	Convicine	Vicine	Convicine
FBPC	100 ± 2(100)	100 ± 3(100)	1.0 ± 0.02(1.0)	1.0 ±0.03(1.0)
Extract	64 ± 0.3(62)	50 ± 3(63)	8.3 ± 0.3(8.1)	7.0 ± 1.1(7.9)
Crude mixed crystals[4]	44 ± 1(43)	42 ±1(50)	49.1 ± 0.1(45.9)	50.8 ±0.2(57)
Vicine, 1st crystallization	32 ± 1(31)	0.6 ± 0.0(0.6)	71.8 ± 0.1(71.8)	— —
Vicine, 2nd crystallization	24 ± 0.6(23)	0 (0)	71.9 ± 0.0(71.9)	— —
Convicine, 1st crystallization	0.6 ± 0.0(0.6)	31 ± 0.7(36)	— —	157 ±0.2(157)
Convicine, 2nd crystallization	0 (0)	23 ± 0.7(27)	— —	163 ±0.2(163)

[1] All fractionation studies were carried out in duplicate.

[2] The initial weight of FBPC was 2.5 kg. The average recovery of extract was 13.0 or 14.4 l when the respective initial extracting solvent was water-acetone (non-bracketed values) or NaOH-acetone (bracketed values). The initial concentration of vicine and convicine ±SE in FBPC were 13.9 ± 0.3 and 6.1 ± 0.2 mg/g, respectively.

[3] Values ±SE represent percent recovery or fold purification of glycoside relative to FBPC. SE for bracketed values were similar to non-bracketed values.

[4] The *crude mixed crystals* contained an average of 68.3% vicine, 32.9% convicine and 3.3% other compounds.

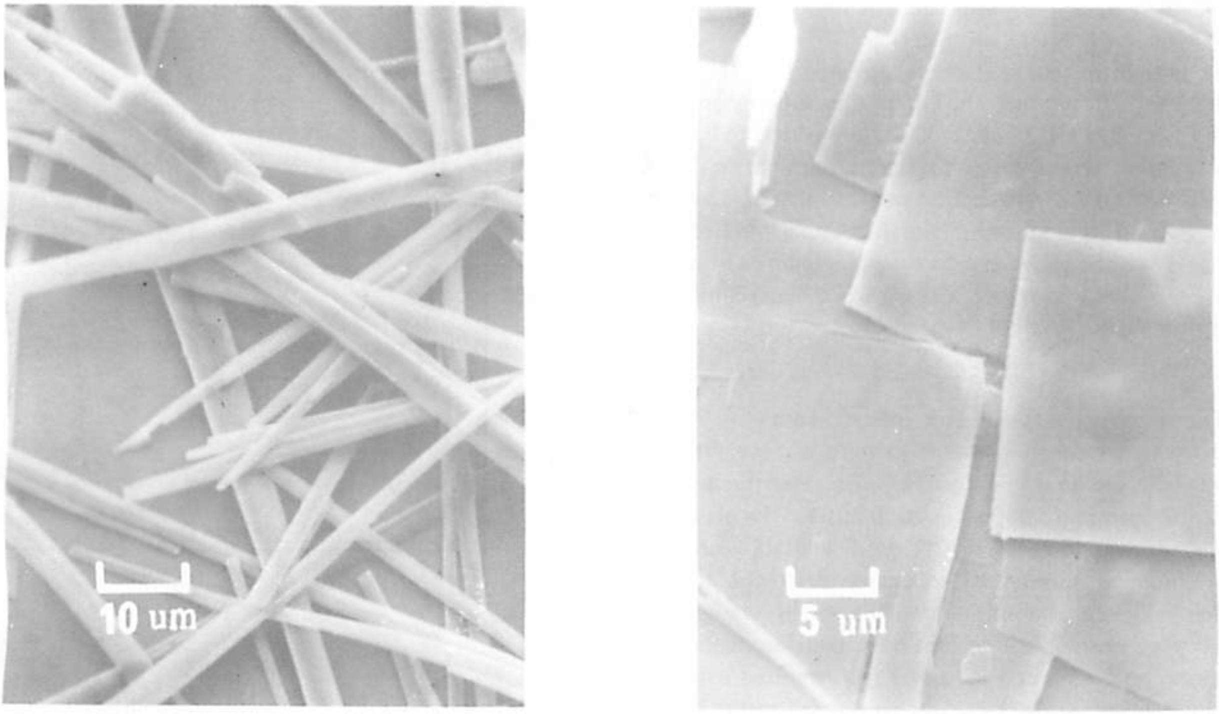


Fig. 2. Vicine (left) and convicine (right) crystals observed using a Cambridge Stereo Scan Mark II at 2500 and 6250 fold magnification, respectively.

vicine, had a low solubility at a low pH. Vicine and convicine can be readily resolved by extraction at a pH level where the solubilities of the two compounds differ.

A summary of the isolation procedure for vicine and convicine is given in Table 1. The final yields (± SE) of vicine (second crystallization) and convicine (second crystallization) were 7.8±0.2 and 3.5±0.1 g, respectively, when the initial extracting solution was water-acetone. The corresponding yields when the solvent was NaOH-acetone were 7.6±0.6 and 4.2±0.1 g.

This procedure, however, can not be used to purify vicine or convicine from whole or dehulled beans. Presumably the high starch content of the beans interferes with the isolation. This procedure may, nevertheless, be adapted to the isolation of these compounds from seed in the early development stage because of elevated vicine and convicine and low carbohydrate concentrations (Pitz *et al.* 1981).

Vicine and convicine were analyzed for impurities using several different procedures (Marquardt *et al.* 1983). No contaminants were detected in the recrystallized glycosides. The crystalline structure of vicine is needle-like, while that of convicine appears to be plate-like (Figure 2).

References

Cansfield, P.E., Marquardt, R.R. and Campbell, L.D. 1980. Journal of the Science of Food and Agriculture 31: 802-812.

Mager, J., Chevion, M. and Glaser, G. 1980. Favism. In Toxic constituents of plant foodstuffs. (Liener, I.E., ed.), 2nd edn., Academic Press, New York, NY.

Marquardt, R.R. and Ward, A.T. 1979. Canadian Journal of Animal Science 59: 781-789.

Marquardt, R.R., Muduuli, D.S. and Frohlich, A.A. 1983. Journal of Agricultural and Food Chemistry (in press).

Muduuli, D.S., Marquardt, R.R. and Guenter, W. 1981. British Journal of Nutrition 47: 53-59.

Muduuli, D.S., Marquardt, R.R. and Guenter, W. 1982. Canadian Journal of Animal Science 61:757-764.

Olaboro, G., Campbell, L.D. and Marquardt, R.R. 1981a. Canadian Journal of Animal Science 61: 751-755.

Olaboro, G., Marquardt, R.R., Campbell, L.D. and Frohlich A.A. 1981b. Journal of the Science of Food and Agriculture 32: 1074-1080.

Olaboro, G., Marquardt, R.R. and Campbell, L.D. 1981c. Journal of the Science of Food and Agriculture 32: 1163-1171.

Pitz, W.J., Sosulski, F.W. and Rowland, C.G. 1981. Journal of the Science of Food and Agriculture 32: 1-8.

Irrigated faba bean and lentil plots in Sudan

ANNOUNCEMENTS

Dr. Ir. G. Dantuma 1924-1983.

It was with great sorrow that we learned of the death of Gerrit Dantuma on 21 September only 3 days after the EEC faba bean seminar.

Born in the Netherlands, Gerrit had a distinguished career in agricultural research and plant breeding. After the war he studied at the Agricultural University in Wageningen where he graduated in 1950 specialising in plant breeding and pathology. He then joined the Foundation for Agricultural Plant Breeding (SVP) as a cereal breeder. In 1958 he obtained his Doctorate from the Agricultural University on a thesis entitled "Breeding of wheat and barley for winter hardiness." In 1964 he joined the Institute for Biological and Chemical Research on Field Crops and Herbage in Wageningen (now Centre for Agrobiological Research, CABO). By 1971 his cereal work was diminished and he concentrated on the physiology and breeding of legumes particularly *Vicia faba*. He was a member of several working groups and from 1974-82 was Chairman of the physiological section of Eucarpia.

It was in 1975 that his ideas on increasing faba bean production became known to other faba bean scientists in Europe, and in 1976 he instigated the first series of EEC Joint Faba Bean Tests which ran from 1977 to 1979. The results were reported by Dantuma *et al.*, 1983 (Zeitschrift fur Pflanzenzuchtung, 90, 85-105). He continued as co-ordinator of the second series, 1980-82, and was enthusiastically planning the next series for 1984-87.

Gerrit contributed regularly to EEC faba bean meetings, in organisation, formal presentations, informal discussions and as Chairman of sessions. All will remember his ability to converse fluently in most European languages.

Physiologists and agronomists will remember him for his planning and contribution towards joint agronomic/physiology trials, an example being the identical trials on irrigation and water stress carried out at CABO and the Univesity of Nottingham in 1983. This project also involved exchange of students from the UK and the Netherlands and was planned to be continued until 1986. A large number of students benefited greatly from his experiments and his wealth of experience which was shared generously with all who sought his advice.

Dr. Dantuma's contributions on 'The whole-crop physiology and yield components' and 'Grain and whole-crop harvesting, drying and storage' to the book 'Faba bean - a basis for improvement', Butterworths, London, are a living memorial to his enthusiasm and achievement.

Favism Meeting

The Favism Meeting referred to in FABIS No. 7 on page 54 has been deferred indefinitely for unavoidable reasons.

Length of Articles

We have removed the length restriction on articles for FABIS; articles of quality of any length will be considered for publication.

Due to the recent lack of articles on microbiology, we invite the submission of General Articles or Short Communications on this topic.

We particularly invite submission of review articles.

I D R C Grant

We gratefully acknowledge the very generous grant from IDRC (the International Development Research Centre) for the development of FABIS and to enable the more frequent publication of the FABIS Newsletter.

This grant also includes funding for the development of special bibliographies, and a question and answer service on all aspects of faba bean research, a facility we hope our subscribers will utilise to the fullest extent.

Mailing List

We are having many items of correspondence returned, due to those on our mailing list having changed their addresses or left their place of employment without notifying us. Obviously this represents a considerable waste of money to the FABIS service.

We request that those who currently receive FABIS should inform us of any change in their address or position in good time to allow us to maintain an efficient service.

Forthcoming Conferences 1984

Inter-Center Seminar on International Agricultural Research Centers (IARCs) and the New Biology, 23-27 April 1984, the International Rice Research Institute, Los Banos, Laguna, Philippines.

This seminar, cosponsored by the Rockefeller Foundation and Centers of the CGIAR (Consultative Group on International Agricultural Research) system, aims to:

1. review, assess, and, where appropriate, develop strategies for improving and transferring those biotechnologies that can contribute to improving the productivity and profitability of crop and animal production;
2. review the status of research in the IARCs in the field of genetic engineering, tissue culture, pest and disease control, and biomass utilization;
3. indentify research priorities to which IARCs should devote greater attention; and
4. develop methods to organize collaborative and network studies with advanced institutions in developing and developed countries.

For further information, contact:

Dr. M.S. Swaminatham,
Director General
International Rice Research Institute,
P.O. Box 933, Manila
PHILIPPINES

Third International Symposium on Parasitic Weeds
ICARDA, Aleppo, Syria, May 1984.

"Parasitic Weeds" is the theme of a four-day symposium to be held on 7-10 May with the collaboration of ICARDA under the auspices of the International Parasitic Seed Plant Research Group. The purpose of this symposium is to provide a forum for the interchange of data, techniques, and research goals in all aspects of parasitic vascular plants. The following topics will be covered: major parasitic groups (*Striga, Orobanche, Cuscuta,* mistletoes) and their biology and control, as well as basic research in physiology, biochemistry, structure, ecology, etc.

The symposium participants will visit field trials to view *Orobanche* infestations and any other parasitic species.

For more information, contact:

Mr. C. Parker,
ARC Weed Research Organization,
Yarnton, Oxford,
UK, OX5 1PF
or Dr. M. Saxena, ICARDA

5-10 Aug
First International Congress of Nematology, University of Guelph, Ontario, Canada. Details from:

Dr. Teo Olthof,
Research Station
Agriculture Canada Vineland
Ontario, Canada I0R 2E0

18-26 Aug
Seventeenth International Congress of Entomology, Hamburg, Federal Republic of Germany. Details from:

Dr. L.A. Mound,
British Museum (Natural History),
Cromwell Road,
London SW7 5BD
UK

1-7 Sept
Sixth International Congress on Virology, Sendai, Japan. Details from:

Prof. S. Glover,
Department of Genetics,
University of Newcastle,
Newcastle-upon-Tyne NE1 7RU
UK

1-6 Oct
Sixth Congress of the Mediterranean Phytopathological Union, Cairo, Egypt. Details from:

Mustafa Fahim,
P.O.Box 198,
Orman, Giza,
EGYPT

FABIS USERS' SEMINAR, 29 November, 1984

It is planned to hold a seminar at ICARDA, Aleppo, for the users of FABIS to try to assess the effectiveness of the service and determine ways by which it can be improved. If you are interested in attending or contributing, please contact:

ICARDA, P.O.Box 5466
Aleppo, SYRIA

Proposed FAO/IAEA coordinated research programme to improve the capability of the grain legume - *Rhizobium* symbiosis to fix atmospheric nitrogen

A consultants meeting on breeding for improved nitrogen fixation in grain legumes was held by the Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development during the period 26 to 30 September 1983 at the Vienna International Centre, Austria.

The cost and restricted availability of nitrogen fertilizer pose a serious problem for agricultural production in some of the developing countries. Biological nitrogen fixation, resulting from symbiosis between legume crops and *rhizobial* bacteria can reduce this problem by providing nitrogen for crop nutrition. Research has demonstrated that some genetic variability exists in both the plant (macrosymbiont) and the bacteria (microsymbiont). Furthermore, it has been possible to breed forage legumes for increased nitrogen fixation. A similar variability exists among grain legumes. It is hoped that it can also be found within species and can be exploited by plant breeding. Where the desired genotypes are not found among existing germ plasm, mutation induction will be employed. Of particular importance would be the use of mutation induction to eliminate the regulatory system that blocks further nitrogen fixation once nitrogen is available in the soil.

Guidelines for scientists regarding approach and methods to be used in breeding grain legumes with better capability to support symbiotic nitrogen fixation were formulated during this meeting. Increasing the yield as well as the nitrogen fixation capacity in grain legumes will require breeding for improvement of the host-*Rhizobium* symbiosis in addition to the improvement of agronomic characteristics and of resistance to pests and diseases. The complex relationships between these factors suggest that the problems will best be tackled by research teams, which should include a plant breeder, a microbiologist, and preferably a plant physiologist, in addition to experts in agronomy and plant protection. It was also recommended that N_2 fixation breeding programs must be built up within established plant breeding programs, where the expertise in dealing with inter-related breeding objectives exist. To verify the improved N-fixation capacity of new lines, ^{15}N techniques to quantify amounts of nitrogen fixed should be appropriately applied.

Anyone interested in applying for participation in such a research program is invited to write to :

Dr. G. Hardarson,
FAO/IAEA Agricultural Biotechnology Laboratory,
A-2444 Seibersdorf,
Austria.

Please indicate your previous experience in this field and if you have been using ^{15}N in your research. The number of participants in such research programs is limited and the decision to approve participation in a coordinated research program is made by the IAEA Director General.

Regional Workshop on Potential for Field Beans (*Phaseolus vulgaris* L.) in West Asia and North Africa.

ICARDA, Aleppo, Syria, 21-23 May, 1983.

This was a collaborative venture between ICARDA and CIAT. The aim of this workshop was to bring together scientists from the region with those from the sister centers, to determine the needs for further research on this crop in the ICARDA region. Delegates from 20 countries were invited to present papers on problems, potential, and research in their respective countries.

Faba beans, Kabuli chickpeas, and Lentils in the 1980's: an International Workshop.

ICARDA, Aleppo, Syria. 16-20 May, 1983

In 1978, ICARDA was host to a workshop at which legume research scientists reviewed production and research of these crops. A strategy of international cooperation was formulated. The aim of this latest workshop was to review the progress made in the past five years, and to identify priorities for research, training and production in the 1980's.

The workshop was attended by 56 delegates from 17 countries, in addition to scientists from ICARDA.

In addition to the workshop itself, meetings were held to formulate recommendations for future activities and co-operation in all aspects of research and production of these crops.

ICARDA (International Center for Agricultural Research in the Dry Areas)/IFAD (International Fund for Agricultural Development). 1982. **Proceedings of the International Faba Bean Conference Cairo, March, 1981.** ICARDA/IFAD Nile Valley Project. Aleppo, ICARDA, Syria. 147 pp

This publication is intended as a supplement to 'Faba Bean Improvement' (Martinus-Nijhoff 1982) and contains the opening remarks; a summary of the discussions of the papers presented; recommendations of the conference; concluding statements, and a list of the participants.

In addition, six papers on faba bean research and production in Cyprus, Ethiopia, Jordan, Lebanon, Spain, and Turkey are presented.

All those who participated in the Conference will have received a copy of these Proceedings. Others can address their request to:

FABIS
Documentation Unit, ICARDA
P.O.Box 5466, Aleppo, SYRIA

Hebblethwaite, P.D. (ed.). 1983. **The Faba Bean (*Vicia faba* L.). A Basis for Improvement.** London, UK, Butterworths, 573 pp.

The aim of this book is to collate and review the substantial amount of research and breeding work that has been carried out world-wide on the faba bean crop. Wherever possible, areas in which further research is needed are highlighted with a view to increasing and stabilising yields.

The Faba Bean - A Basis for Improvement will enable research workers to obtain an up-to-date evaluation of the problems related to *Vicia faba* production on a world scale and will be a useful reference for scientists, advisors and students at all levels.

Contents
I - **Background, Physiology and Breeding:** Background and history of faba bean production. Classification, origin, breeding methods and objectives. Pollination. Developmental physiology. Reproductive physiology of *Vicia faba* L. Chemical constituents and biochemistry. The influence of growth regulators on development and yield of *Vicia faba* L. Cytogenetics. Water relations and irrigation response. Nitrogen fixation. II - **Husbandry:** Beans in crop rotations. The husbandry of establishment and maintenance. III - **Pests:** Aphid pests. Nematode pests of *Vicia faba* L. Pests of *Vicia faba* other than aphids and nematodes. IV - **Diseases:** Root diseases of *Vicia faba* L. Viruses and virus-like diseases of *Vicia faba* L. Shoot diseases caused by fungal pathogens. Parasitic diseases in *Vicia faba* L. with special reference to broomrape (*Orobanche crenata* Forsk). V - **Harvesting, Drying, Storage and Utilization:** Grain and whole-crop harvesting, drying and storage. Utilization of *Vicia faba* L.

234 x 165 mm 448 pp approx.
ISBN 0 408 10695 6 £55 approx.

Hawtin, G.C. and Chancellor, G.J. (eds.). 1979. **Food Legume Improvement and Development:** proceedings of a workshop held at the University of Aleppo, Syria. 2-7 May 1978. Published jointly by ICARDA and IDRC, 216 pp.

Consists of a compilation of workshop papers on food legume production in the Middle East and North Africa - discusses agroclimatology and cultivation systems, nutritional value and food composition; plant production (particularly of chickpeas, lentils and faba beans), agricultural research, cultivation practices for plant protection; plant diseases, insect pests, disease resistance, weed control problems (use of herbicides in arid zones); plant breeding and genetic improvement.

Copies of this publication are available free of charge from:

FABIS
Documentation Unit
ICARDA
P.O.Box 5466
Aleppo, Syria

Saxena, M.C. and Stewart, R.A. (eds). 1983. **Faba Bean in the Nile Valley.** Report on the First Phase of the ICARDA/IFAD Nile Valley Project (1979-82). Martinus Nijhoff Publishers, The Hague, The Netherlands. 151 pp.

This book gives a detailed report of the work of the first phase of the ICARDA/IFAD Nile Valley faba bean project. Much of the work described concerns on-farm trials, which involve farmers, extension workers, and national program research scientists from Egypt and Sudan.

The multi-disciplinary nature of the research, bringing together socioeconomic and agricultural researchers, is a major feature of this unique and highly praised project.

This report should prove useful to all scientists, agricultural administrators, and agricultural research organisations interested in faba beans.

Vincent, E.M. (ed.). 1982. **Nile Valley Faba Bean Abstracts.** Published by the Commonwealth Agricultural Bureaux (CAB) for the ICARDA/IFAD Nile Valley Project 131 pp. ISBN 085 198 5033.

This publication is a compilation of abstracts of research papers and theses on research carried out on faba beans in Egypt and in the Sudan up to and including 1980. Abstracts have been reproduced from CAB journals as well as being prepared at the Documentation Unit, ICARDA, and at the Commonwealth Bureaux of Pasture and Field Crops, Hurley, UK.

Copies may be obtained from: FABIS
Documentation Unit, ICARDA
P.O.Box 5466, Aleppo, SYRIA

Reprints

ICARDA has been designated as the world center for information on faba beans, and as such we are trying to assemble a complete collection of papers relevant to this subject.

We would be most grateful if readers who have published papers relating to faba beans would send reprints to:

FABIS
Documentation Unit, ICARDA
P.O.Box 5466, Aleppo, SYRIA

Lentil Experimental News Service (LENS)

LENS, a scientific newsletter published jointly by the University of Saskatchewan and ICARDA with financial support from IDRC, is designed to improve communication among world lentil researchers.

For your free copy write to:-
LENS
Documentation Unit ICARDA
P.O.Box 5466, Aleppo, SYRIA

FABIS Production Team

Philip Kemp, Senior Information Scientist
Mohan Saxena, Senior Technical editor
Paul Neate, FABIS Coordinator
Suzi Yeshilchimen, Composer
Fouad Wehbe, Printer
Hassan Khairallah and Abdul Rahman Hawa, Art Work

FABIS
Co-ordinating Committee
Members

JAPAN	**Dr. Kiyoshi Kogure** Faculty of Agriculture, Kagawa University, 2393 Ikenobe, Miki-tyo, Kagawa-ken.
CANADA	**Dr. Claude Bernier** Department of Plant Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2
EGYPT	**Dr. Abdalla Nassib** Food Legume Section, Field Crops Institute, Agricultural Research Center, Giza.
SUDAN	**Dr. Farouk A. Salih** Agricultural Research Corporation, Hudeiba Research Station, P.O. Box 31, Ed-Damer.
SYRIA	**Dr. Mohan Saxena** Food Legume Improvement Program, ICARDA, P.O. Box 5466, Aleppo.
BRAZIL	**Dr. Homer Aidar** National Center for Research on Rice and Beans, BR-153, km. 4 - Goiania/Anapolis, Caixa Postal 179, 74.000 - Goiania, Goias.
FRANCE	**Dr. J. Picard** Station d'Amelioration des Plantes, INRA, B.P. 1540, 21034 Dijon Cedex.
ITALY	**Dr. Ciro de Pace** Istituto di Miglioramento *Genetico* della Plante Agrarie, Universita di Bari, Via Amendola 165, 70126 Bari.
SPAIN	**Dr. J.I. Cubero** Escuela Technica Superior de Ingenieros Agronomos, Departmento di Genetica, Apartado 246, Cordoba.
U.K.	**Dr. D.A. Bond** Plant Breeding Institute, Maris Lane, Trumpington, Cambridge CB2 2LQ.

Contributors' Style Guide

Policy
The aim of the newsletter is to publish quickly the results of recent research. Articles should normally be confined to a single subject, be of good quality and of primary interest to research, extension and production workers, administrators and policy makers. Articles for publishing in the newsletter should not be submitted to or published in any other journal.

Editing
Articles will be edited to preserve uniform style but substantial editing will be referred to the author for his approval; occasionally, papers may be returned for revision.

Disclaimers
The views expressed and the results presented in the newsletter are those of the author(s) and not the responsibility of ICARDA . or the University of Saskatchewan.

Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

Language
The Newsletter will be published in English but ICARDA will endeavour to translate articles submitted in Arabic and French.

Manuscript
Articles should be typed double spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute and postal address and telex number if available. Photographs, figures, tables etc. should be either 8.5 cm wide (single column) or 17.5 cm wide (double column including space). Figures and diagrams should be drawn in India ink; send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table.

Units of measurement are to be in the metric system, e.g., t/ha, kg, g, m, km, ml (= mililiter), m^2.

The numbers one to nine should be written as words except in combination with units of measure; all other numbers should be written as numerals, e.g., Nine plants, 10 leaves, 9 g, ninth, 10th, 0700 hr.

Examples of common expressions and abbreviations
3g, 18 mm, 300 m^2, 4 Mar 1983; 27% ; 50 five-day old plants; 1.6 million; 23 u g; 5^oC; 1980/81 season; 1981-82; Fig., No.; FAO, USA. *Fertilizers:* 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec.
versus = vs, least significant difference = LSD, standard error = SE±, coefficient(s) of variation = CV(s).
Probability: Use asterisks to denote probability * = $P < 0.05$; ** = $P < 0.01$; ***= $P < 0.001$.

Botanical. Include the authority name at the first mention of scientific names. Cultivar(s) = cv(s), variety = var(s), species = sp./spp., subspecies = subsp., subgenus = subg., forma = f., forma specialis = f.sp.

References
Journal articles: Murphy, P.T. and Milfin, B.J. 1982. The origin of barley. Euphytica 31: 183-192.

Books: Brues, A.M. 1952. Mineral cycling. Prentice-Hall, Englewood Cliffs, NJ, USA. 200pp.

Articles from books: Hastings, Sir G. 1908 (reprinted 1966). *Cajanus indicus* (arhar). Pages 196-200 *in* The Farm Products of India (Rao, D.M. and Murphy, R.E., eds.). Today and Tomorrow Printer and Publisher, New Delhi, India.

Papers in Proceedings: Hawtin, G.C. 1982. The genetic improvement of faba bean. Pages 15-32 *in* Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G.C. and Webb, C. eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981. Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands.