CHAPTER 8

SUMMARY

*Vicia faba* popularly known as faba bean is an annual legume crop. Faba bean is one of the oldest crops and ranks sixth in production among the different legumes grown in the world after soyabean, peanut, beans, peas and chickpeas (Vidal-Valverde et al., 1997). In India, it is grown in U.P, Bihar, Punjab, Haryana, foothills of Himalayan ranges and Manipur (Jugindra, 1996; Rai and Yadav, 2005). In Manipur, it is grown conveniently as cold season crop. But in countries like China, Ethiopia, Italy, Brazil, Morocco, Spain and Egypt, the crop is grown in larger hectares. China is the main producer of faba bean of the world.

As per the record of Department of Plant Breeding and Genetics (NATP-PB), Central Agricultural University, Iroishemba, Imphal, the number of local *Vicia faba* genotypes of Manipur is eight and they belong to three types i.e. (i) large size seeded type (Maru Achoubi) (ii) medium size seeded type (Maru Mayai ) and (iii) small size seeded type (Maru Macha). Out of these, a most popular genotype belonging to each of the type was selected for the study. Since these genotypes have not been yet distinguished with names both by local language and concerned authority, for convenient presentation of these genotypes elsewhere in the study, the name used for each refers to the local type name and serial number with which it is entered in the register of aforesaid institution.

Thus, the names become as Maru Achoubi-289, Maru Mayai-179 and Maru Macha-598, the three genotypes being of large size seeded,
medium size seeded and small size seeded types respectively. Since the concern authority does not certify them to be pure varieties, we are restricted to use the term genotype.

The seeds of the three genotypes obtained from the above authority, were used for the study. In order to enable selection of the genotype having greater potential in respects of nutritional possibility and yield, apart from being proposed as biochemical works of the study, as additional study, the yield components of the three genotypes have been compared as effect of seed size by growing the plants in randomized blocks. The study envisaged that Maru Achoubi-289 gave relatively greater data for yield components.

The people of Manipur have been consuming substantially the green entire pod of faba bean right from the young stage in the form of several favourite dishes. The whole dry beans are also consumed as delicious dal item after decortication of dry as well as soaked seeds. To know something about the nutritional potential of the locally grown faba bean of Manipur is a must. The investigated results reveal changes of some of nutritional and antinutritional substances of the bean, pod and entire pod for both of their dry matters and intact masses of the three genotypes as effect of maturation.

Changes observed during staging of young beans to completely matured beans were as; crude protein: 4.39 - 6.41% to 22.11-28.26%, crude fat: 0.08 - 0.14% to 0.94 -1.24%, crude fibre: 1.01-1.37% to 9.47-12.01%, ash: 0.72-0.95% to 3.64 - 3.77%, total crude carbohydrates: 7.76 - 8.38% to 45.10 - 51.63%, energy: 49.44 - 60.42Kcal/100g to 303.42 - 311.05 Kcal/100g, starch: 1.88-2.59% to 37.24- 40.66%, total
soluble sugars: 0.71- 0.76% to 4.47- 4.91%, reducing sugars: 434.60 -
498.84mg/100g to 24.48- 35.93mg/100g, calcium: 13.56 - 17.69 mg/
100g to 165.60 - 182.99 mg/100g, phosphorus: 70.15 - 99.23mg/100g
to 387.25 - 454.43 mg/100g, magnesium 16.28 - 18.95 mg/100g to 129.72
- 140.69 mg/100g, potassium: 200.77 - 238.61 mg/100g to 749.89 -
959.58 mg/ 100g, iron: 1.79 - 1.88 mg/ 100g to 10.21 - 11.93 mg/100g,
total phenols: 531.05 - 666.31mg/100g to 1135.54- 1324.06mg/100g,
tannins: 489.22-616.10mg/100g to 769.71 - 825.66mg/100g, phytate:
34.39 - 44.65mg/100g to 267.18 - 285. 35mg/100g.

The crude protein contents of dry matters of both bean and pod of
the three genotypes were found to be significantly decreased with the
advancement of maturation. The crude protein content in the dry matter
of completely matured whole seed of Maru Macha-598 was recorded to
be relatively higher (31.31%) than those of the Maru Achoubi-289
(29.72%) and Maru Mayai - 179 (24.68%). Decortication of these whole
seeds brought about increase of crude protein from 24.68-31.31% to
26.50 - 33.50% for dry matters. Irrespective of the bean, pod and entire
pod, the crude protein contents were found to be significantly increased
during the staging. The accuracy of the present study in the determination
of crude protein was confirmed by comparing with the results produced
for decorticated dry beans for this study by Food Safety and Analytical
Quality Control Laboratory, Central Food Technological Research
Institute, Mysore, India in response to our request.

The protein content of whole dry faba beans is 25.60%
(FAO:www.fao.org.). With this it becomes conspicuous that whole dry
beans of the two genotypes such as Maru Macha-598 and Maru Achoubi-
289 possess proteins more than this value. However, protein content of Maru Mayai-179 is found to be lower than this value.

Commonly, fat content in dry matter of bean increased during later maturation stage (0.62-0.84% to 1.05 - 1.37%), while that of pod did not exhibit significant change.

Parameters of maturation effect taken with dry matters of beans, showed decrease of ash and reducing sugars with the progress of maturation. In case of staging bean, almost of the increase of ash could be observed in the later stage (0.72-0.95% to 3.64 - 3.77%). But, in dry matter of staging pod, ash content increased (4.67- 4.84% to 5.47- 5.91%) while that of reducing sugars decreased (2170.33-2792.19mg/100g to 2053.21-2190.29mg/100g). When the results were produced for fresh form as under maturation effect of pod, significant increase of both ash and reducing sugars was observed.

In dry matter as well as intact mass of bean, levels of crude fibre, crude carbohydrates, total soluble sugars and starch were commonly found to increase significantly under the effect of maturation. In both dry matter of pod and fresh pod, the same changes were observed except for starch. Decortication of dry bean caused decrease of crude fibre, ash and increase of crude protein, crude carbohydrates, fat, reducing sugars, total soluble sugars and starch as common cases.

Phytate was found to gradually accumulate in both bean (244.59-262.10mg/100g to 298.19-318.83 mg/100g) and pod (226.51-244.72 mg/100g to 239.86-261.49 mg/100g) during maturation when investigated with their dry matters. But, rapid accumulation of phytate took place
during later period of bean staging (55.84-60.77mg/100g to 267.18-
285.35mg/100g). Removal of seed coat of dry beans was associated
with appreciable reduction of phytate.

As the maturation advanced, the levels of tannins and total phenols
of dry matters of bean and pod, were found to significantly decrease.
But, in staging pod both tannins and total phenols were found to increase
their levels (796.24-878.93mg/100g to 1100.91-1208.09mg/100g and
852.07-929.69mg/100g to 1157.38-1246.01mg/100g respectively). For
staging bean fluctuating changes of these substances were observed.
Decortication caused decrease of tannins and total phenols in both dry
matters and raw masses of dry beans.

The levels of calcium, magnesium and iron were noted to be
significantly increased during the maturation as found out from dry
matters of beans. Such study for pod exhibited significant increase of
magnesium (565.88-597.75mg/100g to 735.77-795.70mg/100g).
However, during staging of bean and pod, increase was noted for all
these elements.

Phosphorus and potassium decreased significantly during
maturation of bean and pod as exhibited by their changes in dry matters.
Regarding the staging bean, data showed significant increase of
phosphorus (70.15-99.23mg/100g to 387.25-454.43 mg/100g) and
potassium (200.77- 38.61 mg/100g to 749.89-959.58 mg/100g). During
the staging of pod the level of potassium increased significantly (201.19-
222.57mg/100g to 266.08-299.72mg/100g) while the level of phosphorus
did not get changed in majority of the cases.
Decortication of dry bean brought about increase of phosphorus, potassium and magnesium and decrease of calcium and iron in dry matter as well as in raw mass. All such results were also presented for dry matters and fresh forms of entire pods.

Green entire pods bear the character of vegetable in possessing the nutritional substances. Young to premature entire pods of the three genotypes possess: 3.02-4.05% to 4.68-5.90% crude proteins, 0.07-0.10% to 0.13-0.17% crude fat, 1.40-1.88% to 2.42-2.83% crude fibre, 0.64-0.72% to 1.01-1.05% ash, 7.45-7.59% to 11.14-12.03% crude carbohydrates, 43.63-46.90 to 66.45-69.69 Kcal of energy/100g, calcium: 27.22-39.15mg/100g to 34.59-42.34mg/100g, phosphorus: 39.46-48.23mg/100g to 61.03-76.34mg/100g, magnesium: 51.02-56.38mg/100g to 79.11-90.88mg/100g, potassium: 208.29-215.19mg/100g to 262.36-288.43mg/100g and iron: 1.62-1.71mg/100g to 2.47-2.92mg/100g. They possess lesser amounts of total phenols, tannins and phytate than dry beans.

The recorded energy contents of the materials of the three genotypes were as; young to premature bean: 49.44-78.11Kcal/100g, young to premature pod: 40.82-60.66Kcal/100g, young to premature entire pod: 43.63-68.01Kcal/100g, dry beans: 303.42-311.05Kcal/100g and decorticated dry beans: 343.02-348.25Kcal/100g.

Decorticated dry beans of the genotypes; Maru Mayai-179, Maru Achoubi-289 and Maru Macha-598 possessed 23.40%; 27.26% and 27.77% of true proteins respectively in their dry matters. Regarding fractional composition of seed protein, globulins, albumins, glutelins and prolamins constituted 63.94-68.42%; 22.69-24.28%; 7.65-10.56% and 1.15-1.21% respectively.
As per the data obtained for the study from Food Safety and Analytical Quality Control Laboratory, Central Food Technological Research Institute, Mysore, India, the composition of individual amino acids of the seed proteins of decorticated dry bean of Maru Achoubi-289 was displayed. The data revealed that glutamic acid + glutamine had the higher level (20.77g/100g) and it was followed by those of aspartic acid + asparagine, (12.06g/100g), arginine (10.91g/100g), Leucine (8.16g/100g) and lysine (6.81g/100g) etc. On comparing with FAO requirement pattern for 2-5 year old child, only methionine and cystine were found as ones which immensely limit the value of seed protein. This is because recorded values of methionine and cystine are noted to be very low even than those of faba bean reported by Askar (http://www.unu.edu.), which also limit the value of seed proteins.

In order to furnish information for complete extraction of soluble proteins required for characterisation of soluble proteins and determination of amino acid composition of individual as well as fractional proteins, there is need for optimization of pH of extracting solution. The investigation conducted for this purpose using 0.1M phosphate buffers of different pH values(6.50-8.0) but commonly containing 0.4M NaCl as extractant, made known that maximum dissolution of soluble proteins of decorticated beans (21.48-24.56% for DMs) took place at pH 8.0. Our observation was in agreement with that of Flink and Christiansen (1973) who envisaged about complete extraction of seed proteins of faba bean at pH 8.00-10.00. There had never observed genotypic difference in the manner of dissolution of soluble proteins over the pH range of 6.5-8.0 of extracting solutions.
From the literature, it could be ascertained that the antinutritional substances of beans got appreciable reductions from independent or combined effect of several processing treatments. As review, it is pertinent to mention that the extent of reduction of antinutritional substances depends upon processing treatments, which cause change in the composition of nutritional substances too.

In Manipur, dry faba beans have been frequently consumed after overnight soaking and then cooking the decorticated beans without draining out of liquid. Changes of certain nutritional and antinutritional substances, brought about by such processing treatments, have been investigated out as a part of the study.

The results produced with the inclusion of the beans of the three genotypes as materials of investigation indicated that for cotyledonous portion, relative to specified control values of raw cotyledon, soaking caused common increases of crude protein (4.19-9.22%), free amino acids (11.63-20.00%), crude fibre (8.65-16.11%), reducing sugars (27.96-57.31%), total phenols (11.33-14.11%), tannins (2.77-5.48%) and phytate (34.92-40.47%) and common decreases of carbohydrates (1.64-4.39%), crude fat (14.44-18.18%), ash (4.14-8.64%), non-reducing sugars (6.54-14.61%) and total soluble sugars (6.12-14.35%). Changes of these constituents caused by boiling and pressure cooking of soaked cotyledon may be increase, decrease and nil. Compared to pressure cooking, crude fat was more affected by boiling. But the extents of changes of constituents, ensued due to any similar independent or combined processing treatments, were found to vary significantly in majority of the cases, which could be based on inter genotypic variation. Soaking in
water caused decrease of total phenols of whole pigeonpea and climbing bean seeds (Igdebioh et al., 1995) and tannins of faba bean (Askar, http://www.unu.edu). However, it could not affect the phytate of whole faba bean (Vidal-Valverde et al., 1998). Thus the increases of total phenols, tannins and phytate in the cotyledonous portion of faba bean caused by soaking can be remarked as unusual.

The importance of vegetables in providing vitamin C requirement for good health is well known. Since green entire pods of V. faba have been extensively consumed as legume vegetable, there is need of dealing some efforts with its vitamin C. The study was extended to storage and processing effects on the vitamin of these materials.

The investigation displayed ascorbic acid contents of entire young pods (53.04-67.30 mg/100g) and entire premature pods (45.65-54.82 mg/100g) of the three genotypes and their parts (young beans: 55.17-68.32 mg/100g, young pods: 52.27-66.95 mg/100g, premature beans: 38.02-50.21 mg/100g, premature pods: 49.37-60.23 mg/100g). Irrespective of the genotype, when young, the contents of ascorbic acid of entire pod and its parts did not vary significantly. Commonly with the entering into premature stage, the ascorbic acid contents of the entire pod and its parts were noted to be significantly declined but at relatively greater extent in bean thereby giving discriminated contents of the vitamin in these materials. Among the similar materials of same maturity degree of entire pods and their parts belonging to all genotypes, the amounts of ascorbic acid present had significant variations in majority of the cases which could be due to genotype.
Open storage carried out at an ambient temperature of 15.44°C and relative humidity of 60%, conditionally impelled shorter shelf life of both young and premature entire pods to 7 days as compared to 18 and 20 days shelf life respectively bestowed by wet cloth wrapping (12.38°C) and ice cooled (5.61°C) storages, conducted under the same relative humidity. During these storages, the fate of ascorbic acid in each of the materials such as entire pods of both maturity degrees and their parts was followed by determining intermittent levels of the vitamin.

Compared to the effect of open storage, lowering of storage temperature practiced by means of wet cloth wrapping and ice cooled storages caused increasing stability of ascorbic acid. However, with the passage of storage time, the two former storages evoked higher stability of ascorbic acid in premature entire pod than in young entire pod, but with more stability in premature bean. However, due to the latter storage almost absolute stability of ascorbic acid was observed in the entire pods of both maturity stages. These findings got support from the relevant works of Nour (1979) and Kida et al. (1991).

The reductions discussed as to be caused by compounding effects of material, temperature and time were 60.55% and 48.87% in young and premature entire pods respectively on 6th day of open storage against reductions in the categorical materials recorded on day 16; viz, 44.80% and 24.31% for wet cloth wrapping storage, and 3.64% and 3.85% for ice cooled storage.

In the processing study, it was found out that irrespective of the test materials such as young entire pod and its parts, the increasing
amounts of ascorbic acid reduced were successively given by 20min boiling (37.17% - 40.15%), 30 min boiling (48.31% - 50.31%), 20 min boiling + draining (58.58%-65.69%) and 30 min boiling + draining (63.28% - 73.39%).

The changes of total phenols during these storages were also investigated out. Frequently, the material effect of the entire pod was noticed to be the difference of opposing changes of their parts while in some of the cases the material effects of pods, beans and entire pods observed as to be relative increase in earlier storage time could be affected and else it was turned to relative decrease with passage of time. Likely, in some of the cases, material effect can be either relative increase or relative decrease depending upon temperature. Such findings were in accordance with those reported by Lin et al.(1988), Maestro et al.(1993) and Sheikh and Habita (1996) for storage of fruits.

However, compounded decreasing effect of material, temperature and time on total phenols under the conditions of all storages could be observed in cases of young bean and premature pod only. Whereas compounded increasing effect of material, temperature and time on total phenols of premature bean and premature entire pod could be observed under the conditions of wet cloth wrapping and ice cooled storages.

Relative to control values, young bean, young pod, young entire pod, premature bean, premature pod and premature entire pod exhibited changes of -55.78%, -40.59%, -47.63%, +69.66%, -60.77% and -29.83% on 6th day of open storage; -31.48%, -15.91%, -19.74%, +245.16%, -27.35% and +37.84% on 16th day of wet cloth wrapping storage;
-11.11%, -20.45%, -17.11%, +145.16%, -23.93% and +12.16% on 16th day of ice cooled storage; the values shown for each of the case being respective ones (+ and - signs indicate increase and decrease respectively). It is stated that storage at low temperature results in less biochemical changes (Shaha and Nath, 2006). This is in agreement with our findings of less change of ascorbic acid and total phenols during ice cooled storage.

Since the protein content of Maru Achoubi-289 was slightly lower than that of Maru Macha-598, the values of yield components of the former were found to be relatively greater than those of other genotypes with shorter days to maturity, and the most popular adoption of this genotype for growing of faba bean elsewhere in Manipur receives scientific support. The study suggested prior adoption of this genotype in sparing further efforts relating with economy and nutritional prospect of V. faba.