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The grain legumes and cereals are widely recognised as important sources of food and feed protein and together comprise major parts of the human diet in many developing countries. The worldwide production of grain legumes is quite meagre relative to cereals. Their contribution to human nutrition however, is quite appreciable in view of some crucial positive attributes carried by them. Approximately 700 million people use legumes as essential part of their diet (Abbott, 1966). The food legumes make up 9% of the total plant food production and serve as the major sources of proteins in several developing countries (Toenniessen, 1985).

The protein content of legumes varies from 20% to 40% while that of cereals from 7% to 14%. Besides seeds, the legumes offer a variety of edible products especially the immature pods of several legumes comprise a delicious vegetable. Such green and succulent pods although have less proteins than the mature seeds, are rich in vitamins and soluble carbohydrates. The leaves of leguminous plants are eaten on a larger scale in the tropical part of the world. In view of this the increased use of food legumes all through the globe has been considered very much advantageous and desirable.

There exists chronic protein deficiency in virtually every developing country. The “Green Revolution” has not increased the yield of pulses. On the contrary its excessive emphasis on the cereals has often led to decreased production of legumes. In India, the production of pulses in 1996 was 15 million tonnes while that of rice 81 million tonnes, in case of wheat, 64 million tonnes and in other coarse cereals it touched the figure of 30.4 million tonnes (Anonymous, 1996).
Despite possessing less protein content, the cereals have always comprised the major sources of protein worldwide. Nutritionally, the lysine, tryptophan and threonine are the limiting essential amino acids in case of most of the cereals (Shewry and Miflin, 1984; Doll, 1984), while legumes are uniformly limiting in sulphur containing amino acids (Duffus and Slaughter, 1980; Gupta, 1983). Due to this, the overall protein quality of cereal-legume mixture has been construed to be better on account of the complementary nature of their amino acid profiles. In the light of this, a similar revolution in the production of pulses has been considered necessary which can quickly fulfill the protein requirement of the world in near future.

**Nutritional status of legumes:**

The indepth nutritional and biochemical studies carried out in legumes have revealed the existence of several “undesirable features” in most of the food legumes. According to Bressani and Elias (1988) the food legumes became notorious because of their antinutritional factors, rather than because of their nutritional potential. Some of the major factors that are limiting the full utilisation of legumes include,

a) the presence of antiphysiological substances like trypsin inhibitors, chymotrypsin inhibitors, amylase inhibitors and haemagglutinins in seed proteins,

b) the deficiency of sulphur containing amino acids in their protein profiles,

c) the prolonged cooking time requirement, and

d) the presence of phytates, flatus causing factors besides tannins.

It has been quite amazing that despite carrying quite a good number of disadvantageous ingredients, the legumes have always constituted an integral part of human diet for centuries together.
**Protease inhibitors:**

The protein inhibitors of proteinases are quite ubiquitous in plant kingdom. They have been reported in all kinds of legumes. The trypsin inhibitors and chymotrypsin inhibitors comprise the important proteinase inhibitors which have been studied in detail in different grain legumes. Trypsin inhibitors are also found in several food products including the staple cereals and various meat products. They have been implicated in producing depressed growth and pancreatic hypertrophy. One study where the highly purified trypsin inhibitor from soybean was fed to rats has demonstrated 100% pancreatic hypertrophy and 30-60% growth inhibition (Rackis, 1979). It has been opined that the retention of trypsin-inhibitory activity in legumes might be desirable, because it may serve in the plant defence mechanism against insect infestation during storage (Ryan, 1989). The trypsin inhibitor in its inactivated form has been considered to comprise a good source of sulphur containing amino acids, in view of the rich content of cysteine amino acid in such proteins (Kakade, *et al.*, 1969).

**Lectins:**

Haemagglutinins (lectins) are commonly present in seeds of legumes and many other species. They have been the subject of intensive investigations due to their mitogenic properties, affinities for specific blood cell antigen, and their possible antinutritional potential.

**Flatus Factors:**

Legumes are also known to contain flatus causing factors, that are responsible for flatulence. Hence development of varieties with lowered levels of flatulence factors has always comprised a major objective in legume breeding.
**Cooking quality:**
Most food legumes require 3 to 4 hours of boiling for their proper cooking. The long cooking time required by the legume seeds increases the expenditure on fuel, and also causes significant destruction and modification of nutrients. In the light of this, the development of improved varieties of legumes having better cooking qualities and increased acceptability as food, has been considered very vital.

Some organoleptic features, such as, the texture, taste, flavour and colour of the seeds are also obstructing the wide scale usage of the grain legumes in different parts of the world.

**Other toxic compounds:**
There are several other toxic constituents like alkaloids, antivitamins and cyanogens which are known to be present in few of the legumes. Although such factors do not assume any importance from nutrition point of view, but still they also have attracted the attention of researchers while designing legume improvement strategies.

**Legume Crops:**
Legumes are cosmopolitan in occurrence but they have diversified immensely in the tropics and subtropics. Thousands of legume species are known to mankind but nowadays less than 20 species are domesticated for various utility purposes. These are: the *Arachis hypogaea* (L.) (peanut), *Glycine max* (L.) Merr. (soybean), *Cajanus cajan* (L.) Millsp (pigeon pea), *Cicer arietinum* (L.) (chick pea), *Pisum sativum* (L.) (pea), *Lens culinaris* Medic. (lentil), *Vigna radiata* (L.) (mung bean), *Vigna unguiculata* (L.) (cowpea), *Vigna mungo* (L.) (black gram), *Vigna aconitifolia* Jacq. (Moth bean), *Phaseolus vulgaris* (L.) (french bean/Rajma) and *Medicago sativa* (L.) (alfalfa).
Most agricultural scientists seem to be quite unaware of the scope and potential offered by the tropical botany. The utility scope of quite a good number of tropical plants has never been explored systematically. Man has only just begun to take stock of the chemical and genetic possibilities existing in the plant kingdom. The scientific efforts have become necessary for scrutinizing thousands of plant species, many of which are still untested and some even unidentified, as yet.

There is an urgent need on the part of plant researchers to become acquainted with tropical plant life. Given concerted attention and requisite research efforts, it is expected that, many underexploited plants would follow the developmental course of the established commercial crop plant varieties.

**Taxonomy of legumes:**

All legumes are classified under the single family Leguminosae. This family is comprised of three subfamilies, namely, 1) Caesalpinioideae, 2) Mimosoideae and 3) Papilioniodeae. There are about 650 genera and 18,000 species in the family Leguminosae, which makes it the third largest family among the flowering plants after Asteraceae and Orchidaceae, respectively.

Of the three subfamilies, the Papilioniodeae is the largest and comprises 32 tribes while Caesalpinioideae and Mimosoideae encompass 5 tribes each. The Papilioniodeae includes several economically important grain legumes (pulses and oil seeds) and many important pasture and forage crop species. The other two subfamilies also contain many species of considerable economic importance.
What is winged bean?

Many little known but potentially useful tropical grain legumes hitherto unexploited and underexploited possess equal capabilities like those of the conventional tropical legumes. Of these, the winged bean, *Psophocarpus tetragonolobus* (L.) DC. demonstrated an exceptionally fast rate of dispersal, development and acceptance as a new food crop throughout the tropical regions of the world. Numerous superlatives have been used to extol the virtues of this plant. Masefield (1973) was the first person who could highlight the potential utility of this plant. The worldwide interest in this plant got triggered subsequently through the publication entitled “Winged Bean- A High Protein Crop for the Tropics” brought out by the National Academy of Sciences, United States (NAS, 1975).

The winged bean plant has been described as a “supermarket on a stalk” since every portion of the plant can be consumed or profitably utilised. The winged bean is naturally a tropical species. It has been considered to be a poor man’s crop that until recently was found chiefly growing in the rural areas of Papua New Guinea and South East Asia. It lavishly grows in hot and humid equatorial countries such as Indonesia, Malaysia, Thailand, Philippines, India, Myanmar, Bangladesh and Sri Lanka.

The winged bean looks like a pole bean. It is a annual/perennial twinner and usually climbs to a height of 4 metres and more if the support is tall enough. The winged bean possesses the extraordinarily high ability to nodulate and fix nitrogen symbiotically with a wide spectrum of Rhizobia. The plant is not very demanding as regards the soil requirements. It is widely adaptable to diverse soil types. It is grown between 20° N and 10° S latitude in Asia. It has a potential to grow at altitudes ranging from 0 to 2500 metres above mean sea level, and can be grown in the tropical and subtropical conditions.
Winged bean in India:

In India, the winged bean is commonly grown in the southern part of the country. It is also popular by the name, Goa/Asparagus bean. It is described by various regional names in different states of India. It is known as “Choudhari wal” in Maharashtra; as ‘rakki’/’kattuavarai’ in Karnataka; as ‘boondi’/’perandai avarai’, in Tamil Nadu; as ‘choughala sem’ in Madhya Pradesh and as ‘charmatti sem’ in West Bengal, respectively (Banerjee, 1985). The stem of winged bean is moderately thick, slightly ridged and grooved. The leaves are trifoliate and with a long stiff petiole. The inflorescence is borne on an axillary raceme having a length of 15 cm and bearing 2-10 flowers, which may be blue, white, violet or pink in colour.

The pods are green, purple, pink or red in colour. The length of the pod varies from 12 to 33 cm. The pods are four-sided, with characteristic serrated ‘wings’ running down the four corners. The fibre content in young pods is noticeably less. In view of this, the pods can be picked up and used as green vegetable quite easily. They can be eaten raw, boiled or steamed. Practically each and every part of the winged bean plant is important. Its leaves are rich in β carotene (precursor of Vitamin A) and can be used as green vegetable (Cerney et al., 1971).

Protein Rich Food:

The nutritional value of winged bean is mainly due to its mature seeds. The seeds contain high amount of proteins (29%-42%) and are thus comparable to those of soybean (NAS,1981).

The nutritive value of the winged bean seed proteins as revealed by the net protein utilization values, has been found to be comparable to that of soybean (Cerney et al,1971). The amino acid profile in winged bean is quite similar to that of soybean (Claydon,1978,1979 and Haq,1982). The
compositional resemblance of winged bean seeds with soybean indicated that its seeds could be used for similar kinds of products as those of soybean. It is due to this backdrop various researchers are now hailing the winged bean as "A Tropical Soybean". The Kwashiorkor disease has been successfully treated in Africa by employing diet containing a mixture of winged bean plus corn (NAS,1981). The winged bean has been safely used in the treatment of protein malnutrition as a substitute for milk (Cerney and Addy,1973).

**Winged bean oil**

Besides carrying appreciable level of proteins, the winged been seeds also contain about 20% edible oil (Claydon,1978 and 1979) and (Ekepenyong,1980). It has been realised that the seed oil of the winged bean contains high amount of unsaturated fatty acids quite at par with that of soybean and peanut (Cerney et al,1971).

**Tubers**:

The most interesting feature of the winged bean in some varieties is the tuber, which is produced through the swelling of the roots of the plant. The tubers contain significantly larger amount of proteins (20%) than the traditional root crops such as cassava and yam (NAS,1981). They comprise a highly prized food in some parts of Papua New Guinea and Myanmar where they are peeled, backed, boiled and then eaten as a snack (NAS,1981).

**Antinutritional Factors in Winged bean**:

Like soybeans, several antinutritional factors have been found in winged bean as well. Such factors include the trypsin inhibitors (Korte,1974), the chymotrypsin inhibitors (Sohonie and Bhandarkar,1954), the phytohaemagglutinins (Renkonen,1948) and some other biotoxic compounds (NAS,1981).
Protease inhibitors in winged bean:

The protease inhibitors are the polypeptides or proteins capable of inhibiting the activity of specific proteolytic enzymes. They have been studied in greater detail due to their possible deleterious dietary effects on animals. Such inhibitors are predominantly found in storage organs like the seeds and tubers. But sometimes they may accumulate even in non-storage organs also in response to wounding. The protease inhibitors are very much resistant to heat and extreme pH conditions.

The winged bean trypsin inhibitor and chymotrypsin inhibitor belong to the category of serine protease inhibitor, also described as serpins. The molecular weight of winged bean trypsin inhibitor (WBTI) is approximately 20,000 Da (Kortt, 1979), while that of chymotrypsin inhibitor (WBCTI) is 21,000 Da (Kortt, 1980). It has been noticed that the WBTI and WBCTI activities can be destroyed by autoclaving and boiling water treatments (Kadam, 1987).

Despite possessing all promising features and excellent nutritional potential, the winged bean has remained unpopular all through the tropics. This has happened due to certain undesirable features possessed by the plant which can be enlisted as follows:
1. The long duration of the crop, besides late maturity,
2. The twiny-climbing habit with the consequent need for staking and
3. The presence of antinutritional factors in various plant organs.

The different winged bean varieties now cultivated for their pods and seeds, require staking for their proper growth. This particular demerit besides the other fact that all pods of the plant do not mature simultaneously, have indeed hampered the use ofwinged beans on a larger commercial scale. Hence the development of nonstaking, dwarf plant type has been considered
Charaterisation of mutants and hybrids of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) quite crucial and relevant for the commercial exploitation of the winged bean. This has become all the more important as the natural germplasm lines of the plant do not carry the genes for the desired character of dwarfism and self standing habit.

The research efforts for the development of dwarf and erect type of winged bean through mutation breeding have been made by different workers. It is hoped by the pertinent researchers that the genetic improvement of a highly versatile system like winged bean through mutation/conventional breeding would prove immensely beneficial, as it can culminate in providing varieties of winged bean carrying the much sought after bushy/non staking characteristic.

It is envisaged that once success is gained in attaining this objective, it would become easier to streamline the socio-economic aspects of production, consumption and marketing of this legume in India. It may be recalled that the soybean attained the current economic status only when its viny type mutated to determinate type.

Khan and Brock (1975) launched a mutation breeding programme for searching an erect and bushy mutant in winged bean. Kesavan and Khan (1978) obtained an early flowering mutant after gamma ray and EMS treatments. A bushy mutant was recovered through seed irradiation by Karikari (1981). Induced bushy and fertile mutant has been obtained at NBRI, Lucknow through gamma ray treatment (Jugran et al., 1985).

Keeping this end in view a mutation breeding programme was initiated at our end for achieving genetic improvement of winged bean. The pertinent efforts have succeeded in inducing mutant lines with a broad spectrum of variability. Subsequently a cross breeding programme involving
Characterisation of mutants and hybrids of winged bean (Psophocarpus tetragonolobus (L.) DC.) different mutant lines of winged bean, was also undertaken at our end for developing hybrids of better selection value.

In the present study efforts have been made to systematically characterise the various existing mutant lines/germplasm lines of winged bean with reference to their morphological and biochemical attributes. Besides it was also considered desirable to initiate parallel type of work on intermutant hybrids of winged bean for revealing the status of their utility value.