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REVIEW ARTICLE

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ORIGIN, DOMESTICATION, TAXONOMY, BOTANICAL DESCRIPTION, GENETC DIVERSITY AND BREEDING OF DOLICHOS BEAN (*Lablab purpureus* (L.) Sweet)

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ABSTRACT

Dolichos [*Lablab purpureus* (*Dolichos lablab*)] is a genus (*Lablab*) of flowering plants in the legume family, Fabaceae, and the subfamily Faboideae. Dolichos bean (*Lablab purpureus.* L.) is an important vegetable legume crop grown throughout the country. The alternate Scientific Names are *Dolichos benghalensis* Jacq., *Dolichos lablab* L., *Dolichos purpureus* L., *Lablab niger* Medikus, *Lablab purpurea* (L.) Sweet, *Lablab vulgaris* (L.) Savi, *Vigna aristata* Piper. The common names in *English are* Australian pea (South America), bonavist bean, bonavista pea, field bean, hyacinth bean, lablab bean, pig-ears, poor man's bean, rongai dolichos, Tonga bean, Musical Bean, Sweet Pulse and Wild Bean. *In India it is known by different names in different languages* viz., Avare, ballar, chapparadavare, chikkadikai chikkuda, mochai numulu, mochakotta sem, pavta, shim, sin bean, val, wal; urahi, urchi, uri (Assamese); rajashimbi (Bengali); bhatvas, shimi, sem (Hindi); capparada-avare, avare, avare baele (Kannada); amara, avara (Malayalam); hawai uri (Manipuri); anvare, kadavebaala, pandhre pavate (Marathi); nispavah (Sanskrit); avarai, motchai (Tamil); chikkudu, adavi chikkudu, alsanda (Telugu). Hyacinth bean (*Lablab purpureus* (L.) Sweet) is widely distributed in the Indian subcontinent, Africa and Southeast Asia. It is a multipurpose tropical legume valued as a vegetable, pulse, fodder and green manure crop. Dolichos bean or Hyacinth bean or Indian bean [(*Lablab purpureus* L.) Sweet] is a multi-utility and multi-beneficial leguminous crop. It is grown for vegetable, pulse, fodder, green manure, cover crop, medicine and ornamental purpose. Apart from being draught tolerant, it has high adaptability to wide range of production conditions. It also improves soil fertility by fixing atmospheric nitrogen and adding more organic carbon to soil. Despite its multi-utility and multi-benefits, Dolichos is still an underutilized and unexplored crop in terms of area under cultivation and efforts towards its genetic improvement. It is a potential crop for sustainable agriculture in dry land ecosystems assuring food and income security to small and marginal farmers of this region. Thus, attention should be given for comprehensive genetic improvement and conservation of plant genetic resources of Dolichos. Two cultivated type's *viz*.,Lablab purpureosu var.typicus and L. purpureus var. lignosus. Former is vegetable type cultivated for its soft and edible pods and latter is the field bean cultivated for dry seeds as pulse. Both varieties are cross compatible. Eevaluation of *L. purpureus* germplasm, indicated that the pod characters are significant in *L. purpureus* sp. *purpureus*, but it flowers only seasonally. On the other hand,pod characters of *L. purpureus* sp. *uncinatus* are not good, though it flowers throughout the year. Therefore, starting the crop improvement programme for enhancing yield throughoutyear, it is essential to collect information on the reproductivebiology of both the sub-species. The most recent research points to lablab being a native to eastern and southern Africa where it was domesticated and subsequently dispersed across Africa and Asia (pre 2000 BC). 100 g of green pods contain 6.7 g carbohydrates, 3.8g carbohydrates, 3.8 proteins, 1.8 g fibre, 210 mg calcium, 68.0 mg phosphorus, 1.7 mg iron. Hyacinth bean, also known as field bean or dolichos bean, is grown throughout tropical regions of Asia, Africa and America. In India, it is grown as a field crop in Tamil Nadu., Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra. In Kerala, the photo sensitive pole types are grown in homesteads by trailing to bower for its tender fruits which are used as cooked vegetable. Dry beans are also used in various vegetable preparations. In this review article on Origin, Domestication, Taxonomy, Botanical Description, Genetic Diversity, Breeding, Uses, Nutritional Value and Health Benefits of Dolichos Bean are discussed.

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INTRODUCTION

Dolichos [*Lablab purpureus* (*Dolichos lablab*)] is a genus (*Lablab*) of flowering plants in the legume family, Fabaceae, and the subfamily Faboideae. (Al-Snafi, 2017; Wikipedia, 2023). Dolichos belonging to the family *Fabaceae*, is predominantly a self-pollinated crop. The cultivated Dolichos is broadly identified as two botanical types viz., Lablab purpureosu var. typicus and L. purpureus var. lignosus. Former is vegetable type cultivated for its soft and edible pods and latter is the field bean cultivated for dry seeds as pulse. Both varieties are cross compatible and produce fertile progenies upon hybridization. (Raghu et al., 2018; IASRI, 2023). The alternate scientific names are *Dolichos benghalensis* Jacq., *Dolichos lablab* L., *Dolichos purpureus* L., *Lablab niger* Medikus, *Lablab purpurea* (L.) Sweet,*Lablab vulgaris* (L.) Savi, and *Vigna aristata* Piper (Sheahan, 2012). Common names in English are Australian pea (South America), bonavist bean, bonavista pea, field bean, hyacinth bean, lablab bean, pig-ears, poor man's bean, rongai dolichos, Tonga bean, Dolichos bean, Seim bean, Egyptian kidney bean, Indian bean, Pendal bean, Pole bean, Musical Bean, Sweet Pulse and Wild Bean (Al-Snafi, 2017; TF, 2020; Wikipedia, 2023; HB, 2023). In *India Dolichos bean is known in different language viz., Avare*, ballar, chapparadavare, chikkadikai chikkuda, mochai numulu, mochakotta sem, pavta, shim, sin bean, val, wal; urahi, urchi, uri (Assamese); rajashimbi (Bengali); bhatvas, shimi, sem (Hindi); capparada-avare, avare, avare baele (Kannada); amara, avara (Malayalam); hawai uri (Manipuri); anvare, kadavebaala, pandhre pavate (Marathi); nispavah (Sanskrit); avarai, motchai (Tamil); chikkudu, adavichikkudu, alsanda (Telugu); Oliya, Val (Guajarati); Kalalobia, Katjang (Punjabi) (TF, 2020; Singh, 2023).

Dolichos bean is an important vegetable legume crop grown throughout the country (Dhillon and Kumar, 2015). It is indigenous to South-east Asia and has been introduced in Africa and other tropical and subtropical countries (CABI, 2023). It is cultivated as either a pulse or for the young pods which are used as a fresh vegetable; some farmers, especially in India, use it for stock feed. It is usually supported on canes or other structures when cultivated as a vegetable, or on the flat when grown for stock feed or pulses (CABI, 2023)

It is native to Africa and it is cultivated throughout the tropics for food **(**Wikipedia, 2023**).** Now widely cultivated as a crop pan-tropically, and especially important in India (especially southern India) and Bangladesh (TF, 2020). Hyacinth bean, also known as field bean or dolichos bean, is grown throughout tropical regions of Asia, Africa and America (IASRI, 2023). Its green delicious immature pods and seeds are consumed as vegetable. After maturity, dry seeds are harvested and stored, and consumed as a pulse throughout the year (Raghu *et al*., 2018). It is a multipurpose tropical legume valued as a vegetable, pulse, fodder and green manure crop (Vaijayanthi *et al.,* 2019).

In India, it is grown as a field crop in Tamil Nadu., Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra. In Kerala, the photo sensitive pole types are grown in homesteads by trailing to bower for its tender fruits which are used as cooked vegetable. Dry beans are also sued in various vegetable preparations (HORT, 2023; IASRI, 2023). Hyacinth bean (*Lablab purpureus* (L.) Sweet) is widely distributed in the Indian subcontinent, Africa and Southeast Asia. It is a multipurpose tropical legume valued as a vegetable, pulse, fodder and green manure crop (Vaijayanthi *et al*., 2019). Dolichos bean - *Lablab purpureus* (L) is grown across the country primarily as green pods and fresh bean. Dolichos dry beans are also used as a whole or in Dal form as a rich pulse crop (Bighaat, 2020). Dolichos is an oldest leguminous crop knows to man. It grows in dry and semi-arid regions of Asia, Africa and America. In India, it is popular in south, east and north-east parts of the country for vegetable, pulse and fodder purpose. Apart from being draught tolerant, it has high adaptability to wide range of production conditions. It also improves soil fertility by fixing atmospheric nitrogen and adding more organic carbon to soil. Despite its multi-utility and multi-benefits, Dolichos is still an underutilized and unexplored crop in terms of area under cultivation and efforts towards its genetic improvement . It is a potential crop for sustainable agriculture in dry land ecosystems assuring food and income security to small and marginal farmers of this region. Thus, attention should be given for comprehensive genetic improvement and conservation of plant genetic resources of Dolichos (Raghu *et al*., 2018). Dolichos bean or Hyacinth bean or Indian bean [(*Lablab purpureus* L.) Sweet] is a multi-utility and multi-beneficial leguminous crop. It is grown for vegetable, pulse, fodder, green manure, cover crop, medicine and ornamental purpose. It is one of the oldest legume crop known to be cultivated dry and semi-arid regions of Asia, Africa and America. In India, it is popularly grown in south, east and north east parts of the country. It is the major sources of protein in the South Indian diet. It is grown either in pure stand or intercropped with cereals like finger millet, pearl millet, corn and sorghum, and with other crops like groundnut, castor in rainfed ecosystems. It prefers comparatively cool season, and moreover majority of traditional cultivars are temperature-and photoperiod-sensitive and requires short days for flowering (Raghu *et al*., 2018).

Besides, Dolichos is endowed with many medicinal and therapeutic properties. The seeds contain kievitone, which is one of the potential breast cancer fighting flavonoid. Tyrosinase present in the seed has greater potential for the treatment of hypertension in human beings. The beans are used as stomachic, anthelmintic, diuretic, aphrodisiac, anti-spasmodic, digestive, febrifuge, carminative and laxative (Raghu *et al*., 2018). It is very good source of protein (20-25%), amino acids (like Lysine, usually lack in cereals), vitamins (A, C & Riboflavin) and minerals (Ca, Fe, Mg, S, Na & P). Moreover, immature pods and seeds are rich in dietary fiber, and low carbohydrates and lipids. Due to changing pattern of lifestyle and food habit elsewhere, intake of low calorie and low fat vegetarian food is becoming increasingly popular. Thus, Dolichos is very important from nutritional view point (Raghu *et al.,* 2018). It is rich in protein, minerals and vitamins, and is a major source of protein for South Indian diet. It also provides nutritious green fodder to milch animals (Raghu *et al.,* 2018). 100 g of green pods contain 6.7 g carbohydrates, 3.8 g carbohydrates, 3.8 proteins, 1.8 g fibre, 210 mg calcium, 68.0 mg phosphorus, 1.7 mg iron etc. (IASRI, 2023). In this review article on Origin, Domestication, Taxonomy, Botanical Description, Genetic Diversity, Breeding, Uses, Nutritional Value and Health Benefits of Dolichos bean are discussed.

ORIGIN AND DOMESTICATION

Lablab purpureus is an old world food crop that is thought to have originated in Africa or India. It has been successfully grown in the Southern United States, Texas, Florida, Georgia, Puerto Rico, and as far north as the Great Lakes and Canada. It grows from sea level up to 6,500 ft (Sheahan, 2012). India is the centre of diversity for dolichos bean, and a large numbers of indigenous strains are available in Northern India (Dhillon and Kumar, 2015). The origin of lablab is debated and it may have originated either from South or South-East Asia, or from Africa. It was probably dispersed by humans as early as 800 BCE and is now widespread throughout the tropics (Heuzé *et al.,* 2016). The most recent research points to lablab being a native to eastern and southern Africa where it was domesticated and subsequently dispersed across Africa and Asia (pre 2000 BC) (TF, 2020). Hyacinth bean originated in India (HORT, 2023; IASRI, 2023). Native to Africa, it is cultivated widely in North Africa and Asia for its edible pods. Hyacinth bean made its way to India from Africa in between 1600 and 1500 BC. In 1700's, Hyacinth beans were introduced to Europe. In 19th century, Hyacinth beans were introduced to America as an ornamental plant. Hyacinth beans were cultivated in Asia and North Africa as a food source (HB, 2023).

Lablab is cultivated as an annual or a short-lived perennial in South and Central America, East and West Indies, China, South and South-East Asia and Australia. In Australia, lablab became famous as a forage species with the release of the Rongai cultivar in 1962 In the wild, lablab is found in grassland, bushland and gallery forests (Heuzé *et al*., 2016). As a cultivated crop, lablab has many favourable traits such as its ability to grow in a diverse range of environmental conditions. Lablab is a summer growing legume that remains green during the dry season when other fodder is scarce and dry In the wild, lablab is found in grassland, bushland and gallery forests (Heuzé *et al.,* 2016). Lablab withstands high temperatures. It is more tolerant of low temperatures than velvet bean or cowpea (*Vigna unguiculata*). For example it tolerates temperatures down to 3°C for short periods and can survive light frost.. Thanks to its taproot, lablab can extract water from 2 m below the soil surface, which makes it drought hardy and allows it to grow during the dry periods of the year. Lablab tolerates some flooding but does not withstand poor drainage or prolonged water logging. Lablab thrives in a wide range of soils, from poor sandy soils to heavy clays, when drainage is good, pH is between 4.5 and 7.5, and there is no salinity. Lablab does better in full sunlight (Heuzé *et al*., 2016).

Lablab bean is indigenous to South-east Asia and has been introduced to Africa and other tropical and subtropical countries. It has now spread throughout the tropics and is cultivated in warmer regions of the world. It is mainly cultivated in India, South-East Asia, Egypt and the Sudan. It is well established as a food crop in India and South-east Asia, and is also widely grown by small farmers in Africa, being an important subsistence farmer crop in many countries, especially the Sudan (CABI, 2023). It is distributed in Africa and Asia (Wikipedia**,** 2023**).** Hyacinth bean (*Lablab purpureus* (L.) Sweet) is widely distributed in the Indian subcontinent, Africa and Southeast Asia (Vaijayanthi *et al*., 2019).

In the wild, lablab is found in grassland, bushland and gallery forests (Heuzé *et al.,* 2016). Wild lablab types are found from sea level up to an altitude of 2000-2400 m. However, when cultivated, lablab prefers lower altitudes. Lablab grows where daily temperatures are in the range of 18-35 °C, and where annual rainfall is between 650 mm and 2500-3000 mm (Heuzé *et al*., 2016). The wild forms of lablab are believed to have originated in India or South-East Asia, and it introduced into Africa from southeast Asia during the eighth century. It was widely distributed to many tropical and subtropical countries. Now it was found in Malaysia, Indonesia, Philippines, Mainland China, Iraq, Kenya, Tanzania, Uganda, Chad, Ethiopia, Sudan, Angola, Malawi, Mozambique, Zambia, Zimbabwe,Botswana, Namibia, South Africa, Cote, D'Ivoire, Ghana, Niger, Nigeria, Senegal, Sierra Leone, Togo, Cameroon, Gabon, Rwanda, Madagascar, the Caribbean, Central and South America (Al-Snafi, 2017).

TAXONOMY

Dolichos bean belongs to the Family: Fabaceae, Genus: *Lablab*, Species: *Lablab purpureus* (*Dolichos lablab*) (Al-Snafi, 2017; TF, 2020; CABI, 2023; Wiktrop, 2023).It is the only species in the monotypic genus *Lablab* **(**Wikipedia, 2023**).**

There are about 69 species (Wikipedia, 2023). Species include:

1. *Dolichos aciphyllus*
2. *Dolichos angustifolius*
3. *Dolichos angustissimus*
4. *Dolichos antunesii*
5. *Dolichos argyros*
6. *Dolichos axilliflorus*
7. *Dolichos bellus*
8. *Dolichos bianoensis*
9. *Dolichos brevidentatus*
10. *Dolichos capensis*
11. *Dolichos cardiophyllus*
12. *Dolichos complanatus*
13. *Dolichos compressus*
14. *Dolichos corymbosus*
15. *Dolichos decumbens*
16. *Dolichos dinklagei*
17. *Dolichos dongaluta*
18. *Dolichos elatus*
19. *Dolichos falciformis*
20. *Dolichos fangitsa*
21. *Dolichos filifoliolus*
22. *Dolichos formosanus*
23. *Dolichos fragrans*
24. *Dolichos glabratus*
25. *Dolichos glabrescens*
26. *Dolichos grandistipulatus*
27. *Dolichos gululu*
28. *Dolichos hastiformis*
29. *Dolichos homblei*
30. *Dolichos ichthyophone*
31. *Dolichos junghuhnianus*
32. *Dolichos karaviaensis*
33. *Dolichos katali*
34. *Dolichos kilimandscharicus* Taub.
35. *Dolichos linearifolius*
36. *Dolichos linearis*
37. *Dolichos longipes*
38. *Dolichos lualabensis*
39. *Dolichos luticola*

40. *Dolichos magnificus*
41. *Dolichos mendoncae*
42. *Dolichos minutiflorus*
43. *Dolichos nimbaensis*
44. *Dolichos oliveri* Schweinf.
45. *Dolichos peglerae*
46. *Dolichos petiolatus*
47. *Dolichos pratensis*
48. *Dolichos pseudocajanus*
49. *Dolichos pseudocomplanatus*
50. *Dolichos quarrei*
51. *Dolichos reptans*
52. *Dolichos rhombifolius*
53. *Dolichos schweinfurthii*
54. *Dolichos sericeus*
55. *Dolichos sericophyllus*
56. *Dolichos serpens*
57. *Dolichos simplicifolius*
58. *Dolichos smilacinus*
59. *Dolichos splendens*
60. *Dolichos staintonii*
61. *Dolichos subcapitatus*
62. *Dolichos tenuicaulis*
63. *Dolichos thorelii*
64. *Dolichos tonkouiensis*
65. *Dolichos trilobus*
66. *Dolichos trinervatus* Baker
67. *Dolichos ungoniensis*
68. *Dolichos xiphophyllus*
69. *Dolichos zovuanyi*

The subspecies are *viz*.,

1) *Lablab purpureus* (L.) Sweet subsp. bengalensis (Jacq.) Verdc. (Syn.: *Dolichos bengalensis* Jacq., *Dolichos lablab* subsp. *bengalensis* (Jacq.) Rivals, *Lablab niger* subsp. *bengalensis* (Jacq.) Cuf.).

2) *Lablab purpureus* (L.) Sweet subsp. purpureus and Lablab purpureus (L.) Sweet .

In addition *Lablab purpureus* subsp. *Uncinatus* of which a special variant with lobed leaflets exists only in Namibia: *Lablab purpureus* var. *rhomboïdeus* (Schinz).

Two cultivated type's viz., *Lablab purpureosu* var. *typicus* and *L. purpureus* var. *lignosus* were reported. Former is vegetable type cultivated for its soft and edible pods and latter is the field bean cultivated for dry seeds as pulse. Both varieties are cross compatible (Fig. 1) (HORT, 2023). *L. purpureus* var *typicus* and *L. purpureus* var *lignosus* Hyacinth bean is a perennial herbaceous plant often grown as an annual. Pole types are photosensitive (HORT, 2023).

Many subclassifications of *Lablab* species exist in the literature. Some distinguish subspecies, others varieties. Cultivated plants are distinguished by cultivar group (Naeem *et al*., 2023) : Cultivar group *Lablab bean* (widely distributed): mature seeds with long axis at right angles to the suture; pods dehiscent or indehiscent; seeds no longer than one-third to one-quarter of the width of the mature pod.

Cultivar group *Ensiformis* (South-East Asia, East Africa): mature seeds with long axis more or less oblique to the suture, nearly filling the mature pod; pods indehiscent; when young, difficult to distinguish from cultivar group Lablab bean. Cultivar group Bengalensis (South Asia, East Africa): mature seeds with long axis parallel to the suture, more or less filling the mature pod, gibbous dorsally and at base; pods indehiscent (Naeem *et al.,* 2023).

Synonyms (Al-Snafi, 2017):

1. *Lablab purpureus* L. Sweet;
2. *Dolichos lablab* L;
3. *Dolichos purpureus* L;
4. *Dolichos lablab* ssp ensiformis Thunb;
5. *Dolichos cultratus* Thunb;
6. *Dolichos bengalensis* Jacq;
7. *Dolichos lablab* var; hortensis Schweinf & Muschler;
8. *Dolichos albus* Lour;
9. *Dolichos uniflorus*;
10. *Dolichos lablab* ssp bengalensis Jacq;
11. *Lablab niger* Medik;
12. *Lablab vulgaris* Savi;
13. *Lablab leucocarpos* Davi;
14. *Lablab purpureus* ssp purpureus Verdc;
15. *Lablab vulgaris* var;niger DC;
16. *Lablab purpureus* ssp uncinatus Verdc;

17. *Lablab perennans* DC;
18. *Lablab nankinicus* Savi and
19. *Lablab purpureus* ssp bengalensis (Jacq.) Verdc

Synonyms (Wiktrop, 2023)

1	• *Dolichos albus* Lour.
2	• *Dolichos benghalensis* Jacq.
3	• *Dolichos lablab* L.
4	• *Dolichos purpureus* L.
5	• *Glycine lucida "sensu Blanco, non* J.R.Forst."
6	• *Lablab aultratus* DC.
7	• *Lablab niger* Medik.
8	• *Lablab purpurea* (L.) Sweet
9	• *Lablab vulgaris* (L.) Savi
10	• *Vigna aristata* Piper

Synonyms (Wikipedia, 2023)

Dolichos lablab L.
Dolichos purpureus L.
Lablab niger Medikus
Lablab lablab (L.) Lyons
Lablab vulgaris (L.) Savi
Vigna aristata Piper

Synonyms (HB, 2023)

- *Dolichos benghalensis* Jacq.
- *Dolichos lablab* L.
- *Dolichos purpureus* L.
- *Lablab niger* Medik.
- *Lablab nigra* Medik.
- *Lablab vulgaris var. albiflorus* DC.
- *Vigna aristata* Piper

Synonyms (Heuzé *et al*., 2016).

Dolichos lablab L.,
Dolichos purpureus L.,
Lablab leucocarpos Savi,
Lablab niger Medik.,
Lablab vulgaris Savi

Synonyms (CABI, 2023)

- *Dolichos bengalensis*
- *Dolichos lablab*
- *Lablab niger*
- *Lablab vulgaris* SAVI

L. purpureus var typicus

L. purpureus var lignosus

Fig. 1 : Botanical varieties of Dolichos bean

BOTANICAL DESCRIPTION

L. purpureus is an herbaceous, climbing, warm-season annual or short-lived perennial with a vigorous taproot. It has a thick, herbaceous stem that can grow up to 3 feet, and the climbing vines stretching up to 25 ft from the plant. It has trifoliate, long-stemmed leaves. Each egg-shaped leaflet widens in the middle and is 3–6 in. (7.5–15 cm) long. The surface of the leaflet is smooth above and short-haired below. The flowers grow in clusters on an unbranched inflorescence in the angle between the leaf and the mainstem. It may have white, blue, or purple flowers depending on its variety. Seedpods are 2 in. (4–5 cm) to 4 in. (10 cm) long , smooth, flat, pointed, and contain 2 to 4 seeds. Seeds can be white, cream, pale brown, dark brown, red, black, or mottled depending on variety (Sheahan, 2012). Lablab (*Lablab purpureus* (L.) Sweet) is a summer-growing annual or occasionally short-lived perennial forage legume. It is a twining, climbing, trailing or upright herbaceous plant that can grow to a length of 3-6 m. It has a deep taproot and vigorous, glabrous or pubescent trailing stems. Lablab leaves are alternate and trifoliolate. The leaflets are rhomboid in shape, 7.5-15 cm long x 8-14 cm broad, acute at the apex. The upper surface is smooth while the underside has short hairs. Inflorescences are many-flowered racemes borne on elongated peduncles. The flowers are white to blue or purple in colour, about 1.5 cm long, typically papillonaceous in shape. Lablab fruits are linear, 4-15 cm long x 1-4 cm broad, smooth and beaked pods that contain between 2 and 8 seeds. Lablab seeds (beans) are ovoid, laterally compressed with a conspicuous linear hilum. Lablab beans are variable in colour, depending on variety or cultivar, usually white to dark brown, and some are black. Wild varieties and some cultivated varieties tend to have mottled seeds. Lablab purpureus is the only species of the Lablab genus. There are three subspecies: 1) Lablab purpureus subsp. bengalensis is found in most tropical areas of Africa, Asia and the Americas, and has distinctive tender fruits up to 15 cm × 2.5 cm. 2) Lablab purpureus subsp. purpureus is grown in Asia as a field crop for seeds and fodder.

It is a semi-erect bushy perennial usually grown as an annual, showing little or no tendency to climb; the fruits are relatively short, up to 10 cm × 4 cm, and the whole plant is tinged with purple. It has a peculiarly strong and unpleasant smell. And 3) Lablab purpureus subsp. uncinatus, of East African origin, has relatively small fruits, 4 cm long × 1.5 cm broad (Fig.2) (Heuzé *et al.,* 2016). *Dolichos lablab* is a woody climbing herb which can reach a length of 5 m. Leaves are pinnate and generally 3-foliolate. Leaflets are acute, entire, 6–12 cm by 5–9 cm. Flowers are white or purplish pink. Fruits are green pods, 6 cm long by 2 cm wide, flattened, contain 4–5 seeds and turn light brown when mature (Al-Snafi, 2017). A bushy, trailing or twining herbaceous annual, biennial or perennial. Domesticated types are mostly summer growing annuals or occasionally short-lived perennials. Wild germplasm is strongly perennial. Stems robust, trailing to upright to 3–6 m in length; basal stem of perennials may reach up to 4 cm diameter. Leaves trifoliolate; leaflets broad ovate-rhomboid, 7.5–15 cm long, 1.5–14 cm wide, acute at apex, almost smooth above and short haired underneath; petioles long and slender. Inflorescence a lax, fascicled, many-flowered axillary raceme 4– 20 cm long on peduncle 2–40 cm long. Flowers white, blue or purple, on short pedicels; standard almost orbicular, 1.2–1.6 cm diameter; keel bent in a right angle. Pods flat or inflated, 5–20 cm × 1–5 cm, straight or curved, usually with 3–6 ovoid seeds of varying colour and size. Pods of cultivated types 4–5 cm long, broadly scimitar-shaped, smooth and beaked by the persistent style, containing 2–4 seeds, or 6–8 in var. bengalensis. Seed ovoid, laterally compressed, 0.5–1.2 cm long, 0.3–0.9 cm wide, and 0.2–0.7 cm thick, white or cream through to light and dark brown, red to black, sometimes mottled; conspicuous hilum, linear white aril extending around ⅓ of seed circumference. Seed of all wild material mottled. 2,000–6,000 seeds per kg. 1) ssp. purpureus**:** pods scimitar-shaped, 4–10 cm long, 2–4 cm wide, with 2–5 seeds. 2) ssp. bengalensis: pods linear-oblong to oblong, falcate, 3.5–14 cm long, 1.2–4 cm wide. And 3) ssp. uncinatus**:** pods scimitar-shaped, about 4 cm long, 1.5 cm wide (TF, 2020).

Leaves are alternate and trifoliate. Flowers are borne in axillary racemes and are typically papilionaceous and are self-pollinated. Flowering takes place under short day periods irrespective of planting time. Anthesis occurs from 9 a.m. to 5 p.m. (Pokle and Deshmukh, 1971). Anther dehiscence is from 5.00 a.m. to 2.00 p.m. Stigma is receptive on the day of anthesis (HORT, 2023). The plant is variable due to extensive breeding in cultivation, but in general, they are annual or short-lived perennial vines. The wild species is perennial. The thick stems can reach 6 m in length. The leaves are made up of three pointed leaflets, each up to 15 cm long. They may be hairy on the undersides. The inflorescence is made up of racemes of many flowers. Some cultivars have white flowers, and others may have purplish or blue. The fruit is a legume pod variable in shape, size, and color. It is usually several centimeters long and bright purple to pale green. It contains up to four seeds. The seeds are white, brown, red, or black depending on the cultivar, sometimes with a white hilum. Wild plants have mottled seeds. The seed is about a centimeter long **(**Wikipedia, 2023**).**These are herbs and shrubs growing upright, sometimes with climbing stems, or spreading prostrate upon the ground. They have woody rhizomes. The leaves have single blades or are pinnate, divided into three leaflets. The plants sometimes produce their leaves after flowering. The flowers are solitary or in racemes with more than one flower. The flowers are white or purple, or occasionally yellow. The fruit is a flattened legume pod. The plants' general form, annual stems sprouting from a large perennial rootstock, is thought to be adapted to habitat prone to seasonal wildfire. Some of the species grow to heights of 30 feet. The average Dolichos is between 5 and 10 feet high (Wikipedia**,** 2023**).** The plant of Hyacinth beans is annual or short-lived perennial, twining or trailing herb with thick stem which is about 6 meters long. The plant grows up to 10-15 feet high. The leaves are alternate, trifoliate and 7.5 – 15 cm long. The flowers are purple or white. It requires a well-drained soil. The fruit is a broadly scimitar and smooth pods which is bright purple to pale green. The pods are 4–5 cm long. Each pod contains 4-6 seeds, round to oval and 1 cm long. The seeds are white, cream, pale brown, dark brown, red, black or mottled (HB, 2023).

A bushy or a climbing and branching, pubescent herbaceous perennial, often grown as an annual, up to 6 m tall, with a well-developed tap root with many laterals and well developed adventitious roots. Leaves alternate, trifoliolate; leaflets broadly ovate, 5–15 x 4–15 cm, entire, subglabrous or soft hairy. Inflorescences stiff axillary racemes with many flowers; peduncle 4–23 cm long, often compressed, glabrescent; rachis 2–24 cm long; flowers arising 1–5 together from tubercles on rachis; pedicels short, square, sparsely pubescent; flowers white, pink, red or purple; stamens diadelphous (9 + 1); ovary sessile, 10 mm long, finely pubescent; style abruptly upturned, 8 mm long; stigma capitate, glandular. Pods variable in shape and colour, flat or inflated, 5-20 x 1–5 cm, straight or curved, usually with 3–6 ovoid seeds of varying colour and size (CABI, 2023). Lablab bean is a bushy or climbing and branching, pubescent herbaceous perennial, often grown as an annual, up to 6 m tall, with a well-developed taproot with many laterals and well-developed adventitious roots. Leaves alternate, trifoliolate; leaflets broadly ovate, 5–15 × 4–15 cm, entire, subglabrous, or soft hairy. Inflorescences axillary racemes with many flowers; peduncle 4–23 cm long, often compressed, glabrescent; rachis 2–24 cm long; flowers arising 1–5 together from tubercles on rachis; pedicels short, square, sparsely pubescent; flowers white, pink, red or purple; stamens diadelphous (9 + 1); ovary sessile, 10 mm long, finely pubescent; style abruptly upturned, 8 mm long; stigma capitate, glandular. Pods variable in shape and color, flat or inflated, 5–20 × 1–5 cm, straight or curved, usually with 3–6 ovoid seeds of varying color and size (Naeem et al., 2023). Lablab bean is a herbaceous perennial plant, growing in tuft or voluble, reaching 3 m to 4.50 m. The plant has a taproot system. The long-stalked leaves are alternate, compound trifoliate, 10 to 50 cm long. The petiole is framed by 2 oval-triangular stipules, striated, 4 to 6 mm long. The leaflets are ovate-triangular to rhombic-ovate, obtuse to truncate base, with triangular acute to obtuse end, acuminate. They are 4 to 20 cm long and 3 to 19 cm wide. They are generally pubescent. The flowers are held by axillary inflorescence, 10 to 60 cm long. The flower pedicel measure 2 to 3.5mm long, bracteoles 4 to 8 mm long and 1 to 4.5 mm wide. The calyx, 5 to 9 mm long, is glabrous

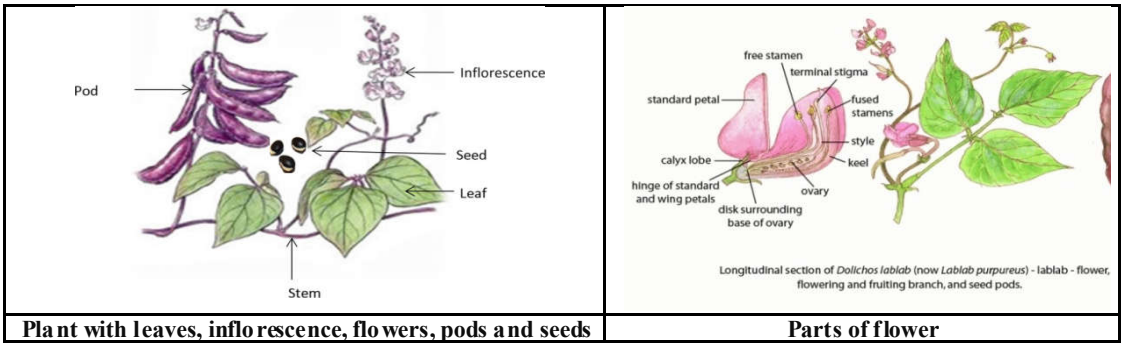
to pubescent, with lower lobes narrow in size matching the tube. The flower is of papilionaceous type. The upper petal (the standard), 1.2 to 1.5 cm long, is variable in color: purple, pink, purple, cream tinged with purple or white. The flattened pod, 3.5 to 14 cm long and 1.2 to 4 cm wide, is generally pubescent. The seed is rounded and flattened, dark brown. It measures 5 to 17 mm long, 4 to 6 mm wide, 3 to 5.5 mm thick (Wiktrop, 2023). Germination is epigeal and normally takes 5 days. Seed remains viable for 2–3 years and on average 85–95% germinate. Growth period varies from 75 to 300 days. Improved cultivars start fruiting 60–65 days after sowing and continue for 90–100 days. Early-maturing cultivars that can be grown all year round produce pods 60 days after sowing and continue up to 120 days. Mature seeds are harvested 150–210 days after sowing, depending upon cultivar and time of sowing. In India, short-day cultivars start flowering 42–330 days after sowing, depending on the sowing date. The flowers are mainly cross-pollinated (CABI, 2023). The plant of Hyacinth beans is annual or short-lived perennial, twining or trailing herb with thick stem which is about 6 meters long. The plant grows up to 10-15 feet high. The leaves are alternate, trifoliate and 7.5 – 15 cm long. The flowers are purple or white. It requires a well-drained soil. The fruit is a broadly scimitar and smooth pods which is bright purple to pale green. The pods are 4–5 cm long. Each pod contains 4-6 seeds, round to oval and 1 cm long. The seeds are white, cream, pale brown, dark brown, red, black or mottled (HB, 2023).

Raghu *et al.* (2018) distinguished the features of *Lablab purpureus* var. *typicus* and *Lablab purpureus* var. *lignosus* as given in Table1.

Table 1. Distinguishing features of *Lablab purpureus* var. *typicus* and *Lablab purpureus* var. *lignosus*

Features	*Lablab purpureus* var. typicus	*Lablab purpureus* var. lignosus
Common names	Garden bean, Hyacinth bean	Field bean, Indian bean, Lablab bean
Vernacular names	Sem (Hindi), Hittalavare or Nelavare (Kannada), Chikudu (Telugu), Wal (Marathi), Aare (Tamil)	Avare (Kannada), Avarai (Tamil);
Growth type	Indeterminate or semi-indeterminate	Determinate
Growth habit	Perennial twining herb usually trained on a pendal (Pole type)	Perennial bush oftenely grown as annual (Bush type)
Cultivation type	Garden type crop	Field crop type, either as pure crop or intercropped with other cereals
Pigmentation	More pigmentation on stem, leaves and pods	Less pigmentation on stem, leaves and pods
Flowering	Thermo-photoperiod sensitive (short day)	Thermo-photoperiod insensitive
Flowering duration	60-90 days after sowing	40-50 days after sowing
Pod traits	Pods are Longer, flat and tapering. Long axis of seeds is parallel to suture of the pod.	Pods are shorter in length and more abruptly truncated. Long axis of seeds is perpendicular to suture of the pod.
Parchment on pod wall	Pods are relatively less fibrous, soft and whole pod is edible	Pods are firm-walled and fibrous pods not suitable for whole pod consumption
Harvesting stage	Green immature pods and green seeds harvested	Fully matured dry pods are harvested for dry seeds; However, pods are harvested for green seeds
Purpose	Usually cultivated for green immature pods and green seeds and consumed as vegetable	Usually cultivated for dry seeds and consumed as pulse
Other traits	No oily substances and characteristic fragrance	It exude oily substances that emit characteristic fragrance
Yield potential	High	Less
Popular local cultivars	'Kanupu Chikudu'	'Magadi local', 'Shivappu avare', 'Yanaikathu Avarai' and 'Kozhikkal Avari', 'Kadalavare'

Floral Biology: It flowers during the months of September to February. Large numbers of small flowers are arranged in long recemes. Flowers open between 11.00 am to 04.00 pm. Anther dehiscence occurs before flower opening. The stigma becomes receptive during 08.00 am to 07.00 pm on the day of flower opening. The stigma is wet, papillate and the style is solid. Pollen viability percentage in TTC was found to be 94.89%. The percentage of *in vivo* pollen germination was recorded as 38.80% which was found to be increased to 40.48 and 54.25% on the second and third day respectively. Flowers are visited by several insects. However, *Xylocopa*, ants, thrips, butterflies are the main visitors. During the present investigations, development of fruit and number of seeds were observed after self- and cross-pollination. The size and shape of the fruits and seeds varied considerably. Mature fruits were collected with 15 total numbers of seeds after self-pollination whereas small fruits with 10 total numbers of seeds were collected after cross-pollination. Self-pollinated flowers showed 80 percent fruit set whereas cross-pollinated flowers showed 60 percent fruit set. The percent fruit set and total number of seeds from self-pollination were higher than those from cross-pollination indicating that dominant mode of reproduction was found to be self-pollination (Kukade and Tidke, 2014). *Lablab purpureus* is an ancient underutilized legume vegetable crop widely grown throughout the world for its green pod for human consumption. *Lablab purpureus* is a twining herb with stipulate and trifoliate leaves. In the present study, variations in the reproductive characters of *L.purpureus* subsp. *purpureus* and *L. purpureus* subsp. *uncinatus* were analysed. For this floral phenology, floral biology, anthesis, stigma receptivity, pollen viability, pollen morphology and seed characters were observed. The inflorescence is a raceme with purple or white flowers. The pod is variable in shape, size and color with a wavy margin (Vishnu and Radhamany, 2020). The flower opening occurs between 11.30 am and 04.00 pm and anther dehiscence occurs before the flower opening. The stigma become receptive from 07.30 am to 06.00 pm on the day of the flower opening. The stigma is wet, papillate with solid style. Flower size and colour were found to be varying between two subspecies,. In *L.purpureus* subsp. *purpureus* the flowering was seasonal but *L.purpureus* subsp. *uncinatus* it was observed throughout the year with peak flowering during the winter. Pollen morphology, pod size, seed color and size varies between two subspecies (Vishnu and Radhamany, 2020). Hyacinth bean is a perennial herbaceous plant grown as an annual. Pole types are photosensitive. Leaves are alternate and trifoliate. Flowers are borne in axillary racemes and are typically papilionaceous and are self-pollinated. Flowering takes place under short day periods irrespective of planting time. Anthesis occurs from 9 a.m. to 5 p.m. Anther dehiscence is from 5.00 a.m. to 2.00 p.m. Stigma is receptive on the day of anthesis (IASRI, 2023).



Plant with leaves, inflorescence, flowers, pods and seeds | **Parts of flower**

Continue…

Inflorescence

Inflorescence

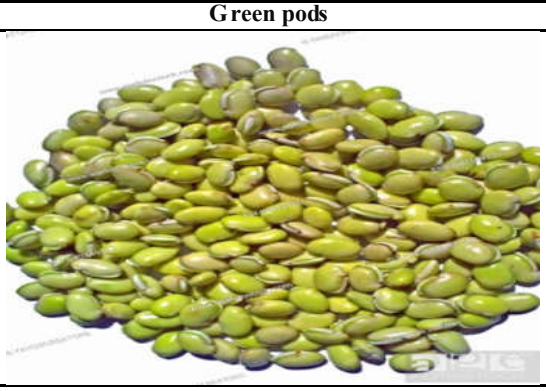
Plant with pods

Plant with pods

Green pods

Green pods

Green pods with seeds



Green seeds

Dry pods and seeds

Dry seeds

Fig. 2: Botanical Description

GENETIC DIVERSITY

Forty-four hyacinth bean genotypes were evaluated for different qualitative and quantitative characters. The genotypes showed considerable variations for most of the morpho-physical traits. Shape, size and colour of vein, leaf, petiole, stem, flower, pod and seed varied among the genotypes. Days to first flower ranged from 47.6 to 136 3 days indicating the presence of early variety. Individual pod weight varied from 1.47 (HB042) to 12.3g (HB009). The genotype HB027 produced the maximum number of pods/ plant (425) closely followed by HB001 (385). Similar trend was observed for pod yield/plant. The genotype HB027 produced the highest pod yield/plant (3.45kg) followed by HB001 (3.35kg). 100-green seed weight ranged from 4.0g to 73.33g, which indicated the presence of bold seeded genotypes. Among the genotypes, HB027 and HB007 produced very bold green seed and higher green pod yield/plant, therefore, they can be selected for both pod and green seed production purpose (Islam *et al.,* 2010). *L. purpureus* is well known and valued for its physiological diversity, and can exhibit both bush and twining growth habits, as well as early-flowering and late- flowering characteristics. More than 3,000 accessions of germplasm have been collected worldwide (Maass *et al*., 2010). Yet despite its morphological diversity, the two varieties Rongai and Highworth (both forage varieties) seem to be most popular in the United States. Rongai (late-flowering) grows upright and has white flowers thatbloom when there is less than 11 hours of daylight (FAO,2012). Highworth (early-flowering) is a twining variety that has purple blooms. There is also an earlier floweringvariety from East Texas called Rio Verde that flowers after 55 days (Sheahan, 2012). Mahalanobis D^2 statistics was used to study the genetic divergence for 19 characters among 48 genotypes of Indian bean. Genotypes were grouped in to eight clusters on the basis of relative magnitude of D^2 values. The highest number of genotypes (14) appeared in cluster III. The maximum intercluster distance was observed between cluster IV and cluster VI followed by cluster IV and VIII. The minimum inter cluster distance was observed between cluster I and cluster IV. Maximum intra cluster distance was in cluster V followed by cluster III. The mean value for most of the traits was highest in cluster VIII. Among the yield contributing characters, the maximum contribution towards divergence was made by protein content followed by number of flowers per inflorescence, pod length and number of pods per plant. Hybridization between cluster IV and VI could be utilized for getting the superior recombinants or transgress segregants in segregating generations (Chaitanya *et al*., 2013).

Variability, heritability, correlation and genetic divergence were studied in 30 strains of dolichos bean (*Lablab purpureus* L.) for various growth and yield attributing parameters. High phenotypic and genotypic coefficient of variation was found in number of flowers per cluster, fresh green pod yield per plant, green pod yield per hectare, and mineral content. High heritability and expected genetic advance was found in number of flowers per cluster, vine length, weight of 10 green pods, fresh green pod yield per plant, and green pod yield per hectare. Genotypic correlation was higher than phenotypic correlation. Yield per plant was positively and significantly correlated with number of branches per plant, number of pods per cluster, number of pods per plant, weight of 10 green pods, number of clusters per plant, and number of flowers per cluster. For genetic divergence studies, the genotypes were grouped into 11 clusters on the basis of relative magnitude of D^2 values. Maximum intercluster distance was recorded between Clusters VII and I, indicating a wide diversity among these two clusters. Minimum intercluster distance was observed between Clusters IX and VIII, indicating their close relationship. Thus, Clusters VII and I were generally the most divergent from the other clusters. Intra-cluster value was highest for Cluster IX. Intra-cluster distance was least for Clusters VI and X. Among the genotypes, SC-5, SC-7, SC-11, SC-16 and SC-17 were the best in traits related to yield compared to the Check, PS-2 (Dhillon and Kumar, 2015). A great range of variation exists for plant and pod characters among the accessions grown all over the country. Planning and execution of a breeding programme for improving quantitative attributes depends, to a great extent, on the magnitude of genetic variability available (Dhillon and Kumar, 2015). Several of the plant traits are governed by polygenes, greatly influenced by environmental conditions. There is a need to partition the overall variability into heritable and non-heritable components. Knowledge on genetic diversity, its nature, degree of variability and interrelationship between traits is useful in selecting suitable parents to initiate a successful breeding programme (Dhillon and Kumar, 2015).

Studies was carried out to assess the genetic divergence among 38 dolichos bean genotypes using Mahalanobis D^2. 38 genotypes were grouped into seven clusters. Cluster I had highest number of genotypes (11) followed by cluster VII (9), cluster V (7), cluster VI (4), cluster II and cluster III (3), cluster IV (2) having 1 genotype. The maximum inter cluster distance was observed between cluster no. III and VII (62168.95) and cluster no. IV and V (2078.16) showed minimum inter cluster distance. The highest intra cluster distance was recorded for cluster no. III (1903.00) and cluster no. V (117659) showed minimum intra cluster distance (Dewangan *et al.,* 2018). Increased and continued use of the diverse genotypes is a prerequisite for developing and diversifying the genetic base of crop cultivars. DNA markers which are crop-stage non-specific environmental neutral, easily assayable and amenable for automation are being used to assess the diversity of germplasm accessions and/or breeding lines. DNA markers also provide information on the population structure, allelic richness, and parameters that specify diversity among the genotypes to help breeders to choose those most appropriate for use in cultivar development. Hence SSR markers were used to assess diversity at marker loci among 16 phenotypically diverse dolichos bean genotypes. In the present study, 52 of 55 SSR-based markers were polymorphic, resulting in 94.55% polymorphism. Amplification of genomic DNA segments complementary to 55 SSR primers resulted in 133 scorable alleles with an average of 2.5 alleles per SSR loci. SSR markers exhibited differential ability to discriminate 16 genotypes as indicated by the estimates of effective multiplex ratio which ranged from 1.89 to 4.73 and marker index ranged from 0.69 to 3.40. The average gene diversity in the present study is more than that reported in dolichos bean. The estimates of Shanon's diversity index complemented those of average gene diversity. These results indicate that these SSR markers are highly informative and could be used to assess genetic diversity among the genotypes. The genotypes, HA 10-8, FPB 15 and RIL 162 share different alleles, FPB 8 and RIL 21 share similar alleles. Hence, the genotypes, HA 10-8, FPB 15 and RIL 162 could be used in crossing programme to derive genotypes with combination of desired traits (Keerthi *et al*., 2018). Research work was undertaken in dolichos bean (*Lablab purpureus* L.) genotypes to identify suitable germplasm for cultivation with high pod yield and quality traits. The study reveals that highly significant difference were observed for all the sixteen traits. Mean performance showed that Arka Jay (912.0 g) registered the highest pod yield per plant and lowest by Glory (228 5 g). From the nutrient point of view, the genotype Sarpan Seeds recorded highest protein content (3.84g) whereas Bhopal local for pod fibemess and Glory for highest total sugar content (1.25%). Hence, these genotypes could be better utilized for further breeding programme for the improvement of pod yield and other quality parameters (Mahesh *et al*., 2019). Despite a wide range of adaptability and diversity, it remains an underutilized crop. Broadening the genetic base and enhancing crop cultivar diversity is the key to sustainable production of hyacinth bean (Vaijayanthi *et al.,* 2019). Despite a wide range of adaptability and diversity, it remains an underutilized crop. Broadening the genetic base and enhancing crop cultivar diversity is the key to sustainable production of hyacinth bean (Vaijayanthi *et al*., 2019).

D. lablab L. is a species of bean that is categorized as local food with its perceived potential as alternative food source rich in nutritional content. This current comparative research aimed at investigating the influences of accessions upon nutritional content of *D. lablab* found in Malang, Probolinggo, Madura, and West Nusa Tenggara (WNT). A proximate analysis was administered to investigate water, ash, lipid, protein, and amylose contents in each of *D. lablab* accessions. One-way MANOVA test was chosen for data analysis in this current research. The interval of water content ranged from 8.95 to 19.35%. Additionally, the intervals of ash, lipid, protein, and amylose

contents respectively signified 3.40-4.11%, 0.33-0.75%, 20.06-24.22%, and 11.89-14.93%. Meanwhile, in terms of dry weight, they respectively varied at the following intervals of 4.11-4.90%, 0.37-0.90%, 22.91-27.21%, and 13.10-17.04%. The result of analysis indicated that the differences set in the accessions significantly influenced the nutritional content of the investigated *D. lablab*. In short, conservation on any *D. lablab* accessions in Indonesia is in urgent need of implementation due to high nutritional contents of the plant (Purwanti *et al.,* 2019).

Dolichos bean occupies a unique position among the legume vegetables of Indian origin for its high nutritive value and wider climatic adaptability. Despite its wide genetic diversity, no much effort has been undertaken towards genetic improvement of this vegetable crop. Knowledge on genetic variability is an essential pre-requisite as hybrid between two diverse parental lines generates broad spectrum of variability in segregating population. The current study aims to assess the genetic diversity in Dolichos genotypes to make an effective selection for yield improvement. Twenty genotypes collected from different regions were evaluated. Data on twelve quantitative traits was analysed using principal component analysis and single linkage cluster analysis for estimation of genetic diversity. Principal component analysis revealed that first five principal components possessed Eigen value > 1, cumulatively contributed > 82.53% of total variability. The characters positively contributing towards PC-I to PC-V may be considered for dolichos improvement programme as they are major traits involved in genetic variation of pod yield. All genotypes were grouped into three clusters showing non parallelism between geographic and genetic diversity. Cluster-I was best for earliness and number of cluster/plant. Cluster-II for vine length, per cent fruit set, pod length, pod width, pod weight and number of seed /pod, cluster III for number of pods/cluster and pod yield /plant. Selection of parent genotypes from divergent cluster and component having more than one positive trait of interest for hybridization is likely to give better progenies for development of high yielding varieties in Dolichos bean (Singh *et al.,* 2021).

29 genotypes of Indian bean (*Lablab purpureus)* were evaluated. The study showed the degree and distribution of genetic diversity in dolichos bean, which can be utilized to identify the parental lines, to develop mapping populations and breeding (Pidigam *et al.,* 2021). Cultivar group Lablab (widely distributed): mature seeds with the long axis at right angles to the suture; pods dehiscent or indehiscent; seeds not longer than one third to one quarter of the width of the mature pod. Cultivar group Ensiformis (South-East Asia, East Africa): mature seeds with long axis more or less oblique to the suture, nearly filling the mature pod; pods indehiscent; when young, difficult to distinguish from cultivar group Lablab. Cultivar group Bengalensis (South Asia, East Africa): mature seeds with long axis parallel to the suture, more or less filling the mature pod, gibbous dorsally and at base; pods indehiscent (CABI, 2023). A large variation in plant height, number of pods/plant, number of seeds/pod, length of pod and seed weight/ plant has been observed. Small-podded types are common in India and Papua New Guinea, while longer-pod types are found in Indonesia and West Africa. Genetic variability for pod and seed was very high, as detected by RAPD markers and RFLP studies. This information has provided an opportunity for breeding strategies to improve the crop (CABI, 2023). Lablab exhibits a wide morphological difference in most of its parameters, such as leaf color, leaf vein color, stem pigmentation, flower, pod and seed color and growth habit. Some of the photos of the different seed and flower morphology are as shown below in Fig. 6. (Letting *et al.,* 2021) (Fig. 3, 4 5, 6).

Bush type plants

Bush type plants

Fig. 3:

Fig. 4. Variability fopr plant leaf, flower, stem color and plant type

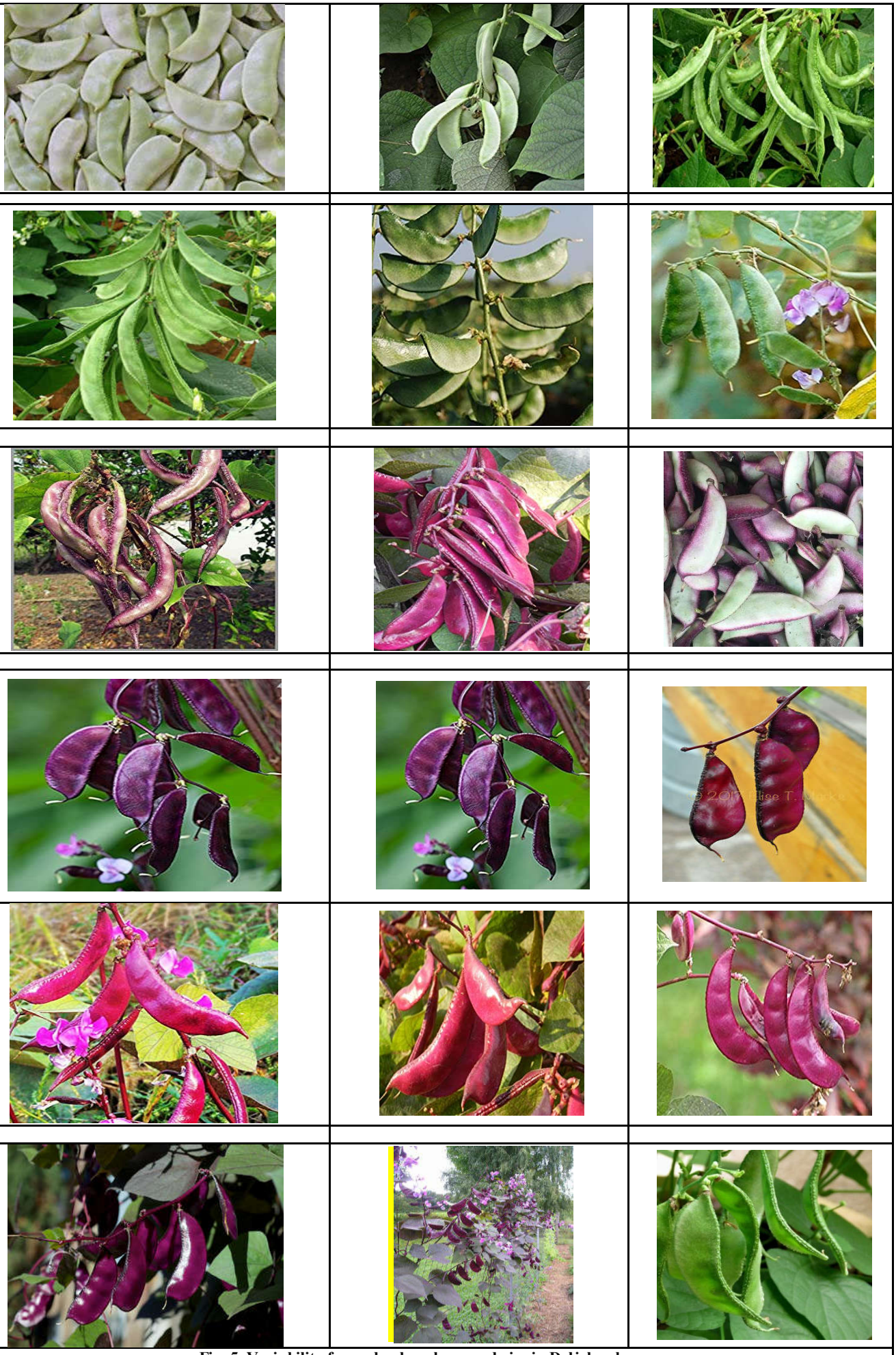


Fig. 5. Variability for pod color, shape and size in Dolichos bean

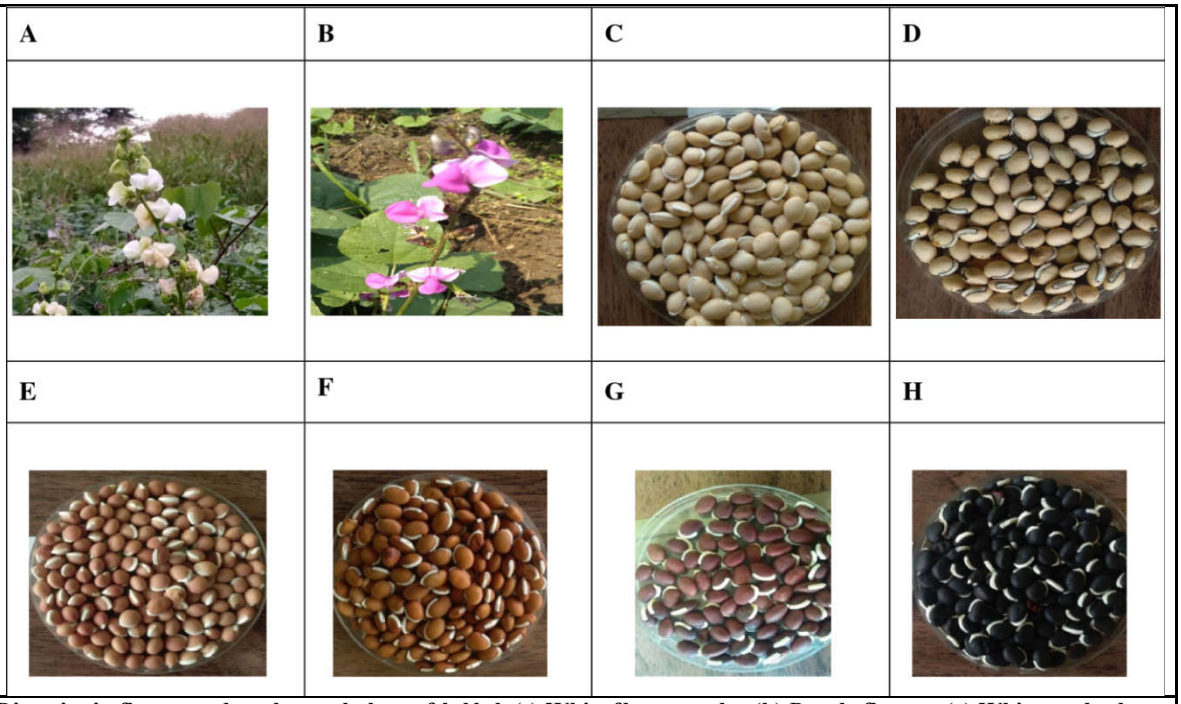


Fig. 6. Genetic Diversity in flower and seed morphology of lablab (a) White flowers color (b) Purple flowers (c) White seed color (d) White seed with black hilum edges (e) Cream seed color (f) Brown seed color (g) Red seed color (h) Black seeds

BREEDING

Genetic Resources: There is wide genetic variation in the tropics and subtropics. No attempts have been made so far to collect and catalogue the germplasm elsewhere in the world. In Australia and New Zealand, only fodder types are maintained. Germplasm collection and evaluation of lablab bean have been carried out in many countries in Asia, with the aim of selection and improvement of the crop. India, Indonesia, Australia and the ILRI (International Livestock Research Institute) and some national institutions in Asia have been storing collections (CABI, 2023). With germplasm collections, India is trying to obtain bushy short-duration day-neutral disease-resistant cultivars. The University of Bangalore, India has been involved in a systematic improvement programme for the crop. More than 250 lines, both indigenous and exotic, are maintained and catalogued at the University of Agricultural Sciences of Bangalore, India (CABI, 2023).

Germplasm resource conservation of lablab: *Ex situ* lablab genetic resources are maintained in various locations across the African, Asian, America, Oceania and Europe (Letting *et al.*, 2021) (Table 2). Germplasm conservation of lablab plays a critical role in identifying the existing and unknown crop diversity as well as maintaining the genetic basis to enhance the development of improved varieties. The advances in phenotypic and genotypic studies allow effective and efficient exploration of the germplasm collections present in gene banks. Research focuses on understanding the conservation status is important for future breeding programs.

Table 2. Lablab genetic resources in different gene banks

Continent	Country and Institutions involved	Acc. No
Asia*	South-east Asia (Other than Bangladesh & India)	82
	South Asia	93
	Philippines	209
	National Bureau of Plant Genetic Resources (NBPGR), India	221
	China	410
	World Vegetable Research and Development Centre (AVRDC), Taiwan	447
	Bangladesh	551
	University of Agricultural Sciences (UAS)- Bengaluru, India*	650
Africa*	Sub-Saharan Africa including International Institute of Tropical Agriculture (IITA), Nigeria	67
	World Vegetable Centre, Eastern and Southern Africa, Arusha-Tanzania	73
	Ethiopia including International Livestock Research Institute (ILRI)	403
	Kenya	403
	Nelson Mandela African Institutions of Science & Technology (NM-AIST), Tanzania*	450
Oceania	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia	104
America	United States, Department of Agriculture (USDA)	52
	Europe	82
Europe	South America	134
	Total	4251

Genetic Improvement of Dolichos: The main breeding objective is higher yield (CABI, 2023). Although this crop originated in India, very little work has been done for its genetic improvement (Dhillon and Kumar, 2015). Most attempts to unravel genetics of quantitative traits are restricted to either first (mean) or second degree (variance) statistics but rarely both. The use of both first and second degree statistics provide dependable information on true properties of genes controlling quantitative traits in crop plants. An investigation was carried to unravel genetics of fresh pod yield and its component traits at first and second degree statistics levels in dolichos bean, one of the important food grain legume extensively

grown in India. The results indicated the importance of both additive and dominance with a predominance of dominance genetic effects in the inheritance of most of the traits. The estimates of additive genetic variances (σ 2 A) and hence narrow sense heritability (ns-h 2) were higher for all the characters in F 2 and F 3 generations derived from two crosses. The study indicated comprehensive and mutually complementary information on the mode of action of genes controlling fresh pod yield and its component traits based on first and second degree statistics. One or two cycles of biparental mating in F 2 and /or F 3 generations followed by recurrent selection are advisable to reduce dominance genetic effects and enhance the frequency of favorable genes in the segregating populations to increase the effectiveness of selection for desired combination of traits (Showkath Babu *et al*., 2016). Despite its multi-utility and multi-benefits, Dolichos is still an underutilized and unexplored crop. It is evident from limited area of cultivation under this crop and efforts towards its genetic enhancement (Vaijayanthi *et al.,* 2018). Though, few efforts are underway to improve the genetic potential of Dolichos for pod yield, grain yield and its attributes elsewhere. More often, they are isolated programmes, characterized by limited use of plant genetic resources (PGR), relies on narrow genetic base. In most cases, breeding methods involves hybridization followed by selection for recombinants in segregating generations, which is more time consuming, more land and resource demanding and less efficient. Whereas, more efficient and enhanced pace of breeding programme in Dolichos require adoption of a well- conceived strategy that hinges on increased use of available plant genetic resources, identification of trait based genotypes, identification and introgression of key genes/ Quantitative Trait Loci (QTLs). Further, it should be supported by comprehensive survey and exploration of wide range of germplasm resources, understanding the extent of genetic wealth, followed by characterization and documentation and regular exchange of germplasm between institutes involved in Dolichos improvement. Development and increasing use of different robust genomic resources such as SSR (Simple sequence repeats) markers, SNPs (Single Nucleotide Polymorphism), DArT (Diversity Arrays Technology) etc,. and their efficient use in identification of elite genotypes and traits discovery. In past, efforts were made to improve Dolichos for vegetable purpose, grain yield and fodder purpose. Many Indian Council of Agricultural Research (ICAR) institutes, State Agricultural Universities (SAU) and few international institutes are actively involved in genetic improvement of Dolichos. The ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru, is a pioneer institute to successfully introgress photo-insensitivity and determinate traits from*Lablab purpureus* var. lignosus (Hebbal Avarai 3, a pulse type Dolichos as a donor) into genetic background of *Lablab purpureus* var. typicus (Kanupu Chikudu, a most priced local garden bean), and developed two bush type vegetable Dolichos varieties namely, Arka Jay and Arka Vijay suitable for round the year cultivation (Fig. 7). Besides, ICAR-IIHR, has developed six varieties of photo-insensitive pole type Dolichos and three more photo-insensitive bush type Dolichos varieties for vegetable purpose (Raghu *et al.,* 2018). Development of purelines through pedigree breeding is the preferred method of breeding in the hyacinth bean, as in other grain legume crops. Screening of germplasm resources, identification of trait-specific material and their use in breeding could be a long-term strategy to addressing various existing and anticipated production constraints. With the advent of molecular marker/omic technology, the pace and efficiency of hyacinth bean breeding has attained considerable momentum. DNA marker-assisted diversity analysis, chromosomal localization and unraveling of the mode of action of genes controlling traits of economic importance, tagging genomic regions controlling economic traits etc., will complement phenotype-based selection and breeding. Furthermore, deployment of various genomic tools will help in introgression of superior alleles into elite agronomic backgrounds and hence sustainable production of hyacinth bean (Vaijayanthi *et al*., 2019). Most of the improvement work is concentrated in India. The local landraces are of long duration, photosensitive and low-yielding (500–600 kg/ha) (CABI, 2023).

The green pods are picked by hand when they have reached a reasonable size, usually when the seeds are three-quarters ripe. They are generally picked from the plants at intervals of 3–4 days, cleaned and graded for size, before being packed in baskets for the market. In many cultivars, the pods mature in succession on the stem and shatter once they are ripe. For seed production, the pods are frequently picked by hand as soon as they ripe, until the plants reach full maturity and the major proportion of the remaining pods has ripened. At that stage, the entire plant is cut close to the ground with a sickle and the vines left to dry for a few days before threshing (CABI, 2023). The average yield of green pods is 2600–4500 kg/ha, and of seed is 450 kg/ha if grown as intercrop and up to 1460 kg/ha in sole cropping. Fodder yields are 25–40 t/ha (CABI, 2023)

Despite its multi-utility and multi-benefits, Dolichos is still an underutilized and unexplored crop. It is evident from limited area of cultivation under this crop and efforts towards its genetic enhancement. Though, few efforts are underway to improve the genetic potential of Dolichos for pod yield, grain yield and its attributes elsewhere. More often, they are isolated programs, characterized by limited use of plant genetic resources (PGR), relies on narrow genetic base. In most cases, breeding methods involves hybridization followed by selection for recombinants in segregating generations, which is more time consuming, more land and resource demanding and less efficient. Whereas, more efficient and enhanced pace of breeding program in Dolichos require adoption of a well-conceived strategy that hinges on increased use of available plant genetic resources, identification of trait based genotypes, identification and introgression of key genes/ Quantitative Trait Loci (QTLs). Further, it should be supported by comprehensive survey and exploration of wide range of germplasm resources, understanding the extent of genetic wealth, followed by characterization and documentation and regular exchange of germplasm between institutes involved in Dolichos improvement. In past, efforts were made to improve Dolichos for vegetable purpose, grain yield and fodder purpose. Many Indian Council of Agricultural Research (ICAR) institutes, State Agricultural Universities (SAU) and few international institutes are actively involved in genetic improvement of Dolichos. The ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru, is a pioneer institute to successfully introgress photo-insensitivity and determinate traits from *Lablab purpureus* var. *lignosus* (Hebbal Avarai 3, a pulse type Dolichos as a donor) into genetic background of *Lablab purpureus* var. *typicus* (Kanupu Chikudu, a most priced local garden bean), and developed two bush type vegetable Dolichos varieties namely, Arka Jay and Arka Vijay suitable for round the year cultivation (Fig. 7). Besides, ICAR-IIHR, has developed six varieties of photo-insensitive pole type Dolichos and three more photo-insensitive bush type Dolichos varieties for vegetable purpose (Raghu *et al*., 2018).

Varieties: Popular varieties of Dolichos released for vegetable, pulse and fodder purpose are furnished below:

Varieties released by IIHR, Bengaluru (IIHR, 2023)

Arka Adarsh: Pole type and photo-insensitive and early variety. Pods are borne in clusters and dark green coloured. Suitable for Karnataka. Developed by Pedigree method of selection from F7 generation involving (IIHR 178 X Arka Swagath). Pod Yield: 30.0 t/ha in 120 days.

Arka Krishna: Pole type and photo-insensitive and early variety. Pods are borne in clusters and dark green coloured. Suitable for Karnataka. Developed by Pedigree method of selection from F7 generation involving (IIHR 178 X Arka Swagath). Pod Yield: 30.0 t/ha in 120 days.

Arka Pradhan: Pole type and photo-insensitive variety. Pods are green in colour, smooth and shiny with undulating surface. Suitable for cultivation in Maharashtra.Developed by Pedigree method of selection from F7 generation involving(IC 556824 IPS-2 X Arka Swagath). Pod Yield: 35.0 t/ha in 120 days.

Arka Visthar: Pole type and photo-insensitive variety. Pods are long, thick, very broad and dark green coloured. Suitable for cultivation in Tamil Nadu and North Eastern states.Developed by Pedigree method of selection from F7 generation involving (IIHR 178 X Arka Swagath). Pod Yield 37.0 t/ha in 120 days.

Arka Bhavani: Pole type and photo-insensitive variety. Pods are slender, wavy and dark green coloured. Suitable for cultivation in Andhra Pradesh.Developed by Pedigree method of selection from F7 generation involving(IIHR 178 X Arka Swagath).Pod Yield: 32.0 t/ha in 120 days.

Arka Prasidhi: Pole type and photo-insensitive variety. Pods are dark green, long, flat and slightly curved. Resistant to rust. Suitable for south Indian states. Developed by Pedigree method of selection from F7 generation involving (IC 556824 IPS-2 X Arka Swagath). Pod Yield: 37.0 t/ha in 120 days.

Arka Swagath: Pole type and photo-insensitive variety and suitable for round the year cultivation. Pods are light green, medium long and suitable for Karnataka.Developed by Pureline selection from IC 556736. Pod Yield: 26.0 t/ha in 120 days.

Arka Amogh: Plants are medium tall and photo-insensitive. Pods are wavy, green, medium long and ready for harvest in 55 days. Suitable for Maharashtra. Developed by Pedigree method of selection from F7 generation involving(Arka Jay X Arka Vijay) X Konkan Bhushan). Pod Yield: 19-20 t/ha in 75 days.

Arka Sambhram: Plants are medium tall and photo-insensitive. Pods are flat, light green, medium long, medium width and ready for harvest in 55 days. Suitable for Tamil nadu.Developed by Pedigree method of selection from F7 generation involving(Arka Jay X Arka Vijay) X Konkan Bhushan). Pod Yield: 19-20 t/ha in 75 days.

Arka Soumya: Plants are medium tall and photo-insensitive. Pods are slender, wavy, medium long and ready for harvest in 55 days. Suitable for Andhra Pardesh. Developed by Pedigree method of selection from F7 generation involving(Arka Jay X Arka Vijay) X Konkan Bhushan). Pod Yield: 19.0 t/ha in 75 days

Arka Vijay: Plants dwarf, bushy, erect and photo-insensitive. Pods short, dark green. Seeds bold. Pods with characteristic aroma and without parchment. Tolerant to low moisture stress. Developed byPedigree method of selection from F7 generation involvingHebbal Avare x IIHR 93. Pod Yield: 12 t/ha in 90 days. **(Fig.7).**

Arka Jay: Plants dwarf, bushy, erect and photo-insensitive. Pods long, light green slightly curved, without parchment. Vegetable type with excellent cooking qualities. Tolerant to low moisture stress. Pod Yield: 12 t/ha in 90 days. **(Fig.7).**

Arka Jay

Arka Vijay

Fig. 7: Varieties released by IIHR, Bengaluru

Varieties released by IIVR, Varanasi (IIVR, 2023**)**

Kashi Khushal (VRSEM-3): Semi-pole type variety has shiny dark green, slightly curved glabrous fruit containing 4-5 coffee colour seed. Tolerant to high temperature and DYMV. Variety is rich in protein 635.6 mg/g low in total sugar and phenol content. Yield 35-38 t/ha. Recommended for cultivation in Uttar Pradesh.

Kashi Sheetal (VRSEM-11): Semi-pole type, tolerant to low temperature and DYMV. It can give yield of 18-20 t/ha. Variety is rich in protein 590.8mg/g and low in total sugar 0.621g/100g. Yield 182.06. Recommended for cultivation in Uttar Pradesh.

Kashi Harittima: Suitable for sowing in Kharif season. High yielding and good pod quality (green, tender and parchment free). It is moderately resistant to Dolichos Yellow Mosaic Virus diseases under field condition. Moderately tolerant to jassid, aphid and pod borer under field condition.

Varieties released by Sarpan Seeds, Dharwad (Bighaat. 2020).

Sarpan Dolichos-3

All season Dolichos is a photo-insensitive breed was researched and developed in 1998 by Sarpan Seeds, has opened new opportunities in Dolichos cultivation in the country. The most popular variety is Sarpan Dolichos-3 has a character of bushy plant, flowers and fruits by 45-50 days. Prolific bearer for a period of 130-150 days with two harvests. Fruits have a typical acidic flavor in all season. Wet bean type, free from bitterness and phenols and are excellent in cooking quality and flavor. Each spike bears 9-12 fruits with each fruit having 3-4 beans.

Sarpan Dolichos-42

The variety is very productive with potential yields of 9-12 MT per acre with a high revenue output. Apart from quality and yields, the acidic flavor, a traditional character is retained in all these varieties across all the seasons. The rich nutritional, medicinal values and the availability of fresh pods, beans in all season has made Dolichos the most popular vegetable in the market.

Sarpan Dolichos-52

The variety is very productive with potential yields of 9-12 MT per acre with a high revenue output. Apart from quality and yields, the acidic flavor, a traditional character is retained in all these varieties across all the seasons. The rich nutritional, medicinal values and the availability of fresh pods, beans in all season has made Dolichos the most popular vegetable in the market.

The other varieties are Sarpan Dolichos-16 and Sarpan Dolichos-27 which is fresh pod vegetable type and

Varieties released by Other Institutes and Universities are furnished in Table 3

Table 3: Varieties developed and release d by different Institutes (IASRI, 2023; HORT, 2023; Singh, 2023)

Developing institution	Variety	Special features
UAS, Bangalore.	Hebbal Avare-1	Bush and photo insensitive variety. Pods small and soft. Yield 0.8 t/ha in 90-100 days.
	Hebbal Avare-3	Bush and photo insensitive variety. Flowers white. Pods green, 2-3 seeded. Seeds brown round and small. Yield 8-10 t/ha in 90-100 days.
	Hebbal Avare-4	Bush and photo insensitive variety. Pods soft and harvested in 5 pickings. Yield 6 t/ha.
IARI, New Delhi.	Pusa Early Prolific	Pole type. Pods flat, green, narrow, cycle shaped. Pod length 9.3 cm, width 1.5 cm, weigh 3.5 g. Yield 14 t/ha in 200-215 days.
	Pusa Sem 2	Pole type. Pods semi-flat, dark green, fleshy and stringless. Pod length 15-17 cm. Yield 13-22 t/ha in 200-215 days. Tolerant to anthracnose, yellow bean mosaic virus, aphids, pod borers and frost.
	Pusa Sem 3	Pole type. Pods flat, green, fleshy and stringless. Pod length 15 cm. Yield 17-27 t/ha in 200-215 days. Tolerant to anthracnose, yellow bean mosaic virus, aphids, pod borers and frost.
KKVP, Dapoli	Wal Konkan 1	Bushy, photo-insensitive, resistant to yellow mosaic virus. Yield 9-10 t/ha in 110-115 days.
	Konkan Bhushan (DPLD 1)	Bushy, photo-insensitive, resistant to yellow mosaic virus. Yield 9-10 t/ha in 110-115 days.
Tamil Nadu Agricultural University	CO.1	Pole type. Pods green, fleshy with slow fibre development. Pod weight 9.7 g. Yield 18-20 t/ha in 160-180 days.
	CO.2	Pole type. Pods, flat, green with purple margin. Pod length 9.3 cm, width 2.1 cm, weight 6.1 g. Yield 11.8 t/ha in 210-220 days.
	CO.3	Pole type. Pods fleshy, green with purple tinge. Pod length 10.6 cm, width 4.8 cm, weigh 11.77 g. Seeds black. Yield 10.0 t/ha in 230 days.
	CO.4	Pole type. Pods deep purple throughout and fleshy. Pod length 10.2 cm, width 3.3 cm, weigh 7.43 g. Seeds black. Yield 13.5 t/ha in 215-220 days.
	CO.5	Pole type. Pods long, narrow, light green to white in colour, tubular, curved with serrated margin. Pod length 13.4 cm, breadth 1.5 cm, weight 5.26 g. Seeds chocolate brown. Yield 6-7 t/ha in 235 days.
	CO.6	Bush variety. Selected from DL 3169 x CO.5. Pods slightly curved and bloated. Yield 12 t/ha in 240 days.
	CO.7	Bush variety. Selected form DL 3169 x CO.5. Pods long, succulent, flat, greenish white and broad. Yield 12 t/ha in 240 days.
	CO.8	Bush variety. Pods green tubular and fleshy. Yield 6-8 t/ha in 120 days.
	CO.9	Bush variety. Pods and grains are used. Yield 7-8 t/ha in 120 days.
	CO.10	Bush variety. Induced mutant from CO.6 by gamma ray (24 krad). Pods greenish white tubular and curved. Yield 5-6 t/ha in 120 days.
	CO.11	Bush variety. Hybrid derivative of CO.9 x a pandal type. Compact plant type. Pods flat and light green with purple margin. Yield 9-10 t/ha.
	CO.12	Bush variety. Hybrid derivative of CO.9 x CO.4. Pods deep purple. Yield 10-12 t/ha in 110 days.
	CO.13	Bush variety. Hybrid derivative of Co.9 x a training type. Pods long green. Yield 10t/ha in 110-120 days
CSAUA&T, Kanpur.	Rajani	Pole type. Pods narrow oval in cross section, shining green. Pod length 10.4 cm, width 1.2 cm, weight 1.78 g. Yield 7-8 t/ha in 200-210 days.
	KDB 403	Pole type. Pods long, narrow, shining green. Pod length 12.9 cm, width 1.2 cm, weight 2.0 g. Yield 5-6 t/ha in 180-210 days.
	KDB 405	Pole type. Pods medium long, narrow, dark green band in the middle and boarders ligh green. Pod length 9.6 cm, width 1.3 cm, weight 1.1 g. Yield 3-4 t/ha in 180-200 days.
MPKV, Akola	Dasarawal	Pole type. Pods dirty green with purple tinge at both boarders. Pod length 7.8 cm, width 2.0 cm, weight 3.2 g. Yield 7-8 t/ha.
	Deepaliwal	Pole type. Pods extra long (18.4 cm), white, not smooth due to bulging at each seed. Pod width 2.7 cm, weight 1.5 g. Yield 6-8 t/ha in 200-210 days.
JNKV, Jabalpur.	JDL. 79	Pole type. Pods flat, broad, whitish green with parrot green boarder along the line of seed

		attachment. Pod length 11.8 cm, width 3.6 cm, weight 1.5 g. Yield 5.6 t/ha in 200 days.
	JDL 53	Pole type. Pods flat, small, narrow, dull whitish green with purple tinge along the boarder. Pod length 7.2 cm, width 1.8 cm, weight 3.75 g. Yield 10-12 t/ha in 200-220 days.

USES

Commercial crop: *Lablab purpureus* is grown as a pulse crop (crop harvested for dry seed) in Africa, Asia, and the Caribbean. It is also consumed as a green vegetable (green bean, pod, leaf). *L. purpureus* may suffer from low yields when grown as a main cash crop, and suggest that it is more popular in homegardens and mixed-cropping schemes. Protein isolate from the bean can be used as a food additive for improving cake quality (Sheahan, 2012).

Forage: *L. purpureus* is used as forage, hay, and silage. As forage, it is often sown with sorghum or millet. The leaf is very palatable but the stem is not. The seeds are moderately palatable. Overall, it is one of the most palatable legumes for animals. The leaf has crude protein of 21 to 38% and the seed contains 20 to 28% crude protein. The seeds contain large amounts of various vitamins and minerals, but contain tannins and trypsin inhibitors so must be soaked or cooked before human consumption. The leaves make excellent hay for cattle and goats, but the stem is difficult to dry, and must be mechanically conditioned through crushing. Silage made from a mix of *L. purpureus* and *Sorghum* sp. raised the protein content of sorghum by roughly 11% with a 2:1 mixture of lablab: sorghum (Sheahan, 2012).

Cover crop/green manure: *L. purpureus* is used as a nitrogen-fixing green manure to improve soil quality. It often produces more dry matter than cowpea (*Vigna unguiculata*), especially during drought, and can produce roughly 1,750 lb of leaf matter or 2.5 tons of total biomass per acre. Each ton of biomass produced 50 lb of nitrogen. It not only produces nitrogen through fixation, but returns nitrogen through leaf decay. Initially growth is slow, but once established, it competes well with weeds. It has an extensive root system that improves the physical condition and function of the soil (Sheahan, 2012).

Wildlife: *L. purpureus* is a good choice for food plots and will attract deer. Plots may require electric fencing to keep out deer during early seedling development (Sheahan, 2012).

Hyacinth bean (*Lablab purpureus* (L.) Sweet) is grown in India and in many tropical regions of the world. Mature seeds are consumed as a cooked food or a sprouted seed. The immature pods and seeds are also harvested as vegetable foods. Although this plant is cultivated as an annual, it will persist as a perennial, and when cultivation is extended it will form large, starchy roots that can be eaten. Some varieties (mostly dark-seeded types) contain high levels of a cyanogenic glycoside in their seeds. When cyanogenic glycosides are hydrolyzed by plant enzymes during cooking, or possibly by intestinal enzymes after ingestion, cyanide can be released and lead to cyanide poisoning (Allen, 2013). Lablab is a multipurpose legume. Its immature seeds and pods, and young leaves are edible and cooked as vegetables. Mature dry beans are edible but they require prolonged cooking with several changes of water (Heuzé et al., 2016). An annual forage crop in broad-acre agricultural systems in tropical environments with a summer rainfall and occasionally used for forage in cut-and-carry systems. Lablab can be incorporated into cereal cropping systems as a legume ley to address soil fertility decline. It is also used as an intercrop species with maize to enable cereals and pulses to be grown simultaneously on the same land, usually in smallholder systems, and to achieve better legume/stover feed quality. Lablab is a major pulse crop in southern India and an important vegetable elsewhere especially in Bangladesh, where the green pods are widely used like snow peas. It is a minor pulse crop across Asia and Africa especially in Kenya and Tanzania (TF, 2020)

The hyacinth bean is an old domesticated pulse and multi-purpose crop. *L. purpureus* has been cultivated in India as early as 2500 BC. Due to seed availability of one forage cultivar (cv. Rongai), it is often grown as forage for livestock and as an ornamental plant. In addition, it is cited both as a medicinal plant and a poisonous plant. The fruit and beans are edible if boiled well with several changes of the water. Otherwise, they are toxic due to the presence of cyanogenic glycosides, glycosides that are converted to hydrogen cyanide when consumed. Signs of poisoning include weakness, vomiting, shortness of breath, twitching, stupor, and convulsions.[16] It has been shown that there is a wide range of cyanogenic potential among the varieties. The leaves are eaten raw or cooked like spinach. The flowers can be eaten raw or steamed. The root can be boiled or baked for food. The seeds are used to make tofu and tempeh **(**Wikipedia, 2023**).** In India lablab is called *surti papdi* (in Gujarati). In Bangladesh and West Bengal, the green pods along with the beans, known as *sheem* , are cooked as vegetables or cooked with fish as a curry. In Kerala, it is known as *amarakka, avara* or *amara payar* (Malayalam). The beans as well as the bean pods are used in cooking curries. The bean pods are also used (along with spices) for preparing a stir-fried dish known as *thoran.* In Tamil Nadu, it is called *avarai* or *avaraikkaay* (Tamil: The entire bean is used in cooking dry curries and in sauces/gravies such as *sambar*. The seed alone is used in many recipes and is referred to as *mochai* (Tamil). In Maharashtra, dry preparations with green masala are often made out of these green beans mostly at the end of monsoon season during fasting festivals of Shravan month. In Karnataka, the hyacinth bean is made into curry (*avarekalu saaru*)(Kannada) salad (*avarekaalu usli*), added to upma (*avrekaalu uppittu*), and as a flavoring to Akki rotti. Sometimes the outer peel of the seed is removed and the inner soft part is used for a variety of dishes. This form is called *hitakubele avarekalu*, which means "pressed (*hitaku*) hyacinth bean," and a curry known as *hitikida avarekaalu saaru* is made out of the deskinned beans. In Telangana and Andra Pradesh, the bean pods are cut into small pieces and cooked as a spicy curry in the Pongal festival season. Sometimes the outer peel of the seed when tender and soaked overnight is removed and the inner soft part is used for a variety of dishes. This form is called *pitakapappu hanupa/anapa*, which means "pressed (*pitaku*) hyacinth bean, and a curry known as pitikina anapaginjala chaaru/pitaka pappu is made from the deskinned beans and eaten along with *bajra* bread **(**Wikipedia, 2023**)**. In South-East Asia lablab is popular as a vegetable and young leaves, flowers and pods of lablab are used as vegetables. The young fruits are eaten boiled like common beans or used in curries; immature green seeds are eaten boiled or roasted; leaves, young shoots and inflorescences are eaten boiled. In other parts of Asia, lablab is predominantly used as a pulse and mature seeds are consumed after cooking as dhal and sometimes used as a substitute for broad beans in the preparation of the fried bean cake tanniah. It should be emphasized that some types and cultivars require cooking before being eaten. Sometimes sprouted seeds are sun-dried and stored to use as a vegetable. Lablab is also used as fodder, hay, silage, green manure and as a cover crop. Protein concentrates can be made from seeds. It makes good silage and is used as green manure in soil improvement and often grown as a second crop in rice fields. Seeds and leaves are also used for medicinal purposes (CABI, 2023)

The plant was used as decoction in alcoholic intoxication, for the treatment of cholera, diarrhoea, globefish poisoning, gonorrhoea, leucorrhoea and nausea. Seeds were used to stimulate stomach, as antidote for poisoning, for menopause and spasms, and for the treatment of cholera, diarrhoea, colic, rheumatism and sunstroke. The juice from the fruit pods was used as astringent, digestive, stomachic, to expel worms and for

the treatment of inflamed ears and throats. The flowers were used to treat inflammation of uterus and to increase menstrual flow. The plant was also used as anti-inflammatory, aphrodisiac, antispasmodic, antidiabetic, febrifuge and for flatulent, bilious, stomachic and phlegmatic disorders. In Africa, Asia, and the Caribbean. It was also consumed as a green vegetable (green bean, pod, leaf).

Traditional uses (HB, 2023)

- In Peninsular Malaysia, the leaves are used with rice flour and turmeric as a poultice for eczema.
- An infusion made from leaves is used to treat gonorrhoea.
- In Indo-China, the leaves are used for colic.
- In Philippines, the leaves are used for leucorrhoea and menorrhagia.
- In East Africa, the crushed leaves are used to cure headache.
- Leaves are used to treat stomach disorders.
- Green leaves with vinegar are used to cure snakebites.
- In Rwanda, a decoction made from leaves is used to cure heart problems.
- In Democratic Republic of Congo, an infusion made from leaves is used to treat sore throat andtonsillitis.
- In Asia, the flowers are used as antivinous, emmenagogue, alexiteric and carminative.
- In Indo-China, the flowers are used as the treatment for leucorrheoa and menorrhagia.
- In Assam, the pods juice is used to treat an inflammation of ear and throat.
- The mature seeds are anthelmintic, aphrodisiac, antispasmodic, digestive, astringent, depurative, febrifuge and stomachic.
- The decoction is used to treat sunstroke, vomiting, nausea, enteritis, diarrhoea, alcoholism, abdominal pain and arsenism.
- The Chinese use the boiled ripe seeds as a carminative and tonic.
- In India, the seeds are used to stop nose bleeding.
- In Senegal, the seed is used as stomachic, antispasmodic and as a treatment for sunstroke and cholera.

NUTRITIONAL VALUE

The mature seeds of five cultivars of dolichos bean (Dolichos lablab L.) were analysed for some nutritional and antinutritional factors. The cultivars showed considerable variation in their composition. On a dry matter basis, the percentage of crude protein varied from 22·4 to 31·3, crude fibre, 7·62 to 9·63 and total carbohydrate, 54·2 to 63·3. The amounts (mg/100 g) of calcium, phosphorus, phytate phosphorus and iron ranged from 36·0 to 53·5, 388 to 483, 282 to 380 and 5·95 to 6·90, respectively. All the cultivars tested contained moderately high levels of TIA and 2400–3200 TIU g^{-1}, on a dry weight basis, of the seeds. Phytic acid and tannins varied from 1000 to 1350 and 2000 to 2205 mg/100 g, respectively (Deka and Sarkar, 1990). Lablab beans contain about 26% of the DM as protein, but it varies widely either within cultivars or between varieties (23 to 28%). The lysine content of lablab beans is rather high (6.3% protein) and similar to that of soybean, but the methionine and cystine content is lower. The starch content of lablab seeds is relatively high (45%) while the fibre content is rather low (crude fibre less than 10% DM) (Heuzé *et al.,* 2016). *Dolichos lablab* contained sugar, alcohols, phenols, steroids, essential oils, alkaloids, tannins, flavonoids, saponins, coumarins, terpenoids, pigments, glycosides and anthnanoids [65-67].Phytochemicals study of the raw and aqueous crude extracts of the three varieties (Rongai brown, Rongai white and Highworth black) of *Lablab purpureus* seeds showed that the seeds contained trypsin inhibitor contents, Heamagglutinin content, cyanogenic glycosides, oxalates, phytates, tannins and saponins. Nutritional analysis revealed that the dry seed contained 33% starch as the major component, protein 25%, a very low fat content 0.8% and high dietary fibre 7.2%. It also contained oligosaccharides included raffinose and stachyose 3.5%, phytic acid 82.0 mg/g, phosphorus 430mg/g and phytates phosphorus 243 mg/g. The leaves were rich in protein (up to 28 percent), legumes, and iron 155 mg, zinc 30 mg per 100 g of leaves, dry weight. The grain had zinc of 34mg/kg and iron of 57mg/kg [69-70].However, the mature seeds of five cultivars of dolichos bean (*Dolichos lablab*.) were analysed for some nutritional factors. The cultivars showed considerable variation in their composition. On a dry matter basis, the percentage of crude protein varied from 22.4 to 31.3, crude fiber, 7.62 to 9.63 and total carbohydrate, 54.2 to 63.3. The amounts of calcium, phosphorus, phytate phosphorus and iron ranged from 36.0 to 53.5, 388 to 483, 282 to 380 and 5.95 to 6.90 mg/100 g Respectively (Al-Snafi, 2017). The phytochemical analysis of *Dolichos lablab* showed that it contained sugar, alcohols, phenols, steroids, essential oils, alkaloids, tannins, flavonoids, saponins, coumarins, terpenoids, pigments, glycosides, anthnanoids, wide range of minerals and many other metabolites (Al-Snafi, 2017). Fresh green pods and fresh beans are rich source of proteins 3.8 to 4.3 %, carbohydrate 6.9%, minerals and low in fat. They are also good source of vitamin-A -325 IU, Vitamin B and Vitamin –C. They are rich in dietary fiber, acts as excellent laxative (Bighaat, 2020). Leaf has CP content of 21–38%, commonly about 26%. Much lower for stem (7–20%). Grain contains 20–28% CP. Digestibility ranges from 55 to 76%, commonly >60% (leaves). Grain high in vitamins A, B and C (TF, 2020). Nutritional composition of lablab is furnished in Table 4 (Letting *et al.,* 2021).

Table 4. Nutritional composition of lablab

Component	Lablab
Carbohydrates (g)	62
Fiber (g)	8.6
Fat (g)	1
Protein (g)	22.8
Calcium (mg)	90
Iron (mg)	9
Phosphorus (mg)	328
Ascorbic acid (mg)	trace
β-carotene (mg)	N/A
Niacin (mg)	2.3
Riboflavin (mg)	0.1
Thiamin (mg)	0.5

Dry beans are also used in various vegetable preparations; 100 g of green pods contain 6.7 g carbohydrates, 3.8 g carbohydrates, 3.8 proteins, 1.8 g fibre, 210 mg calcium, 68.0 mg phosphorus, 1.7 mg iron etc (HORT, 2023). A 100 g portion of immature raw seeds contain 87.87 g water, 46 kcal, 2.1 g protein, 0.2 total lipid, 9.19 g carbohydrate, 3.3 g fibre, 4.08 sugars, 50 mg calcium, 0.74 mg iron, 40 mg magnesium, 49 mg phosphorus, 252 mg potassium, 2 mg sodium, 0.37 mg zinc, 12.9 mg vitamin C, 0.077 mg thiamin, 0.092 mg riboflavin, 0.52 mg niacin, 0.024 mg vitamin B6, 62 µg folate, 43 µg vitamin A, 864 IU vitamin A, 0.51 mg vitamin E, 18.1 µg vitamin K (CABI, 2023). Table 5 gives the nutritional value per 100 g prepared immature seeds of Dolichos bean (Wikipedia, 2023).

Table 5. Nutritional value per 100 g prepared immature seeds of Dolichos bean.

Hyacinth-beans, immature seeds, prepared	
Nutritional value per 100 g (3.5 oz)	
Energy	209 kJ (50 kcal)
Carbohydrates	9.2 g
Fat	0.27 g
Protein	2.95 g
Vitamins	Quantity %DV†
Thiamine (B1)	5% 0.056 mg
Riboflavin (B2)	7% 0.088 mg
Niacin (B3)	3% 0.48 mg
Folate (B9)	12% 47 µg
Vitamin C	6% 5.1 mg
Minerals	Quantity %DV†
Calcium	4% 41 mg
Iron	6% 0.76 mg
Magnesium	12% 42 mg
Manganese	10% 0.21 mg
Phosphorus	7% 49 mg
Potassium	6% 262 mg
Zinc	4% 0.38 mg

Table 6 gives the nutritional value per 194g prepared mature seeds, cooked nd boiled without salt of Dolichos bean (HB, 2023).

Table 6: Nutritional value of Hyacinth beans, mature seeds, cooked and boiled without salt Serving Size: 1 Cup, 194 g **Calories** 227 Kcal. **Calories from Fat** 10.17 Kcal.

Proximity	Amount	% DV
Water	134.11 g	N/D
Energy	227 Kcal	N/D
Energy	953 kJ	N/D
Protein	15.79 g	31.58%
Total Fat (lipid)	1.13 g	3.23%
Ash	2.83 g	N/D
Carbohydrate	40.14 g	30.88%

Minerals	Amount	% DV
Calcium, Ca	78 mg	7.80%
Iron, Fe	8.89 mg	111.13%
Magnesium, Mg	159 mg	37.86%
Phosphorus, P	233 mg	33.29%
Potassium, K	654 mg	13.91%
Sodium, Na	14 mg	0.93%
Zinc, Zn	5.53 mg	50.27%
Copper, Cu	0.662 mg	73.56%
Manganese, Mn	0.935 mg	40.65%
Selenium, Se	5.4 µg	9.82%

Vitamins	Amount	% DV
Water soluble Vitamins		
Vitamin B1 (Thiamin)	0.524 mg	43.67%
Vitamin B2 (Riboflavin)	0.072 mg	5.54%
Vitamin B3 (Niacin)	0.797 mg	4.98%
Vitamin B5 (Pantothenic acid)	0.613 mg	12.26%
Vitamin B6 (Pyridoxine)	0.072 mg	5.54%
Vitamin B9 (Folate)	8 µg	2.00%
Folic Acid	0 µg	N/D
Folate, food	8 µg	N/D
Folate, DEF	8 µg	N/D

Lipids	Amount	% DV
Fatty acids, total saturated	0.192 g	N/D
Fatty acids, total monounsaturated	0.05 g	N/D
Oleic acid 18:1 (octadecenoic acid)	0.05 g	N/D
Fatty acids, total polyunsaturated	0.475 g	N/D
Linoleic acid 18:2 (octadecadienoic acid)	0.475 g	N/D

Amino Acids	**Amount**	**% DV**
Tryptophan	0.132 g	30.00%
Threonine	0.611 g	34.72%
Isoleucine	0.757 g	45.28%
Leucine	1.341 g	36.28%
Lysine	1.079 g	32.27%
Methionine	0.126 g	N/D
Cystine	0.184 g	N/D
Phenylalanine	0.795 g	N/D
Tyrosine	0.565 g	N/D
Valine	0.819 g	38.78%
Arginine	1.16 g	N/D
Histidine	0.452 g	36.69%
Alanine	0.706 g	N/D
Aspartic acid	1.866 g	N/D
Glutamic acid	2.567 g	N/D
Glycine	0.681 g	N/D
Proline	0.768 g	N/D
Serine	0.869 g	N/D

The cooked Hyacinth beans without salt provides 227 calories per 1 cup of 194 grams. It contains 111.13% of iron, 73.56% of copper and 50.27% of Zinc. The same amount of serving size of 1 cup provides 159 mg of magnesium, 233 mg of phosphorus, 15.79 g of protein and 78 mg of calcium. Hyacinth Bean contains various nutrients, minerals, vitamins and lipids that help to enhance the overall health. It possess antimicrobial, antifungal, anti-inflammatory, tonic, aphrodisiac, hypocholesterolemic, galactagogue, appetite suppressants and antispasmodic properties that prevents from various types of ailments (HB, 2023).

Toxicity: Leaf does not contain anti-nutritive factors such as tannins. Mixed plantings with forage sorghum prevents the occurrence of bloat. Grain contains tannins, and phytate and trypsin inhibitors. Concentrations vary among varieties. Soaking or cooking reduces the activity of these compounds (TF, 2020)

HEALTH BENEFITS (HB, 2023).

- **Brain health:** Copper is essential for the brain pathways such as galactose and dopamine which helps to maintain mood, outlook and focus. The low presence of copper leads to fatigue, poor mood, concentration trouble and low metabolic activity. It is also associated in utilizing tyrosinase, ascorbate oxidase, superoxide dismutase and Vitamin C. The antioxidants prevent the damage caused by free radicals and slow down the aging process, neuro-degenerative disease and cancer.
- **Cardiovascular health:** Vitamin B1 is vital for the production of acetylcholine which is a neurotransmitter that relay messages from the nerves to the muscles. Heart depends on these signals. The proper use of energy helps to provide signals between the nerves and muscles. The studies show that Vitamin B1 helps to counteract heart disease as it maintains the healthy ventricular function and also treats heart failure.
- **Prevent cancer:** Zinc possesses an antioxidant and anti-inflammatory properties which helps to counteract oxidative stress and reduce the risk of diseases. Zinc assists the healthy cell division, prevents mutation of cells and prohibits tumor growth. The research shows that the adequate intake of zinc reduced the oxidative stress along with the infections and side effects. It has the ability to promote the immune system.
- **Assist respiration:** Minerals such as selenium, manganese and zinc assist the people having the lung disorders like chronic obstructive pulmonary disease. Oxidative stress is the cause for respiratory disorders and chronic obstructive pulmonary disease. Manganese is able to reduce the oxidative stress as well as inflammation by producing the SOD's which helps to heal the lungs.
- **Supports digestion:** Fiber plays a vital role in the digestion. Insoluble fiber provides bulk to the stool and speeds up the time to pass the waste from the body. It helps to prevent bloating, constipation and indigestion. Soluble fiber enhances digestion by absorbing the water to form a viscous substance which is fermented by the bacteria in a digestive tract.
- **Treats insomnia:** The low consumption and absorption of nutrient is the cause for insomnia. The adequate amount of magnesium helps to increase the sleep, lower levels of cortisol and higher concentrations of melatonin that are related to stress. The research shows that the magnesium supplements reduce the symptoms of insomnia, improve sleep time, sleep efficiency and sleep onset. It also reduces the cortisol.
- **Assist levels of energy:** Iron helps to transport the oxygen to the cells. It helps to body to absorb nutrients and digest proteins from the food. The low presence of iron results sluggish, trouble being active and cause exhaustion. The symptoms of iron deficiency are mood change, low concentration and muscle co-ordination problem.
- **Gum health:** Vitamin D, Calcium and phosphorus is essential for maintaining bone health by supporting jaw-bone mineral density, tooth enamel and holds teeth in place. Vitamins and minerals help to cure tooth decay. Children require the foods rich in calcium and phosphorus

which helps to form the hard structure of the teeth. Along with phosphorus, Vitamin D is essential to balance the calcium in the body and enhance it absorption for the formation of tooth. Vitamin D reduces the gum inflammation that is related with periodontal gum disease.

- **Enhance mood:** The protein foods contain the amino acids that are essential to balance hormones, control mood and treats anxiety. Protein assists the function of neurotransmitters and harmonizes the hormones such as serotonin and dopamine which helps to calm us. Proteins balance the glucose and prevent irritability, mood chance and cravings which are associated with the fluctuation of blood sugar level.
- **Prevent cramps:** Hyacinth beans contains adequate amount of potassium which reduce the muscle cramps and improves the strength of muscles. The deficiency of potassium is the cause of muscle cramps. The potassium soothes the muscles by balancing the fluid levels. Low level of potassium leads to cramps, general pains and muscle spasms. It helps to breakdown the proteins and carbs which the muscle depend upon for the repair and energy.

L. purpureus has been used in the Philippines and China as a stimulant, to reduce fever, to reduce flatulence, to stimulate digestion, and as an antispasmodic. In Namibia, the root has been used to treat heart conditions (Sheahan, 2012). The World Health Organization (WHO) estimates that 4 billion people, 80 percent of the world population, presently use herbal medicine for some aspect of primary health care. Plant showed wide range of pharmacological activities including antimicrobial, antioxidant, anticancer, hypolipidemic, cardiovascular, central nervous, respiratory, immunological, anti-inflammatory, analgesic antipyretic and many other pharmacological effects. Phytochemical analysis of *Dolichos lablab* showed that it contained sugar, alcohols, phenols, steroids, essential oils, alkaloids, tannins, flavonoids, saponins, coumarins, terpenoids, pigments, glycosides, anthnanoids, wide range of minerals and many other metabolites. The preliminary pharmacological studies revealed that *Dolichos lablab* possessed antidiabetic, antiinflammatory, analgesic, antioxidant, cytotoxic, hypolipidemic, antimicrobial, insecticidal, hepatoprotective, antilithiatic, antispasmodic effects and also used for the treatment of iron deficiency anemia (Al-Snafi, 2017):

Antidiabetic effect: The antidiabetic activity of methanolic extract of *Dolichos lablab* (MEDL) seeds was studied in streptozotocin-nicotinamide induced diabetic rats. The methanolic extract of the seeds of *Dolichos lablab* was given by oral route at doses of 200 and 400 mg/kg bw. MEDL dose dependely ($P < 0.001$) reduced blood glucose levels, total cholesterol, triglycerides, SGPT, SGOT levels compared to untreated diabetic rats. MEDL 400 mg/k bw possessed more promising antidiabetic activity compared to 200mg/kg bw [61, 67].The antidiabetic effect of ethanolic extract of *Dolichos lablab* leaves and seeds was investigated in alloxan induced diabetic rat. Alcoholic extracts of dried leaves of *Dolichos lablab* was given orally for 7 days. The oral administration of extracts at doses of 200 mg/ kg lead to a significant blood glucose reduction. The antihyperglycemic properties of methanol extract of beans (fruits containing seeds) of *Lablab purpureus* was investigated using oral glucose tolerance test. Administration of methanol extract of beans led to dose-dependent and significant reductions in blood glucose levels in glucose-loaded mice. At doses of 50, 100, 200 and 400 mg per kg body weight, the extract reduced blood glucose levels by 16.4, 39.1, 40.1, and 54.8%, respectively compared to control animals (Al-Snafi, 2017).

In the Treatment of Iron deficiency anemia: The effectiveness of *Dolichos lablab* beans extract in iron deficiency was investigated in rats. Anemia was induced by tail clipping procedure until the level of hemoglobin and hematocrit became below normal. The activity of aqueous extract of the beans of *Dolichos lablab* at the dose of 100 mg / kg body weight orally for 14 days, was investigated by monitoring the change in hemoglobin and hematocrit levels of rats after 14 days of treatment. Results of the study showed a significant increase in hemoglobin level in experimental group from 11.33 to 14.33, while hematocrit level was increased from 34.00 to 43.00 (Al-Snafi, 2017).

Antiinflammatory and analgesic effects: The anti-inflammatory effect of methanol extracts of two Bangladeshi bean pods *Lablab purpureus* sweet white and purple was studied using protease inhibition. *In vitro* anti-inflammatory investigation showed that there was a linear relation of % inhibition for the white bean pods which indicated positive anti-inflammatory property. Mannose-specific legume lectin isolated from the seeds of *Dolichos lablab* (FRIL) evoked dose- dependent paw edema and increasing animal paw volumes. The edematogenic effect of FRIL was paralleled by an increase in vascular permeability, about 10-fold higher compared to control. FRIL also significantly raised the animals flinch reaction in the first, third and fifth hours in response to mechanical stimulation. The anti- inflammatory effect elicited by FRIL was partly inhibited by α-d-methyl mannoside. The histopathological analysis of animal paws showed a characteristically acute inflammatory process that included severe infiltration of mixed leukocytes, changes in cytoarchitecture, edema and focal areas of hemorrhage. In addition, in silico assays confirmed that FRIL preferentially interacted with trimannoside that makes up the core N-glycans cell. The antinociceptive properties of methanol extract of beans (fruits containing seeds) of *Lablab purpureus* was observed by cecking abdominal constrictions in intraperitoneally administered acetic acid-induced pain model in mice. The methanolic extract reduced the number of abdominal constrictions by 32.3, 45.2, 54.8, and 58.1, respectively at four doses. A standard pain relieving (antinociceptive) drug, aspirin, reduced the number of writhings by 48.4 and 61.3%, respectively, when administered at doses of 200 and 400 mg per kg body weight (Al-Snafi, 2017).

Antioxidant effect: The antioxidant effect of methanol extracts of two Bangladeshi bean pods *Lablab purpureus* sweet white and purple was studied using DPPH free radical scavenging method. In DPPH test the lowest and highest IC_{50} values were 430.00µg/ml and 853.13μg/ml, with *Lablab purpureus* sweet purple and *Lablab purpureus* sweet white respectively. The total flavonoid contents of the test samples were 42.55±5.77 and 32.09±0.36 mg/g quercetin equivalents for white and purple respectively. The effects of dry heated and pressure cooking of *Dolichos lablab* bean, on total phenolic components were investigated. The raw and processed samples were extracted with 70% methanol. Processing of legumes caused decreases in total phenolic content when compared to the raw samples. However, the dry heating caused remarkable increase in tannin contents (1.809 ± 0.25 g GAE/100 g extract) (Al-Snafi, 2017).

Cytotoxic effect: The cytotoxic effect of methanol extracts of two Bangladeshi bean pods *Lablab purpureus* sweet white and purple was studied using brine shrimp lethality test. In Cytotoxicity test LC_{50} value was 960.06 µg/ml for *Lablab purpureus* sweet purple and 66.5 µg/ml for *Lablab purpureus* sweet white, so *Lablab purpureus* sweet white was more potent. The cytotoxic activity of crude extracts (chloroform, n-hexane, ethyl acetate) of leaves of *Lablab purpureus* were studied using Brine Shrimp Lethality Bioassay and compare with LC_{50} values of standard Vincristin sulphate as a positive control. The results revealed significant cytotoxicity against *A. salina,* with LC_{50} 13.88µg/ml, 19.17µg/ml and 17.97µg/ml for n-hexane, chloroform and ethyl acetate extracts respectively (Al-Snafi, 2017).

Hypolipidemic effect: The hypocholesterolemic effect of germinated Indian bean (*Dolichos lablab* L. var lignosus) was studied in hypercholesterolemic rats. Supplementation of the diet with dried powder of soaked bean almost brought the plasma cholesterol from 178 ± 1.85 to 72.5 ± 0.75mg/dl compared with that of the control (61.5 ± 0.70), although the liver cholesterol was still three times higher compared with the control. The authors concluded that the 24h germinated Indian bean cotyledons could effectively counteract the effects of added cholesterol on liver and plasma by their high fiber content coupled with enormous increase in ascorbic acid levels (Al-Snafi, 2017).

Antimicrobial effect: The antibacterial activity of leaf and flower extracts of *Lablab purpureus* was studied against clinical *Staphylococcus aureus* isolates. Both extracts showed antibacterial activity, but the flower extract showed marked inhibition of *Staphylococcus aureus* isolates. The antimicrobial activity of crude extracts (chloroform, n- hexane, ethyl acetate) of leaves of *Lablab purpureus* L. were studied using disc diffusion technique. Extracts were tested against eleven important pathogenic bacteria including both Gram positive and Gram negative bacteria and three fungi. The tested bacteria were *B. megaterium, B. subtilis, Staphylococcus aureus, Sarcina lutea, Escherichia coli, Salmonella paratyphi, S. typhi*, *Shigella boydii, S. dysenteriae, Vibrio mimicus* and *V. parahemolyticus*. The extracts showed antimicrobial activity against most of the bacterial strains with an average zone of inhibition of 8- 20mm. The tested fungi were *Saccharromyces cerevaceae*, *Candida albicans* and *Aspergillus niger*. The extracts showed moderate to good antifungal activity with an average 9 -15 mm zone of inhibition. Among the three solvent extracts used, the most effective extract was n-hexane extract and maximum activity (20 mm, zone of inhibition) was recorded against *Staphylococcus aureus* with minimum inhibitory concentration (MIC) values of 64µg/ml. The maximum zone of inhibition for chloroform extract was 17mm against *Bacillus subtilis* and *E.coli* with MIC of 128µg/ml and 32µg/ml respectively. The maximum zone of inhibition for ethyl acetate extract was 17mm against *Vibrio mimicus* with MIC values of 64µg/ml. A protein, dolichin isolated from *Dolichos lablab*,exhibited antifungal activity against Fusarium oxysporum, Rhizoctonia solani, and Coprinus comatus. A 36- kDa alpha-amylase inhibitor was isolated from *Lablab purpureus*. It inhibited the alpha-amylases from several fungi but had little effect on those from animal and plant sources. The protein inhibited conidial germination and hyphal growth of A. flavus. It also agglutinated papain-treated red blood cells from human and rabbit. Dolichin, was also capable of inhibiting human immunodeficiency virus (HIV) reverse transcriptase and alpha- and beta-glucosidases which were glycohydrolases implicated in HIV infection. It had very low ribonuclease and cell-free translation-inhibitory activities (Al-Snafi, 2017).

Insecticidal effect: Arcelins, the protein isolated from seed flour of the Indian wild bean, *Lablab purpureus* showed insecticidal activity against Callosobruchus maculates [74], *Lablab purpureus* proteins at 2% in the diet resulted in retarded *Rhyzopertha dominica* and *Oryzaephilus surinamensis* development. However, 5% dose of the *Lablab purpureus* fraction resulted in complete mortality of all larvae of *Rhyzopertha dominica* and *Oryzaephilus surinamensis* (Al-Snafi, 2017).

Hepatoprotective effect: The hepatoprotective effects and underlying mechanism of *Dolichos lablab* water extract (DLL-Ex) were assessed using an *in vitro* cellular model in which nonalcoholic fatty liver disease (NAFLD) was simulated by inducing excessive FFA influx into hepatocytes. HepG2 cells were treated with DLL-Ex and FFAs for 24 h. DLL-Ex inhibited expression of CD36 in HepG2 cells, which regulates fatty acid uptake, as well as BODIPY- labled fatty acid uptake. Additionally, DLL-Ex significantly attenuated FFA-mediated cellular energy depletion and mitochondrial membrane depolarization. Furthermore, DLL-Ex enhanced phosphorylation of AMPK, indicating that AMPK was a critical regulator of DLL-Ex-mediated inhibition of hepatic lipid accumulation, possibly through its antioxidative effect (Al-Snafi, 2017).

Other effects: Antilithiatic study revealed that the methanolic extract of white and black seeds of *Dolichos lablab* possessed antilithiatic activity, but less than that recorded for the extract of leaves and bulbs of *Nymphaea odorata*. Sixty seven percent inhibition of spasm in smooth muscles were possessed by *Dolichos lablab* alcoholic fraction at 100 mg/kg body weight. Three kinds of serine protease inhibitors were purified from *Dolichos lablab* seeds and named Dolichos protease inhibitor 1, 2 and 3 (DI-1, DI-2 and DI-3), respectively. The inhibition constant (Ki) for these inhibitors was measured against several known serine proteases. All three Dolichos protease inhibitors (DI-1, DI-2 and DI-3) inhibited the activity of trypsin and plasmin, but had no effect on thrombin and kallikrein (either for human plasma kallikrein or for porcine pancreas kallikrein). DI-1 inhibited chymotrypsin most effectively ($Ki = 3.6\text{-}10^{-9}$ M), while DI-2 displayed inhibitory activity for porcine pancreatic elastase ($Ki = 6.2\text{-}10^{-8}$ M). Pre-treatment with 33 mg/kg of DI-mixture (active fractions from C18 open column chromatography that included DI-1, DI-2 and DI-3) inhibited the induction of pseudomonal elastase-induced septic hypotension and prevented an increase in bradykinin generation in pseudomonal elastase-treated guinea pigplasma. Also, the increase of kallikrein activity, by injection of pseudomonal elastase, was inhibited by the pretreatment of the DI-mixture in a guinea pig. Since the DI-mixture had no inhibitory effect on kallikrein activity when Z-Phe-Arg-MCA was used as a substrate. *In vitro* study showed that its inhibitory activity in the pseudomonal elastase-induced septic hypotension model might not be due to a direct inhibition of plasma kallikrein in the activation cascade of the Hageman factor and prekallikrein system (Al-Snafi, 2017).

Side effects and contraindications: Acute and chronic toxicity studies were carried out using mice. In acute toxicity studies, a dose of 250 mg/kg of dried extract were orally administered to mice, then, they were observed for motor reflexes for 48 h. No mortality was observed and the behavioral pattern and motor reflex were unaffected. In chronic toxicity studies, mice were divided into two groups, in the test group, a dose of dried extract of *Dolichos lablab* leaves of 250 mg/kg was administered daily to mice for a period of 15 days. The body weights were recorded at an interval of 5 days. No mortality or biochemical changes were recorded in the chronic toxicity study. Extraction of the beans with 80% ethanol did not however alter the trypsin inhibitor or haemagglutinin activities. The protein isolate and acid-extracted residue which had low trypsin inhibitor and haemagglutinin activities, did not also promote growth. Thus, the antigrowth and toxic effects of the green bean were not due to only trypsin inhibitor and haemagglutinin and heat treatment of both dry and green beans was essential for promoting growth in rats. However, even after heat treatment, the nutritional value of the protein was lower than that of casein presumably on account of amino acid deficiencies. The plant beans should not be taken internally uncooked. Uncooked hyacinth bean can cause abdominal problems and was considered toxic. The herb was avoided in people suffering from cold, flu or chills. While boiling or cooking the herbal pods, the water should be changed as many times as possible. Dry seeds of hyacinth bean have high amounts of cyanogenic glucosides and therefore they were considered toxic (Al-Snafi, 2017).

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