Evaluation of Lablab Purpureus (L.) Sweet Germplasm Using Yield and Quality Traits

VISHNU V S (✉ vishnuvs2212@gmail.com)

University of Kerala

P.M. RADHAMANY

University of Kerala

Research Article

Keywords: Lablab purpureus, nutritional analysis, underutilized crop

Posted Date: March 12th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-277538/v1>

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Abstract

The crops that are not commercially grown or widely traded are known as underutilized or unusable crops. Most of the legumes have come under these categories. Giving importance to such neglected and underutilized crops is an effective way to maintain a diverse and healthy diet and to combat micronutrient deficiencies. *Lablab purpureus* (L.) Sweet is one of the most important underutilized legume vegetable crops, which exhibits broad genetic variability in multiple characteristics such as the habit, pigmentation of the stem, and color of the pod. In the past, researchers paid very little attention to the systematic crop improvement of *L. purpureus*. In the present study, fifty accessions of *L. purpureus* were collected from different places of Kerala and Tamil Nadu and analyzed for yield, yield contributing characters, and biochemical factors. Nutritional and anti-nutritional factors were analyzed using the standard protocol. The accessions exhibited significant variations for all the characters tested. The nutritional content of all the accessions were found to be high, whereas anti-nutritional factors were very low. The differences in phenotypic and genotypic coefficient of variation was compared for different traits, and it was found to be very narrow for almost all the characters studied. The fifty genotypes involved in the study varied in the number of pod/ inflorescence, length and width of the pod, number of flower/ inflorescence, and length of the peduncle. So these observations can be used as a baseline data for the selection of parental lines for future improvement of *Lablab purpureus*.

Introduction

World food distribution relies upon agriculture, and increasing population growth in developing countries leads to food scarcity. Globally, food legumes and cereals are the primary sources of protein. Most of the legumes are underutilized, and their use is restricted among poor people living in developing countries. Among the numerous available legume crops, *Lablab purpureus* (L.) is one of the important underutilized legumes. The origin of *Lablab* is highly likely eastern and southern Africa, the only continent of natural occurrence (Verdcourt B 1970). Due to the occurrence of wild plants only in eastern and southern Africa, these areas are likely centers of origin, and the Indian subcontinent constitutes a center of secondary diversity (Maass 2016). A large number of taxa are distributed throughout the country and most of them are grown in South India. *Lablab* possesses wide adaptability to the tropics and sub-tropic regions; it is highly drought resistant when established (Shaahu et al. 2015) and also shades tolerant. *Lablab* is grown as a vegetable, pulse, fodder, green manure, and cover crop, pharmaceutic and ornamental plant. These are recognized as economically important vegetable crops. The immature pods and seeds are consumed as a vegetable, after maturity, dry seeds stored and consumed as pulse throughout the year. It is an excellent source of protein (20–25%), amino acids (like Lysine which usually lacks in cereals), vitamins (A, C & Riboflavin), and minerals (Ca, Fe, Mg, S, Na & P) (CR. 1990) moreover, immature pods and seeds are rich in dietary fiber, and low in carbohydrates and lipids (CR. 1990). However, the average production of *Lablab* beans within the farming community is obscure due to the negative influence of constraints such as unavailability of high quality, productive, and improved cultivars. Lack of awareness on the importance of this crop on food security, lack of exploration, and farmer's involvement in the breeding program of this crop results in reduced adoption rate, thus make this crop underutilized. The consumer preference, moreover, changes with pod size, shapes, color, and aroma. The seeds and pods are offered at many local markets, but there are no statistical data available on its production or trade.

Regardless of reports on poor cooking and eating characteristics of *Lablab*, the board related qualities, moreover, may have prompted diminished usage of *Lablab*. As do other legumes, also *Lablab* contains some anti-nutritional compounds such as trypsin inhibitors and cyanogenic glycosides (Deka, R.K. and Sarkar 1990). However, the amount of this anti-nutrient content varies considerably across genotypes and environments. Even though it contains a meager amount of anti-nutritional factors such as tannins, phytate, and trypsin inhibitors, it remains under-utilized. A vast range of variations exists in the phenotypic characters of plant, particularly pod characters among plants which are grown all over the country. A systematic evaluation and documentation of yield contributing characters are essential for selecting parental lines in the hybridization program. So far, very little research work has been done for improvement in yield and quality traits of this crop. Hence, the present study was conducted with a specific objective to assess variability in the yield and yield contributing characters along with nutritional and anti-nutritional factors of *L. purpureus* germplasm for further improvement of the crop.

Materials And Methods

The work was carried out in the Department of Botany, University of Kerala, India, during 2016–2019. *Lablab purpureus* seeds were collected from fifty different places of Kerala and Tamil Nadu (Table.1) and were grown in the experimental field in a randomized block designing and analyzed for yield, yield contributing characters, and biochemical factors. Twenty yield contributing characters (Table.2) were selected for the present investigation based on the descriptors provided by the University of Agricultural Science Bangalore, India. The proximate (nutritional and anti-nutritional) analysis of the collected accessions was also carried out with standard protocol.

Data Analysis

The quantitative data obtained from the yield contributing were statistically analyzed using one-way ANOVA. The statistical data analyses were performed using IBM SPSS Statistics 22. ANOVA with post hoc Duncan's test ($P \leq 0.05$) were used to compare the mean value. The results expressed as mean $\pm$ standard error.

Nutritional Analysis of pod

Estimation of carbohydrate (Hedge, J.E. and Hofreiter 1962)

The total carbohydrate was estimated by the Anthrone method. Weighed 100 mg of the sample and transferred into the boiling water bath for 3hr with 5ml of 2.5N HCl and cooled to room temperature. It was neutralized with solid sodium carbonate until the effervescence ceased, made up the volume to 100 ml and centrifuged. The supernatant was discarded; from the pellet, 1ml aliquot was taken and made up the volume to one ml in all the test tubes by adding distilled water and 4 ml of anthrone reagent. The mixture was heated for eight minutes in a boiling water bath, cooled rapidly and read the green to dark green color in a spectrophotometer at 630 nm. The amount of carbohydrate present in the samples were calculated from the calibration plot.

Estimation of protein (Lowery, O H., Rosebrough, N J., A L and Randall 1951)

Estimation of protein was done according to Lowry's method. Weighed 500 mg of the sample and ground well with a mortar and pestle in 5–10 ml of the buffer. The supernatant was centrifuged and used the supernatant for protein estimation. One ml of the sample was pipetted out in a test tube and made up to one ml. A tube with one ml of water serves as the blank. Five ml of reagent C (Alkline copper solution: 50ml of reagent A (2% sodium carbonate in 0.1N NaOH) and one ml of reagent B (0.5% $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) were added to 1% potassium sodium tartrate and mixed prior to use) to each tube including the blank and mix well, allow standing for 10 minutes. Added 0.5ml of the reagent D (Folin-ciocalteau reagent), mix well and incubate at room temperature in the dark for 30 min. Blue color indicated the presence of protein and took the readings at 660 nm. From the calibration plot, calculated the amount of protein present in the samples.

Estimation of lipid (Bligh,E.G. and Dyer 1959)

Fresh tissue (25mg) was homogenized using chloroform: methanol (2:1), made up to 25 ml, and the filtrate pour into separating funnel. Added distilled water, chloroform, and Na_2CO_3 shake vigorously and kept for separation. Elute the bottom layer of liquid into a pre-weighed petri dish. The petri dish was then kept in an oven to dry, weighed the petri dish after drying, and calculated the amount of lipid.

Estimation of ascorbic acid (Sadasivam, S. and Balasubramanian 1987)

Pipetted out five ml of the working standard solution into a 100 ml conical flask. Added 10 ml of 4% oxalic acid and titrated against the dye (V1 ml). The endpoint is the appearance of a pink color which persists for a few minutes. The amount of the dye consumed is equivalent to the amount of ascorbic acid. Extracted one ml of the sample in 4 % oxalic acid and made up to 100 ml and centrifuge. Pipetted out five ml of this supernatant, added 10 ml of 4 % oxalic acid and titrated against the dye (V2 ml).

Estimation of Thiamin (Koche 2011)

Estimation and quantification of Thiamin present in the pod were estimated according to the standard procedure. About 5 gm sample was extracted with 100ml ethanol for one hour. To the 10ml of this filtered extract, added 10ml 5% potassium permanganate and 10ml 30% H₂O₂ and allowed to stand on the hot water bath for 30 min. To this, added 2ml of 40% sodium sulphate and made up to 50ml, and absorbance was recorded.

Estimation of Riboflavin (Koche 2011)

The estimation of riboflavin was done according to the standard procedure. One gram of sample was boiled with 3ml of distilled water and 1ml of glacial acetic acid for 5 min. The solution was collected and added 0.1 N sodium hydroxide and diluted to 50 ml distilled water. The solution was filtered and absorbance was measured at 444 nm in spectrophotometer by using distilled water as blank.

Anti-nutritional Analysis

Estimation of phytate (AOAC. 1975)

The sample (5g) was soaked with 100 ml of 2% HCl for five hours and filtered. The filtrate (25ml) was measured in a conical flask, 50 ml 0.5% potassium thiocyanate solution was added and the mixture titrated with a standard 1.04% Fe^{3+} iron chloride until a brownish yellow color persisted for five minutes.

Estimation of Oxalate (AOAC. 1990)

Weighed one gm of the fresh sample and crushed it into the slurry. From the slurry, take one gm homogenate in a crucible, added 10 ml distilled water and, one ml concentrated sulphuric acid, and the mixture was allowed to stand for one hour. Made up the volume to 50 ml using distilled water, pipetted out five ml, and titrated against 1% potassium permanganate solution. Endpoint is the appearance of red color.

Estimation of Tannins (Schanderl SH 1970)

One gram of the powdered material was weighed and transferred to a 250ml conical flask. Added 75ml distilled water, heated gently and boiled for 30 min. Centrifuged at 2000 rpm for 20min and collected the supernatant in 100ml volumetric flask containing 75ml distilled water. Added 5ml of Folin-Denis reagent 75ml distilled water added 10gm sodium tungstate, 2gm phosphor molybdic acid and 5ml of orthophosphoric acid, refluxed for 2hr., cooled and diluted to 100ml in a standard flask to 10 ml of sodium carbonate and diluted to 100ml with water, shaken well and read at 700nm after 30 min.

Variability Studies

The phenotypic variance, genotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad-sense heritability (H^2B) and Genetic advance as % of the mean (GAM) were performed by the formula given by Burton GW and de Vane EH, (1953) and Johnson HW (1955) as follows,

Genotypic variance

$$\sigma^2 G = (\text{MSG} - \text{MSE})/r,$$

Where $\sigma^2 G$ is genotypic variance

MSG is the mean square of tested accession,

MSE is the mean square of error, and

“r” indicates number of replications.

MSE is an estimate of $\sigma^2 E$

Phenotypic variance

$$\sigma^2 P = \sigma^2 G + \sigma^2 E$$

$\sigma^2 P$ is phenotypic variance

$\sigma^2 G$ genotypic component of variance

$\sigma^2 E$ is environmental variance

Phenotypic coefficient of variation

$$PCV = \sqrt{\sigma^2 P} / \bar{x} \times 100$$

Where, $\sigma^2 P$ the phenotypic variance and $\bar{x}$ is the mean of the trait

PCV is phenotypic coefficient of variation and $\bar{x}$ is the mean of the trait.

Genotypic coefficient of variation

$$GCV = \sqrt{\sigma^2 G} / \bar{x} \times 100$$

GCV is genotypic coefficient of variation,

Where, $\sigma^2 G$ the genotypic variance and $\bar{x}$ is the mean of the trait

Broad sense heritability

$$H^2_B = \sigma^2 G / \sigma^2 P$$

Where, $\sigma^2 G$ the genotypic variance and $\sigma^2 P$ is the phenotypic variance

H^2_B is the Broad sense heritability

Genetic advance as % of the mean

$$GA \text{ (genetic advance as \% of the mean- GAM)} = K \times \sqrt{\sigma^2 P} / \bar{x} \times H^2_B \times 100,$$

Where, K (the standardized selection intensity) = 2.06 (at 5% selection intensity), $\sigma^2 P$ = the phenotypic variance, H^2_B is the heritability in broad sense, and $\bar{x}$ refers to the mean of the trait being evaluated.

Results And Discussion

Legumes are a good source of protein, carbohydrate, vitamins and minerals for the vegetarian population. *Lablab purpureus* or Hyacinth bean is a multi-beneficial leguminous vegetable crop and it is one of the oldest legume vegetable crops known to be cultivated in dry and semi-arid regions of Asia (Raghu, B.R., Samuel, D.K. 2018). Even though it supplies the right amount of nutrients, this potential legume is considered to be underutilized in the majority of the places. Therefore, a brief study was done to evaluate the nutritional and anti-nutritional properties of *L. purpureus* (Table 3). From the biochemical investigation pod, significant variations were observed in the protein content. The crude protein content was high in all the accessions of which maximum was recorded in LP 15 (3.074 mg/gm). The proximate analysis of *Lablab* pod revealed that the total protein content which is also higher than the other commonly consumed legumes. Carbohydrates are essential for the maintenance of the various metabolic processes and the availability of these carbohydrates is essential for energy utilization by monogastric animals and man for which legumes form part of the staple diet (Soetan and Fafunso 2010). The results found that all the

accessions showed high amount of carbohydrate value for the human diet. In *Lablab* the tender pods are the main harvest product for use as a fresh vegetable and its nutritive value is more, especially carbohydrate and protein content (Sarma et al. 2010). The storage lipids of legume seeds are a significant source of dietary fat (H. E. Pattee, D.K. Salunkhe, S.K. Sathe 2009). The content of dietary fat is more or less similar level in all the accessions. Ascorbic acid (Vitamin C) is a reliable reducing agent and it is involved in collagen synthesis, bone and teeth calcification and other reactions in the body as a reducing agent (Kalpanadevi and Mohan 2013). The nutritional analysis showed that vitamin C is high in all the accessions. The currently investigated legume *Lablab* shows a higher amount of vitamin C than that of earlier reports of *Cicer arietinum* (Fernandez and Berry JW 1988) *Teramnus labialis* (ArinathanV, Mohan VR 2009) and *Vigna* spp. (Tresina et al. 2014). In plants, thiamine occurs predominantly as free thiamine and pulses contain about 0.40–0.80 mg thiamine/100 g (Ogunlesi 2004). In the present study, it is found that the *Lablab* pod is a good source of vitamin B1 and B2 (Table. 3)

Table 1
The accessions of *L. purpureus* screened from two southern states in India.

Accession code	Sub-species	Place of Collection	State/District	Latitude	Longitude
LP 1	LPP	Akkikavu	Kerala, Thrissur	10°41'44.20"N	76°05'30.29"E
LP 2	LPP	Athmanilayam (Brown)	Kerala, Thiruvananthapuram	8°19'46.60"N	77°09'03.84"E
LP 3	LPP	Athmanilayam (white)	Kerala, Thiruvananthapuram	8°19'46.60"N	77°09'03.84"E
LP 4	LPP	Eravikulam	Kerala, Idukki	10°08'33.23"N	77°02'09.17"E
LP 5	LPU	Kodaikanal	TN, Dindugal	10°14'20.16"N	77°29'20.43"E
LP 6	LPU	Kovalam	Kerala, Thiruvananthapuram	8°23'56.15"N	76°58'28.06"E
LP 7	LPP	Mukkali	Kerala, Palakkad	11°03'31.83"N	76°32'24.39"E
LP 8	LPU	Uthamapalayam	TN, Theni	9°48'31.68"N	77°19'40.81"E
LP 9	LPP	Vattavilai	TN, Kanyakumari	8°14'18.09"N	77°16'21.72"E
LP 10	LPP	Memuttam 1	Kerala, Idukki	9°45'13.58"N	76°52'53.42"E
LP 11	LPP	Memuttam 2	Kerala, Idukki	9°45'13.58"N	76°52'53.42"E
LP 12	LPP	Vanchivayal	Kerala, Idukki	9°34'20.42"N	77°05'22.70"E
LP 13	LPP	Rajapalayam	TN, Virudhunagar	9°27'44.64"N	77°31'44.21"E
LP 14	LPP	Trichy (White seed)	TN, Tiruchirapalli	10°47'31.32"N	78°42'18.08"E
LP 15	LPP	Trichy (Black seed)	TN, Tiruchirapalli	10°47'31.32"N	78°42'18.08"E
LP 16	LPP	Trichy (Mottled seed)	TN, Tiruchirapalli	10°47'31.32"N	78°42'18.08"E
LP 17	LPU	Pallivasal	Kerala, Idukki	10°02'38.19"N	77°04'25.22"E
LP 18	LPU	Mattupetty	Kerala, Idukki	10°05'11.49"N	77°04'21.57"E
LP 19	LPU	Poopara	Kerala, Idukki	9°58'49.81"N	77°12'11.97"E
LP 20	LPP	Avaniswaram	Kerala, Kollam	9°02'08.80"N	76°51'0.41"E
LP 21	LPP	Coimbatore	TN, Coimbatore	11°01'00.62"N	76°57'21.07"E

LP: *Lablab purpureus*; LPP: *Lablab purpureus* subsp. *purpureus*; LPU: *Lablab purpureus* subsp. *uncinatus*; TN:Tamil Nadu.

Accession code	Sub-species	Place of Collection	State/District	Latitude	Longitude
LP 22	LPP	Munnar	Kerala, Idukki	10°06'58.55"N	77°09'01.30"E
LP 23	LPP	Krishnagiri 1	TN, Krishnagiri	12°28'39.28"N	78°11'17.27"E
LP 24	LPP	Krishnagiri 2	TN, Krishnagiri	12°28'19.19"N	78°11'42.66"E
LP 25	LPP	Kannannur	Kerala, Palakkad	10°47'21.51"N	76°09'34.21"E
LP 26	LPP	Kannannur	Kerala, Palakkad	10°47'11.82"N	76°09'38.44"E
LP 27	LPP	Kuzhalmannam	Kerala, Palakkad	10°42'59.60"N	76°35'21.08"E
LP 28	LPP	Kuzhalmannam	Kerala, Palakkad	10°42'41.03"N	76°35'33.03"E
LP 29	LPP	Kuzhalmannam	Kerala, Palakkad	10°42'49.06"N	76°35'43.15"E
LP 30	LPP	Yakkara	Kerala, Palakkad	10°47'13.07"N	76°39'17.60"E
LP 31	LPP	Anchalummood	Kerala, Kollam	8°56'14.76"N	76°36'43.18"E
LP 32	LPP	Kodaikkanal	TN, Dindugal	10°14'08.48"N	77°29'34.59"E
LP 33	LPP	Angadipuram	Kerala, Malappuram	10°58'20.66"N	76°12'36.58"E
LP 34	LPP	Muthanga	Kerala, Wayanad	11°40'10.91"N	76°22'09.99"E
LP 35	LPP	Muthanga	Kerala, Wayanad	11°39'59.06"N	76°22'10.55"E
LP36	LPU	Chunkankada	TN, Kanyakumari	8°11'57.34"N	72°23'12.85"E
LP37	LPP	Ambalavayal	Kerala, Wayanad	11°37'11.96"N	76°12'45.14"E
LP38	LPP	Vythiri	Kerala, Wayanad	11°33'07.13"N	76°02'25.26"E
LP39	LPP	Vandiperiyar 1	Kerala, Idukki	9°34'20.11"N	77°05'22.55"E
LP40	LPP	Vandiperiyar 2	Kerala, Idukki	9°34'20.20"N	77°05'26.52"E
LP41	LPP	Wagamon	Kerala, Kottayam	9°41'10.26"N	76°54'18.83"E
LP42	LPP	Angadimogar	Kerala, Kasargod	12°38'09.18"N	75°00'52.26"E
LP43	LPP	Dharmathadka	Kerala, Kasargod	12°39'58.63"N	75°01'44.36"E

LP: *Lablab purpureus*; LPP: *Lablab purpureus* subsp. *purpureus*; LPU: *Lablab purpureus* subsp. *uncinatus*; TN:Tamil Nadu.

Accession code	Sub-species	Place of Collection	State/District	Latitude	Longitude
LP44	LPP	Mulleria	Kerala, Kasargod	12°33'03.59"N	75°05'47.85E
LP45	LPP	Marayoor	Kerala, Idukki	10°16'34.33"N	77°09'41.24"E
LP46	LPP	Marthandam	TN, Kanyakumari	8°18'27.34"N	77°13'18.51"E
LP47	LPP	Malampuzha	Kerala, Palakkad	8°18'27.17"N	77°13'18.58E
LP48	LPP	Malampuzha	Kerala, Palakkad	10°50'19.92"N	76°41'25.34"E
LP49	LPP	Pulpally	Kerala, Wayanad	11°47'32.44"N	76°09'58.56"E
LP50	LPP	Kambalakkad	Kerala, Wayanad	11°40'32.46"N	76°04'31.66"E
LP: <i>Lablab purpureus</i> ; LPP: <i>Lablab purpureus</i> subsp. <i>purpureus</i> ; LPU: <i>Lablab purpureus</i> subsp. <i>uncinatus</i> ; TN:Tamil Nadu.					

Table 2
Quantitative yield contributing characters
selected for the study

Sl. No.	Descriptors
1	Length of leaflet (C)
2	Width of leaflet (C)
3	Length of leaflet (R)
4	Width of leaflet (R)
5	Length of leaflet (L)
6	Width of leaflet (L)
7	Length of leaflet (C)
8	Days to 50% flowering
9	Number of flower /receme
10	Number of receme/ plant
11	Peduncle length
12	Pod length
13	Pod width
14	Number of pods/ inflorescence
15	Seed Length (mm)
16	Seed breadth (mm)
17	Seed thickness (mm)
18	Number of seeds / pod
19	seed weight (gm)
20	Pod yield per plant

Table 3
Nutritional and ati-nutritional Analysis of Pod

Acce. Code	Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)	Vitamin C (mg/gm)	Vitamin B2 (mg/gm)	Vitamin B1 (mg/gm)	Oxalate (mg/gm)	Phytate (mg/gm)	Tanin (mg/gm)
LP 1	2.650 ± 0.005 ^{ef}	3.512 ± 0.001 ^{cde}	0.039 ± 0.008 ^{ij}	2.012 ± 0.004 ^{bcde}	1.979 ± 0.006 ^a	1.074 ± 0.034 ^{fg}	0.280 ± 0.177 ^{cde}	0.207 ± 0.007 ^{bcde}	0.149 ± 0.002 ^{bcd}
LP 2	2.008 ± 0.008 ^{cd}	3.191 ± 0.008 ^h	0.031 ± 0.006 ^{op}	2.016 ± 0.004 ^{bcde}	1.700 ± 0.003 ^{hij}	1.040 ± 0.018 ^{fg}	0.105 ± 0.001 ^{de}	0.220 ± 0.002 ^f	0.143 ± 0.001 ^{efg}
LP 3	2.608 ± 0.002 ^{de}	3.104 ± 0.001 ^{hi}	0.019 ± 0.007 ^r	1.982 ± 0.008 ^{fgh}	1.040 ± 0.024 ^{mn}	1.026 ± 0.018 ^{gh}	0.108 ± 0.002 ^{de}	0.200 ± 0.002 ^h	0.163 ± 0.001 ^a
LP 4	2.205 ± 0.002 ^{fg}	3.565 ± 0.001 ^{cde}	0.052 ± 0.005 ^c	1.968 ± 0.009 ^{ghi}	0.998 ± 0.002 ^{mn}	1.106 ± 0.004 ^{fg}	0.111 ± 0.001 ^{de}	0.205 ± 0.006 ^{cde}	0.145 ± 0.009 ^{def}
LP 5	1.390 ± 0.004 ^{de}	3.162 ± 0.003 ^{hi}	0.025 ± 0.005 ^q	2.018 ± 0.005 ^{bcde}	1.626 ± 0.008 ^l	1.080 ± 0.003 ^{fg}	0.456 ± 0.218 ^{bcd}	0.202 ± 0.009 ^{cdef}	0.159 ± 0.001 ^a
LP 6	2.054 ± 0.015 ^{ef}	3.184 ± 0.001 ^{hi}	0.030 ± 0.008 ^p	2.106 ± 0.004 ^{bc}	1.036 ± 0.010 st	1.006 ± 0.002 ^h	0.111 ± 0.002 ^{de}	0.210 ± 0.003 ^{bcde}	0.151 ± 0.001 ^{bc}
LP 7	2.796 ± 0.002 ^{efg}	3.572 ± 0.009 ^{cde}	0.038 ± 0.005 ^j	2.040 ± 0.008 ^{bcde}	1.084 ± 0.019 ^u	1.006 ± 0.002 ^h	0.102 ± 0.001 ^e	0.200 ± 0.003 ^f	0.143 ± 0.002 ^{efg}
LP 8	2.480 ± 0.003 ^{de}	3.460 ± 0.007 ^{efg}	0.042 ± 0.009 ^{gh}	2.014 ± 0.006 ^{bcde}	1.970 ± 0.005 ^a	1.048 ± 0.015 ^{fg}	0.103 ± 0.001 ^e	0.206 ± 0.007 ^{cde}	0.146 ± 0.002 ^{cde}
LP 9	2.170 ± 0.008 ^{fg}	3.424 ± 0.007 ^{efg}	0.044 ± 0.008 ^e	2.080 ± 0.008 ^{bcde}	1.628 ± 0.004 ^l	1.074 ± 0.016 ^{fg}	0.107 ± 0.005 ^{de}	0.211 ± 0.004 ^{bc}	0.150 ± 0.004 ^{bc}
LP 10	2.974 ± 0.002 ^{de}	3.313 ± 0.006 ^{fg}	0.034 ± 0.008 ^{lmn}	2.022 ± 0.011 ^{bcde}	1.360 ± 0.010 ^p	1.066 ± 0.002 ^{fg}	0.102 ± 0.009 ^e	0.199 ± 0.003 ^{gh}	0.125 ± 0.001 ^{kl}
LP 11	2.119 ± 0.005 ^{de}	3.191 ± 0.008 ^g	0.052 ± 0.006 ^c	1.962 ± 0.015 ^{ghi}	1.036 ± 0.011 st	1.020 ± 0.015 ^h	0.280 ± 0.177 ^{cde}	0.201 ± 0.003 ^{ef}	0.136 ± 0.002 ^{hi}
LP 12	2.797 ± 0.002 ^f	3.351 ± 0.007 ^{fgh}	0.051 ± 0.006 ^c	1.994 ± 0.002 ^{efgh}	1.222 ± 0.006 ^r	1.032 ± 0.008 ^{gh}	0.106 ± 0.001 ^{de}	0.205 ± 0.007 ^{cde}	0.143 ± 0.009 ^{efg}
LP 13	2.947 ± 0.004 ^{cd}	3.211 ± 0.006 ^{hi}	0.011 ± 0.006 ^t	1.968 ± 0.006 ^{ghi}	1.284 ± 0.010 ^q	1.044 ± 0.022 ^{fg}	0.105 ± 0.001 ^{de}	0.210 ± 0.003 ^{bcd}	0.109 ± 0.002 ^{op}
LP 14	3.001 ± 0.006 ^{bc}	3.612 ± 0.007 ^{bcd}	0.071 ± 0.005 ^b	2.018 ± 0.009 ^{bcde}	1.730 ± 0.010 ^g	1.380 ± 0.096 ^a	0.097 ± 0.009 ^e	0.200 ± 0.004 ^f	0.105 ± 0.001 ^{ij}
LP 15	3.048 ± 0.007 ^a	3.712 ± 0.007 ^a	0.081 ± 0.005 ^a	2.282 ± 0.018 ^a	1.666 ± 0.006 ^k	1.038 ± 0.002 ^{fg}	0.106 ± 0.009 ^{de}	0.193 ± 0.018 ^a	0.132 ± 0.001 ^{fg}
LP 16	3.005 ± 0.006 ^b	3.402 ± 0.005 ^{def}	0.051 ± 0.006 ^c	2.110 ± 0.005 ^b	1.774 ± 0.016 ^e	1.340 ± 0.092 ^{ab}	0.101 ± 0.006 ^e	0.216 ± 0.004 ^{ab}	0.142 ± 0.007 ^v
LP 17	2.966 ± 0.004 ^{ef}	2.983 ± 0.008 ⁱ	0.038 ± 0.008 ^j	2.104 ± 0.004 ^{bcd}	1.412 ± 0.004 ^o	1.010 ± 0.007 ^h	0.111 ± 0.008 ^{de}	0.201 ± 0.007 ^{ef}	0.133 ± 0.001 ^{ij}
LP 18	2.234 ± 0.009 ^{fg}	3.113 ± 0.001 ^{fg}	0.037 ± 0.011 ^{jk}	2.026 ± 0.013 ^{bcde}	1.690 ± 0.004 ^{ijk}	1.200 ± 0.054 ^{cde}	0.104 ± 0.004 ^{de}	0.200 ± 0.007 ^f	0.125 ± 0.001 ^{kl}
LP 19	2.369 ± 0.003 ^{de}	3.014 ± 0.001 ^h	0.041 ± 0.006 ^h	1.962 ± 0.011 ^{ghi}	1.024 ± 0.007 ^{rs}	1.078 ± 0.007 ^{fg}	0.112 ± 0.009 ^{de}	0.203 ± 0.009 ^{cdef}	0.145 ± 0.001 ^{def}

Acce. Code	Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)	Vitamin C (mg/gm)	Vitamin B2 (mg/gm)	Vitamin B1 (mg/gm)	Oxalate (mg/gm)	Phytate (mg/gm)	Tanin (mg/gm)
LP 20	2.980 ± 0.004 ^{cde}	3.112 ± 0.007 ^{gh}	0.041 ± 0.008 ^h	1.986 ± 0.004 ^{efg}	1.304 ± 0.002 ^q	1.040 ± 0.024 ^h	0.110 ± 0.001 ^{de}	0.199 ± 0.004 ^{gh}	0.122 ± 0.001 ^{lm}
LP 21	2.013 ± 0.001 ^{bcd}	3.607 ± 0.001 ^{cd}	0.038 ± 0.005 ^j	2.010 ± 0.007 ^{bcde}	1.164 ± 0.012 ^s	1.024 ± 0.002 ^{deg}	0.105 ± 0.008 ^{de}	0.204 ± 0.001 ^{cde}	0.105 ± 0.001 ^p
LP 22	2.701 ± 0.006 ^{efg}	3.104 ± 0.007 ^{hi}	0.041 ± 0.006 ^h	2.032 ± 0.010 ^{bcde}	1.714 ± 0.006 ^{hi}	1.132 ± 0.028 ^{fgh}	0.111 ± 0.005 ^{de}	0.203 ± 0.001 ^{cde}	0.118 ± 0.001 ^{mn}
LP 23	2.104 ± 0.001 ^{bc}	3.411 ± 0.008 ^{fgh}	0.032 ± 0.010 ^{no}	2.016 ± 0.007 ^{bcde}	1.086 ± 0.002 ^u	1.036 ± 0.020 ^f	0.108 ± 0.002 ^{de}	0.200 ± 0.009 ^{ef}	0.136 ± 0.001 ^{hi}
LP 24	2.993 ± 0.001 ^{bcd}	3.113 ± 0.001 ^{hi}	0.031 ± 0.006 ^{op}	2.012 ± 0.007 ^{bcde}	1.126 ± 0.002 ^t	1.060 ± 0.036 ^{bc}	0.109 ± 0.002 ^{de}	0.202 ± 0.009 ^{cdef}	0.122 ± 0.001 ^{lm}
LP 25	2.383 ± 0.001 ^{fg}	3.239 ± 0.005 ^{gh}	0.014 ± 0.005 ^s	2.088 ± 0.045 ^{bcde}	1.596 ± 0.016 ^{mn}	1.280 ± 0.048 ^h	0.106 ± 0.002 ^{de}	0.199 ± 0.002 ^{gh}	0.132 ± 0.001 ^{ij}
LP 26	2.701 ± 0.002 ^{def}	3.207 ± 0.001 ^h	0.032 ± 0.003 ^{op}	1.892 ± 0.002 ^{kl}	1.028 ± 0.011 ^{rs}	1.004 ± 0.002 ^h	0.113 ± 0.006 ^{de}	0.200 ± 0.003 ^{gh}	0.139 ± 0.001 ^{gh}
LP 27	2.654 ± 0.007 ^{cde}	3.573 ± 0.001 ^{cde}	0.044 ± 0.005 ^{em}	1.542 ± 0.200 ^o	1.066 ± 0.027 ^{uv}	1.012 ± 0.004 ^h	0.107 ± 0.002 ^{de}	0.201 ± 0.001 ^e	0.122 ± 0.006 ^{lm}
LP 28	2.911 ± 0.002 ^g	3.433 ± 0.001 ^{efg}	0.034 ± 0.006 ^{ln}	2.004 ± 0.002 ^{cdef}	1.044 ± 0.006 ^v	1.012 ± 0.001 ^h	0.111 ± 0.004 ^{de}	0.200 ± 0.004 ^{gh}	0.123 ± 0.001 ^k
LP 29	2.516 ± 0.002 ^{ef}	3.222 ± 0.001 ^{gh}	0.037 ± 0.011 ^{jk}	1.756 ± 0.002 ⁿ	1.018 ± 0.004 ^{ef}	1.009 ± 0.002 ^h	0.107 ± 0.007 ^{de}	0.210 ± 0.004 ^{bcde}	0.114 ± 0.001 ^{no}
LP 30	2.999 ± 0.004 ^{bc}	3.682 ± 0.006 ^{bc}	0.038 ± 0.003 ^j	2.008 ± 0.003 ^{bcde}	1.040 ± 0.010 ^{ef}	1.206 ± 0.120 ^{cd}	0.102 ± 0.005 ^e	0.201 ± 0.002 ^{ef}	0.142 ± 0.001 ^{efg}
LP 31	2.624 ± 0.002 ^{cde}	3.215 ± 0.001 ^g	0.039 ± 0.002 ^j	2.010 ± 0.003 ^{bcde}	1.980 ± 0.002 ^a	1.110 ± 0.009 ^{efg}	0.100 ± 0.003 ^e	0.210 ± 0.002 ^{bcde}	0.134 ± 0.001 ^{hi}
LP 32	2.016 ± 0.002 ^{bcd}	3.434 ± 0.001 ^{ef}	0.031 ± 0.004 ^{iop}	2.000 ± 0.002 ^{def}	1.844 ± 0.001 ^c	1.094 ± 0.001 ^{fg}	0.106 ± 0.004 ^{de}	0.211 ± 0.006 ^{bc}	0.124 ± 0.009 ^{kl}
LP 33	2.606 ± 0.002 ^{de}	3.203 ± 0.001 ^{gh}	0.019 ± 0.005 ^r	1.904 ± 0.007 ^{ijk}	1.726 ± 0.008 ^{gh}	1.010 ± 0.002 ^{fg}	0.806 ± 0.176 ^a	0.201 ± 0.007 ^{def}	0.143 ± 0.001 ^{efg}
LP 34	2.019 ± 0.006 ^{fg}	3.515 ± 0.005 ^{efg}	0.052 ± 0.004 ^c	1.744 ± 0.002 ⁿ	1.810 ± 0.002 ^d	1.005 ± 0.002 ^h	0.101 ± 0.007 ^e	0.203 ± 0.001 ^{cde}	0.123 ± 0.009 ^{kl}
LP 35	2.283 ± 0.019 ^{efg}	3.360 ± 0.005 ^{gh}	0.025 ± 0.004 ^q	1.901 ± 0.003 ^{jk}	1.628 ± 0.002 ^l	1.091 ± 0.003 ^h	0.456 ± 0.218 ^{bcd}	0.200 ± 0.004 ^f	0.134 ± 0.001 ^{hi}
LP 36	3.010 ± 0.002 ^b	3.487 ± 0.009 ^{def}	0.032 ± 0.024 ^{op}	1.984 ± 0.004 ^{efgh}	1.741 ± 0.004 ^{fg}	1.052 ± 0.007 ^{fg}	0.106 ± 0.004 ^{de}	0.201 ± 0.009 ^{def}	0.114 ± 0.001 ^{no}
LP 37	2.788 ± 0.003 ^{bc}	3.434 ± 0.008 ^{de}	0.035 ± 0.003 ^{lm}	2.005 ± 0.001 ^{cdef}	1.601 ± 0.002 ^{lm}	1.006 ± 0.002 ^{fg}	0.632 ± 0.217 ^{ab}	0.201 ± 0.001 ^{ef}	0.125 ± 0.001 ^{kl}
LP 38	2.586 ± 0.002 ^{ef}	3.450 ± 0.005 ^{efg}	0.047 ± 0.002 ^d	1.907 ± 0.007 ^{hijk}	1.880 ± 0.002 ^b	1.020 ± 0.003 ^h	0.100 ± 0.002 ^{bc}	0.202 ± 0.001 ^{cdef}	0.143 ± 0.001 ^{efg}
LP 39	2.166 ± 0.002 ^{cd}	3.441 ± 0.006 ^{fgh}	0.044 ± 0.004 ^e	1.980 ± 0.002 ^{fgh}	1.744 ± 0.009 ^{fg}	1.084 ± 0.016 ^h	0.100 ± 0.004 ^{bcd}	0.201 ± 0.001 ^e	0.134 ± 0.009 ^{hi}

Acce. Code	Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)	Vitamin C (mg/gm)	Vitamin B2 (mg/gm)	Vitamin B1 (mg/gm)	Oxalate (mg/gm)	Phytate (mg/gm)	Tanin (mg/gm)
LP 40	2.960 ± 0.002 ^{ef}	3.373 ± 0.001 ^{efgh}	0.035 ± 0.008 ^k	1.901 ± 0.003 ^{jk}	1.574 ± 0.009 ⁿ	1.071 ± 0.006 ^{fg}	0.630 ± 0.216 ^{ab}	0.203 ± 0.009 ^{cde}	0.144 ± 0.001 ^{efg}
LP 41	2.110 ± 0.003 ^{fg}	3.424 ± 0.001 ^{fg}	0.052 ± 0.002 ^{cl}	1.986 ± 0.002 ^{efgh}	1.763 ± 0.002 ^{ef}	1.060 ± 0.024 ^{fg}	0.456 ± 0.217 ^{bc}	0.200 ± 0.002 ^f	0.123 ± 0.001 ^{lm}
LP 42	2.015 ± 0.003 ^{efg}	3.550 ± 0.006 ^{cde}	0.048 ± 0.003 ^d	1.891 ± 0.006 ^k	1.800 ± 0.002 ^d	1.026 ± 0.005 ^{fg}	0.455 ± 0.216 ^{bcd}	0.200 ± 0.009 ^f	0.148 ± 0.001 ^{cde}
LP 43	2.700 ± 0.004 ^{cd}	3.303 ± 0.001 ^{def}	0.042 ± 0.048 ^{fgh}	2.002 ± 0.004 ^{defg}	1.720 ± 0.002 ^{gh}	1.142 ± 0.023 ^{gh}	0.279 ± 0.177 ^{cde}	0.200 ± 0.003 ^{ef}	0.124 ± 0.001 ^{kl}
LP 44	2.221 ± 0.006 ^{fg}	3.411 ± 0.007 ^{ef}	0.038 ± 0.004 ^j	1.841 ± 0.004	1.608 ± 0.004 ^{lm}	1.041 ± 0.006 ^{def}	0.110 ± 0.004 ^{de}	0.204 ± 0.001 ^{cde}	0.154 ± 0.004 ^b
LP 45	2.997 ± 0.003 ^{bcd}	3.413 ± 0.001 ^{efgh}	0.041 ± 0.003 ^h	2.000 ± 0.002 ^{defg}	1.730 ± 0.002 ^g	1.091 ± 0.008 ^{fg}	0.278 ± 0.177 ^{cde}	0.211 ± 0.006 ^{bc}	0.154 ± 0.001 ^b
LP 46	2.411 ± 0.003 ^{bc}	3.614 ± 0.001 ^{cd}	0.034 ± 0.003 ^{lmn}	1.990 ± 0.003 ^{efgh}	1.744 ± 0.001 ^{fg}	1.041 ± 0.005 ^{fg}	0.111 ± 0.006 ^{de}	0.198 ± 0.003 ^{gh}	0.141 ± 0.001 ^{fg}
LP 47	2.626 ± 0.045 ^{efg}	3.405 ± 0.001 ^{ef}	0.033 ± 0.005 ^{mno}	1.890 ± 0.002 ⁿ	1.680 ± 0.002 ^{jk}	1.061 ± 0.005 ^{fg}	0.630 ± 0.216 ^{ab}	0.200 ± 0.003 ^{ef}	0.149 ± 0.005 ^{bcd}
LP 48	2.565 ± 0.009 ^{cde}	3.574 ± 0.008 ^{def}	0.045 ± 0.001 ^e	1.900 ± 0.003 ^{klm}	1.594 ± 0.001 ^m	1.060 ± 0.006 ^{fg}	0.102 ± 0.008 ^e	0.201 ± 0.008 ^e	0.128 ± 0.008 ^{jk}
LP 49	2.870 ± 0.002 ^{ef}	3.432 ± 0.007 ^{efg}	0.044 ± 0.002 ^e	2.000 ± 0.004 ^{defg}	1.602 ± 0.005 ^{lm}	1.006 ± 0.002 ^h	0.105 ± 0.001 ^{de}	0.205 ± 0.002 ^{cde}	0.142 ± 0.001 ^{efg}
LP 50	2.614 ± 0.003 ^f	3.473 ± 0.001 ^{efg}	0.051 ± 0.002 ^k	1.961 ± 0.004 ^{ghi}	1.701 ± 0.006 ^{hij}	1.047 ± 0.002 ^{fg}	0.104 ± 0.001 ^{de}	0.209 ± 0.003 ^{bcde}	0.145 ± 0.001 ^{def}

Table 4
Correlation Studies for Yield and yield contributing characters

	NF/R	NR/P	PDL	PL	PW	NP/L	SL	SB	ST	NS/P	SW	PY/P
NF/R	1	.676**	.051	-.025	.346*	.736**	.088	.077	.089	-.292*	-.391**	.402**
NR/P		1	.321*	.122	.380**	.607**	.292*	.286*	.368**	-.100	-.130	.404**
PDL			1	.389**	.096	.145	.297*	.286*	.285*	.076	.190	.072
PL				1	-.243	-.332*	.088	.075	.004	.132	.291*	-.319*
PW					1	.387**	.304*	.321*	.385**	.140	.010	.564**
NP/L						1	.367**	.350*	.360*	-.103	-.529**	.513**
SL							1	.976**	.876**	.443**	-.257	.486**
SB								1	.853**	.513**	-.217	.473**
ST									1	.374**	-.021	.596**
NS/P										1	.065	.085
SW											1	-.107
PY/P												1
Means with in a column followed by same letters are not significantly ($p \leq .05$) different as determined by Duncan's Multiple Range Test. *** highly significant ($p \leq .001$), *significant ($p \leq .05$)												
NF/R = Number of flower /receme; NR/P = Number of receme/ plant; PDL = Peduncle length; PL = Pod length; PW = Pod width; NP/L = Number of pods/ inflorescence; SL = Seed Length (mm); SB = Seed breadth (mm); ST = Seed thickness (mm); NS/P = Number of seeds / pod; SW = seed weight (gm); PY/P = Pod yield per plant												

The Legumes commonly contain toxic factors, which decreases the digestibility and prevent bioavailability of nutrients (Kalpanadevi and Mohan 2013). It is assumed that from the nutritional point of view, the presence of tannins, even in low quantity, is not beneficial; the reason is that tannins are known to inhibit activities of digestive enzymes. Tannins cause decreased feed consumption in animals, bind dietary protein and digestive enzymes to form complexes that are not readily digestible and also cause decreased palatability and reduced growth rate (Soetan and Oyewole 2009). In the present study it is found that the anti-nutritional content, tannin is very low in almost all the accessions (0.105 ± 0.001) (Table 3). The result showed that the tannin content in *L.purpureus* is comparatively lower than the *Phaseolus vulgaris*, *Cajanus cajan* (Sangronis and Machado 2007) and *Vigna* sps (Kakati et al. 2010). The permissible limit of tannin for the human diet is 2g/100gm (Ndidi et al. 2014). The results confirmed that the pod contains tannin lower than the permissible limit. The soaking and cooking process is known to reduce the tannin content significantly (Vadivel V and Pugalenthil 2008).

Phytic acid has an anti-nutritional property because of its ability to lower the bioavailability of essential minerals and to form a complex with protein (Kalpanadevi and Mohan 2013). In the present study, the phytic acid content is very low (0.220 mg/gm) when compared with that of some commonly consumed legumes, *Vigna radiata* and *Vigna mungo* (Kakati et al. 2010). The permissible range of phytate for the human diet is 0.25–0.50 g/100gm (Ndidi et al. 2014). In this study the phytate content of

tender pod (0.193 ± 0.018) lower than that of permissible range (Table 3). Oxalate is produced and accumulated in many crop plants and is a concern in legumes because high oxalate diets can increase the risk of renal calcium absorption since calcium is made unavailable to the body due to the presence of oxalate (Audu et al. 2013). From the anti-nutritional analysis it is observed that the oxalate content is very low in all the accessions (0.097 ± 0.009) (Table 3). In the present study, the values recorded for oxalate content were similar as reported by Soetan and Fafunso (2010). Isong and Idiong (1997) reported that the permissible range of oxalate in the human diet is 2.5 g/100gm which is higher when compared to the oxalate content in *Lablab* pod.

Variability Studies

The variability of a character is measured by the range and genotypic coefficient of variation. The estimation of genetic and environmental components of the total variability are required as these together helps us in a further breeding program (Singh et al. 2015). In the present study, the difference in the phenotypic and genotypic coefficient of variations was compared for different traits, and it was found to be very narrow for almost all the characters studied. But a wide range of variability in the nutrient composition and anti-nutritional factors of the *L. purpureus* was noticed. For the production of nutritionally improved variety, elite plants can be selected for future breeding programs.

Mean value for yield and yield contributing characters

The fifty genotypes included in the study varied in the number of pod/ inflorescence, length and width of pod, number of flower/ inflorescence and length of the peduncle. The mean value of number of pod/inflorescence is highest in LP 8. Length and width of pod was highest in LP21. The highest mean value for the number of flower/inflorescence was in LP8 accession. These characters can be utilized for the improvement of this crop.

Correlation studies for yield and yield contributing characters

The variability evaluations are capable of providing data to the degree of improvement through selection. However, they do not focus on the extent and nature of the relationship between the characters, which could be utilized for selection following hybridization. The main objective of germplasm conservation is to collect and preserve the genetic pool in a given crop species to be exploited in future breeding programs and, wide variability in the genetic stocks provides a better chance of producing the desired genotype of a crop plant (Rai et al. 2014). The correlation coefficients among the twelve characters estimated from the data recorded on 50 genotypes of *Lablab* were shown in Table.4. Length of the pod, number of seed per pod, the width of pod, and length of peduncle had a strong positive correlation with yield. It showed that these characters could be considered for selection in the improvement of pod yield. Similar findings were reported by Mohan et al (2009). Significant variations noted in yield and yield contributing characters among the accessions of the present study may be due to genetic variability.

Genotypic correlation coefficient for yield contributing traits

The genotypic correlation coefficient of pod yield revealed that the pod yield per plant was positively correlated to pod width, number of flower per raceme, number of raceme per plant, peduncle length, seed length and seed width (Table 5). Similar results was also reported by Ali, F., Sikdar B., Roy, A.K. and Joarder (2005). The results showed that low, moderate, and high PCV and GCV values were obtained for different traits in the present study indicating the influence of environmental factors.

Table 5
Estimation of variability parameter

Characters	σ^2G	σ^2E	σ^2P	GCV	PCV	H ² B	GAM
Length of leaflet (C)	4.02	0.08	4.09	20.41	20.59	0.98	41.55
Width of leaflet (C)	2.52	0.08	2.60	18.61	18.90	0.96	37.36
Length of leaflet (R)	3.77	0.09	3.86	20.22	20.47	0.97	40.89
Width of leaflet (R)	2.57	0.06	2.63	21.17	21.47	0.97	42.78
Length of leaflet (L)	3.64	0.09	3.73	19.88	19.93	0.97	39.81
Width of leaflet (L)	2.38	0.05	2.43	20.84	21.06	0.97	42.06
Length of leaflet (C)	15.45	0.58	16.03	8.95	9.12	0.96	18.02
Days to 50% flowering	15.36	0.62	15.98	7.55	7.70	0.96	15.22
Number of flower /receme	35.90	1.37	37.27	30.66	31.24	0.96	61.77
Number of receme/ plant	4.66	0.97	5.63	12.66	13.92	0.82	23.50
Peduncle length	139.93	4.46	144.39	21.80	22.14	0.96	43.77
Pod length	7.13	0.06	7.19	30.10	30.23	0.99	61.63
Pod width	0.23	0.0008	0.23	31.97	31.97	1.00	65.85
Number of pods/ inflorescence	5.59	0.52	6.11	26.09	27.28	0.91	51.29
Seed Length (mm)	0.06	0.003	0.06	20.86	20.86	1	42.97
Seed breadth (mm)	0.02	0.003	0.02	18.13	18.13	1	37.34
Seed thickness (mm)	0.02	0.003	0.02	27.19	27.19	1	56.02
Number of seeds / pod	0.23	0.006	0.23	11.50	11.50	1.00	23.69
seed weight (gm)	40.75	0.000012	40.75	23.75	23.75	1.00	48.92
Pod yield per plant	0.008	0.00014	0.008	8.68	8.68	1.00	17.88
$\sigma^2 G$ = Genotypic variance; $\sigma^2 P$ = Phenotypic variance; PCV = Phenotypic coefficient of variation; GCV = Genotypic coefficient of variation; H ² _B = Broad sense heritability; GAM = Genetic advance as % of the mean							

Phenotypic correlation coefficient for yield contributing traits

The phenotypic correlation coefficient also showed similar results as the genotypic correlation coefficient. The number of receme/ plant, number of pods/ inflorescence and pod yield per plant had a direct positive effect on yield. The pod width exhibited the maximum values for genotypic and phenotypic coefficients of variation followed by the number of flower/inflorescence. These results are in agreement with those of Kambale et al (2016) in *L.purpureus*. It is also suggested that the hybridization of genotypes possessing a combination of these traits will be useful for obtaining desirable segregants as reported earlier in pea (Sonali. G., Nirmala, C. and Saroj 2009). High GAM was observed for pod width, number of flower/receme, pod length, number of pods/inflorescence and seed thickness. This is in accordance with the findings of Kambale et al (2016) in *L.purpureus*.

Conclusion

Based on the variability studies on yield and yield contributing characters, accession LP8 (Collected from Uthamapalayam, Tamil Nadu) is considered as the elite plant, but considering the proximate factors, LP15 showed high nutritional quality. So

these accessions can be used for further crop improvement programs of *Lablab purpureus*. From the correlation study, it may be concluded that the following important traits viz., number of receme/ plant, number of pods/ inflorescence and pod yield per plant were positively and significantly correlated both at genotypic and phenotypic levels. These indicate that these traits may be very important in the selection and any improvement in these characters would bring about an enhancement in yield and quality. The present evaluation concluded that high heritability, PCV and GCV of number of receme/plant, number of flower/inflorescence, number of pods/ inflorescence and pod yield per plant, pod width signifying the presence of sufficient amount of heritable variation and a broader possibility for desirable selection. Hence the present study contributes preliminary data to the diversity of *L. purpureus* for the selection of an elite accession for further crop improvement and commercial production of the crop.

Declarations

Conflict of interest

The authors declare that, have no conflict of interest to publish this manuscript.

Ethics approval

All authors have carried out fieldwork and data generation ethically, including obtaining appropriate permitting.

References

1. Ali F, Sikdar B, Roy AK, Joarder OI (2005) Correlation and genetic variation of twenty different genotypes of lablab bean, *Lablab purpureus* (L.) Sweet. Bangladesh Journal of Botany 125–128
2. AOAC (1975) Official methods of Analysis of the AOAC international 15th Edition. Association of Official Analytical Chemists, Washington
3. AOAC (1990) No Title. Association of Official Analytical Chemists, Washington DC, USA
4. Arinathan V, Mohan VRMA, AT (2009) Chemical evaluation of raw seeds of certain tribal pulses in Tamil Nadu, India. Trop Subtrop Agroecosys 10:287–294
5. Audu SS, Aremu MO, Lajide L (2013) Effects of processing on physicochemical and antinutritional properties of black turtle bean (*phaseolus vulgaris* L.) seeds flour. Orient J Chem 29:979–989. <https://doi.org/10.13005/ojc/290318>
6. Bligh EG, Dyer WJ (1959) No Title. Canadian journal of Biochemistry physiology 37:341
7. Burton GW, de Vane EH (1953) Estimating heritability in tall fescue (*Festuca arundinacea* L.) from replicated clonal material. Agron J 45:478–481
8. CR. DR and S (1990) Research Article Dolichos Bean: An Underutilized and Unexplored Crop with Immense Potential. Food Chem 05:239–246
9. Deka RK, Sarkar CR (1990) Nutrient composition and anti-nutritional factors of *Dolichos lablab* L. seeds. Food Chemistry 239–246
10. Fernandez, Berry JW (1988) Nutritional evaluation of chickpea and germinated chickpea flours. Plant food Hum Nutr 38:127–134
11. Pattee HE, Salunkhe DK, Sathe SK NRR and RLO (2009) Legume lipids. Food Science and Nutrition 97–139
12. Hedge JE, Hofreiter BT (1962) No Title. Carbohydrate chemistry, Chap. 17
13. Isong EU, Idiong UI (1997) Comparative studies on the nutritional and toxic composition of three varieties of *Lesianthera africana*. Plant Foods Hum Nutr 51:79–84. <https://doi.org/10.1023/A:1007922308985>
14. Johnson HWRH and CR (1955) Estimates of genetic and environmental variability in soybeans. Agron J 47:314–318
15. Kakati P, Deka SC, Kotoki D, Saikia S (2010) Effect of traditional methods of processing on the nutrient contents and some antinutritional factors in newly developed cultivars of green gram [*Vigna radiata* (L.) Wilezek] and black gram [*Vigna*

mungo (L.) Hepper] of Assam, India. International Food Research Journal 17:377–384

16. Kalpanadevi V, Mohan VR (2013) Nutritional and anti nutritional assessment of under utilized legume *D. lablab* var. *vulgaris* L Bangladesh journal of scientific industrial research 48:119–130
17. Kambale SS, Devmore JP, Bhawe SG et al (2016) Genetic variability for yield and yield attributing traits in F4 generation of *Lablab* bean (*Lablab purpureus* L. Sweet). Electronic Journal of Plant Breeding 7:809–813. <https://doi.org/10.5958/0975-928X.2016.00109.5>
18. Koche D (2011) Trace element analysis and vitamins from an Indian medicinal plant *Nepeta hindostana* (Roth) haines. International Journal of Pharmacy Pharmaceutical Sciences 3:53–54
19. Lowery OH, Rosebrough NJ, A L and Randall RJ (1951) No Title. J Biol Chem 193.p.265
20. Maass BL (2016) Origin, domestication and global dispersal of *Lablab purpureus* (L.) Sweet (Fabaceae): Current understanding. Legume Perspectives 5–8
21. Mohan N, Aghora TS, Devaraju (2009) Evaluation of *Dolichos* (*Lablab purpureus* L.) Germplasm for Pod Yield and Pod Related Traits. Journal of Horticultural Sciences 4:50–53
22. Ndidi US, Ndidi CU, Olagunju A et al (2014) Proximate, Antinutrients and Mineral Composition of Raw and Processed (Boiled and Roasted) *Sphenostylis stenocarpa* Seeds from Southern Kaduna, Northwest Nigeria. ISRN Nutrition 2014:1–9. <https://doi.org/10.1155/2014/280837>
23. Ogunlesi TA (2004) Thiamine deficiency: A cause of childhood ataxia not to be ignored. Ann Trop Paediatr 24:357–360. <https://doi.org/10.1179/146532804X10835>
24. Raghu BR, Samuel DK, MN and ATS (2018) Dolichos Bean: an Underutilized and Unexplored Crop With *Dolichos* Bean: an Underutilized and Unexplored Crop With Immense Potential. International Journal of Recent Advances in Multidisciplinary Research 5:4338–4341
25. Rai N, Rai KK, Tiwari G, Kumar S (2014) Nutritional and antioxidant properties and their inter-relationship with pod characters in an under-exploited vegetable, Indian bean (*Lablab purpureus*). Indian J Agric Sci 84:1051–1056
26. Sadasivam S, Balasubramanian T (1987) No Title
27. Sangronis E, Machado CJ (2007) Influence of germination on the nutritional quality of *Phaseolus vulgaris* and *Cajanus cajan*. LWT - Food Science Technology 40:116–120. <https://doi.org/10.1016/j.lwt.2005.08.003>
28. Sarma B, Sarma A, Handique GK, Handique AK (2010) Evaluation of country bean (*Dolichos lablab*) land races of north east india for nutritive values and characterization through seed protein profiling. 33:184–189
29. Schanderl SH (1970) Tannins and related phenolics. Determination of tannin content. In “Methods of Food Analysis.” 701–725
30. Shaahu DT, Carew SN, Ikurior SA (2015) Effect Of Processing On Proximate, Energy, Anti- Nutritional Factor, Amino Acid And Mineral Composition Of *Lablab* Seed. International Journal of Scientific Technology Research 4:4–7
31. Singh S, Singh PK, Singh DR et al (2015) Genetic variability and character association study in *dolichos* bean. Indian Journal of Horticulture 72:343–346. <https://doi.org/10.5958/0974-0112.2015.00067.5>
32. Soetan KO, Fafunso MA (2010) Studies on the Proximate and Mineral Composition of Three Varieties of *Lablab* Beans (*Lablab Purpureus*). 5:291–300
33. Soetan KO, Oyewole OE (2009) The need for adequate processing to reduce the anti- nutritional factors in plants used as human foods and animal feeds: A review. Afr J Food Sci 3:223–232
34. Sonali G, Nirmala C, Saroj D (2009) Genetic variability, correlation and path analysis studies in pea (*Pisum sativum* L.). Crop Research 179–183
35. Tresina PS, Daffodil ED, Lincy P (2014) Assessment of Biochemical Composition and Nutritional Potential of Three Varieties of *Vigna radiata* (L.) Wilezek. 2:655–667
36. Vadivel V, Pugalenth (2008) Removal of anti-nutritional substances and improvement in the protein digestibility of velvet bean (*Mucuna pruriens*) seed during processing. J Food Sci Tech 45:242–246

37. Verdcourt B (1970) *Lablab* Adans. Studies in the Leguminosae-Papilionoideae III. Kew Bull 24:409–411