3-бөлім

ӨСІМДІКТЕР ФИЗИОЛОГИЯСЫ ЖӘНЕ БИОХИМИЯСЫ

Раздел 3

ФИЗИОЛОГИЯ И БИОХИМИЯ РАСТЕНИЙ

Section 3

PLANTS PHYSIOLOGY AND BIOCHEMISTRY

Aytasheva Z.G., Baiseitova S.K., Zhumabayeva B.A., Dzhangalina E.D., Baqytbek Zh.

Al-Farabi Kazakh National University, Kazakhstan, Almaty

University common bean collection and its amino acid composition in seeds

Under mountain and steppe conditions of the Almaty Region, morphogenetic traits of almost 40 cultivars of common bean, Phaseolus vulgaris L. from Kazakhstan as well as American, Chinese, Polish, Russian, Turkish, and Czech collections have been assessed.

Six local and foreign accessions have been subject to high-performance liquid chromatography to identify amino acid composition. Studied accessions, varieties and lines could be classified by an Osborne classification presenting bulk of proteins.

Ketogenic amino acids (leucine, lysine and tryptophan) have been detected in much lower concentrations thus allowing to recommend related cultivars and lines for manufacturing diabetic products with a minor risk of ketone bodies accumulation.

Essential amino acids have been registered to achieve 27.5-29.8%. Local lines have been determined to contain the greatest amount of sulfur-containing amino acids, methionine and cysteine (335-350 mg / 100 g and 55-62 mg/100 g, respectively). In addition, the line "Aktatti" has appeared to be enriched by lysine (410 mg/100 g). Accumulation of sulfur-containing amino acids may point to slowing down seed protein storage under sharply continental conditions. It is thereby confirmed that the protein content is dependent of the climatic changes, breeding technologies, soil characteristics and genotypic classification of the variety or line.

Key words: Phaseolus vulgaris L., domestic lines common bean, collection, amino acid composition, cluster analysis

---

Айташева З.Ғ., Байсеитова С.Қ., Жұмабаева Б.Ә., Жанғалина Э.Д., Бақытбек Ж.

Әл-Фараби атындағы Қазақ ұлттық университеті, Қазақстан, Алматы қ.

Үрмебұршақ университет коллекциясы және оның аминқышқылдық құрамы

Алты жергілікті және шетелдік кәдімгі үрмебұршақ Phaseolus vulgaris L. сорт үлгілерінің тұқым сығындылары жоғары тиімді сұйық хроматографияда аминқышқылдық құрамын анықтау үшін алынды. Зерттелген сортүлгілері мен линияларын Осборн бойынша құрамында негізгі белоктар бөлігін глобулиндерге және альбуминдерге топтастыруға болады. Тұқымның негізгі фракциялары глутамин (3980-2082 мг/100 г) мен аспартат қышқылдарынан (2806-1045 мг/100 г), сондай-ақ аланин (1405-928 мг/100 г) және пролин (1273-694 мг/100 г). амин қышқылдарынан тұрды. Отандық сортүлгілері шетелдік аналогтарға қарағанда глутамат құрамы бойынша 91% астам, аланиндық құрамы – 51%-дан астам, пролин – 83% артық көрсеткіш көрсетті. Отандық линияларда шетелдік аналогтармен салыстырғанда кетогенді амин қышқылдары әлдеқайда аз мөлшерде екені анықталды, сондықтан жергілікті сортүлгілерін диабет ауруын емдеуге арналған ең төменгі деңгейде кетондық денелер жинақтайтын өнімдер шығаруға ұсынуға болады. Барлық амин қышқылдарының құрамының алмастырылмайтын амин қышқылдары 27,5-29,8% құрайтыны көрсетілді. Жергілікті сортүлгілерінің құрамы метионин және цистеин (335-350 мг / 100 г және 55-62 мг / 100 г, тиісінше) сияқты жоғары концентрациялы күкірті бар амин қышқылдарына бай болды. Сонымен қатар «Ақтәтті» сорты лизинмен (410 мг / 100 г) құнарландырылған болып шықты.

Түйін сөздер: кәдімгі үрмебұршақ, отандық сортүлгілер, коллекция, аминқышқылдық құрамы, кластерлі талдау.

Айташева З.Г., Байсеитова С.К., Жумабаева Б.А., Джангалина Э.Д., Бакытбек Ж.

Казахский национальный университет им. аль-Фараби, Казахстан, г. Алматы

Университетская коллекция и аминокислотный состав семян фасоли

Экстракты из семян шести местных и зарубежных сортообразцов фасоли обыкновенной Phaseolus vulgaris L. были подвергнуты высокоэффективной жидкостной хроматографии для определения аминокислотного состава. Изученные сортообразцы и линии можно классифицировать по Осборну как содержащие основную массу белков в виде глобулинов и альбуминов. Ключевые фракции аминокислот этих семян состояли из глутаминовой (3980-2082 мг/100 г) и аспарагиновой кислот (2806-1045 мг/100 г), а также аланина (1405-928 мг/100 г) и пролина (1273-694 мг/100 г). Отечественные сортоформы оказались превосходящими иностранные аналоги по содержанию глутамата более чем на 91%, аланина – на 51% и пролина – на 83%. Кетогенные аминокислоты содержатся в отечественных линиях в гораздо меньших количествах по сравнению с зарубежными аналогами, что позволяет рекомендовать местные сортоформы для выпуска диабетических продуктов с минимальным риском накопления кетоновых тел. Незаменимые аминокислоты достигают 27,5-29,8% от общего содержания. При этом местные сортоформы содержали повышенные концентрации серосодержащих аминокислот, а именно метионина и цистеина (335-350 мг / 100 г и 55-62 мг/100 г, соответственно). Кроме того линия «Актатти» оказалась обогащенной лизином (410 мг/100 г).

Ключевые слова: фасоль обыкновенная, отечественные сортоформы, коллекция, аминокислотный состав, кластерный анализ.

UDC 581.1:575.1

*Aytasheva Z.G., Baiseitova S.K., Zhumabayeva B.A., Dzhangalina E.D., Baqytbek Zh.

Al-Farabi Kazakh National University, Kazakhstan, Almaty,
*e-mail: zaure.aitasheva@kaznu.kz

UNIVERSITY COMMON BEAN COLLECTION AND ITS AMINO ACID COMPOSITION IN SEEDS

Introduction

The breeding outcome of new cultivars for common bean, *Phaseolus vulgaris* L. may be predicted from natural hybrids that are adapted to varying climate conditions within its growing zone. Consequently, the crop's ability to grow in other areas can be predicted. Transformation of wild species became especially extensive with human intervention, when forms with desirable nutritional quality and agronomic traits had been sought for [1].

During the course of evolution, bushy, large-leaf, early maturity forms with determinant type of growth, large number of flowers, and non-dehiscent pods have been selected [2].

In comparison to other legumes, common bean is more capricious in that it prefers fertilized sandy soils or light clay-containing soils. Cold clay soils with high moisture content are not considered to be appropriate for common bean. In addition, turf formation and soil compaction, caused by high acidification, may also decrease crop yield [3]. Due to acidic soils, the growth of nitrogen-fixing bacteria is reduced resulting in suppression of nitrogen fixation [4]. Neutralization or lime addition (calcification) to acidic soils leads to increasing yields of common bean. Moreover, two filed experiments were undertaken in Behaira Governorate, Egypt through 2012 and 2013 summer seasons. The effect of the seaweed extract at three different concentrations and a mixture of free amino acids from a plant source at three different concentrations apart from the mixture of seaweed and amino acids have been trialed as foliar spray three times on common bean plants. The obtained results clearly indicate that different applied treatments increased average growth characteristics i.e., plant height, stem diameter, number of branches and leaves/ plant, total leaf area /plant, dry weight of shoots and specific growth rate as well as simulataneous increase of the content for total chlorophyll [5].

Under mountain and steppe (plain) conditions of the Almaty Region, morphogenetic traits of 37 cultivars of common bean from different soil and climatic zones (Kazakhstan, American, Chinese, Polish, Russian, Turkish, and Czech collections) have been evaluated as described earlier [6].

This study was carried out under crop rotation in mountain and steppe (plain) zones of the Almaty Region in 2011-2012. Thirty-seven cultivars of common bean and its relatives were planted in "Zhanga Talap" Agrobiocenter of al-Farabi Kazakh National University.

Materials and methods

Part of stock varieties after preliminary propagation and introduction has been registered as the State Certificate on the subject of author rights No. 612 of 14 May, 2012 entitled: "Distribution and exchange of bean specimens".

Investigation on the varieties of this collection has been performed according to the Vavilov Institute and Awassa Agricultural Research Center protocols [7]. Seeds were sown on plots of 2 x 10 meters, using double-row sowing with wide inter-row spacing (40-60 cm) and at least two replicates. Pods were harvested and seeds were extracted by hand. The cultivar "Aktatti" was used as a standard for the Almaty Region. Observations, measurements and assays were conducted in accordance with "Methodical Instructions on The Study of The Collection for Grain Legume Crops" issued by a Vavilov Institute and followed the Classifier's grading for the genus *Phaseolus L.* [8]. To provide computer aid to planning of the work and planting of cultivars our own software entitled "Planting manager" (the State Certificate on the Subject of Property Rights No. 1034 of August, 1, 2012) was used.

Seed stocks for the mountain zone were sown at two sites, namely: i, the field of the Institute of Botany and Phytointroduction of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan; and ii, mountain plot in the Almarasan Gorge along the River Bolshaya Almatinka (800-1200 m above the sea level). Seed stocks for the flat zone were sown in a field of "Zhanga Talap" Agrobiocentre of al-Farabi Kazakh National University and Kazakh Institute of Soil Science and Crop Research (both of which are nearly 600 m above the sea level).

Seventeen cultivars and lines of common bean, (*Phaseolus vulgaris L.*) were planted in the mountain zone (9 – at the field of the Institute of Botany and Phytointroduction; 8 – mountain plot in the Almarasan Gorge). Twenty cultivars and lines of common bean and its relatives (broad bean, *Vicia faba L.* and Turkish beans, *Phaseolus coccineus L.*) were planted in the steppe zone ("Zhanga Talap" Agrobiocentre).

Phenotypic analysis of common bean plants was carried out on a range of main traits (stem height in cm; length and width of upper leaf at 30-th, 45-th and 65-th days of vegetation, cm; number of pods and number of seeds per plant in pieces; number of seeds per pod; weight of seeds per plant (seed productivity) in g; 100-seed weight, g, and others). The current paper is focused specifically on percentage of emergence and pod length. Domestic bioorganomineral fertilizer, provided by the Faculty of Chemistry and Chemical Technologies, KazNU, was introduced into soil after 25-35 days post-planting in amounts of 25-30 g per plot with subsequent moderate watering.

Seeds of six local and foreign accessions have been subject to high-performance liquid chromatography, or HPLC to clarify amino acid composition.

To determine qualitative and quantitative composition of amino acids in the seeds, seed powder was subjected to acidic hydrolysis with 6N HCl at 105ºC for 24 hours. The hydrolysate was dried with rotory evaporator three times at 40ºC. Final precipitate was re-suspended with added factions of salicyl-sulphonic acid and centrifuged to remove the aggregates. Supernatant was subjected to chromatography by loading onto Dowex-50 column under elution velocity of 150 µl/sec. After neutralization of the column with deionized water factions of amino acids were eluted with 6N NH_4OH (rate of elution 300 µl/sec). The eluate was dried with the rotavap under the pressure of 1.0 atm at 50 – 60ºC. Dried preparation was diluted with $SnCl_2$ – 2,2 – dimethoxy-propane-propanol mixture saturated with HCl. Then the preparation was incubated under rising temperature up to 110ºC for 20 min and dried again. Dry pellet was subsequently acetylated with the mixture of acetic oxide (acetic anhydrate), thriethylamine and acetone (1:2:5, v/v). The mixture was incubated at 60ºC for 1.5-2 min to be then dried and diluted with ethyl acetate saturated with NaCl. Posteriously to rigorous stirring, upper phase of the preparation containing ethyl acetate was collected. Gas chromatography of amino acids in the composition of the upper phase picked out was performed by using "Carlo Erba 4200" chromatography machine, Italy-USA. Elution of amino acids was conducted using the column made of stainless steel (40 x 0.3 cm), containing polar mixture of 0.31% Carbowax 20M, 0.28% Silar 5av (5CP) and 0.06% Lexan on Chromosorb WA-W-120-140m used as the template. Standard mode of elution was maintained at the temperature of plasmic ionization detector of 300ºC, evaporator temperature of 250ºC, initial column (furnace) temperature of 110ºCº and the following regimes of column incubation: 6º per 1 min at 110 – 185ºC and 32º per 1 min at 185 – 250º. Maximal temperature was maintained until complete exit of fractions [9]. Statistical treatment of the data obtained was fulfilled by the methods of analysis for variances [10,11].

Results and discussion

In the case of Czech collection of introduced cultivars, it was observed that the cv. "Zuzka" showed the highest percentage of emergence (53.0%) at the 30-th day after sowing under mountain conditions. Two other Czech cultivars showed the emergence of 23.3% (cv. "Katka") and 16.6% (cv. "Luna") under the same conditions. The Cv. "Zuzka" surpassed other cultivars in leaf size (11. 2 x 8.0 cm), whereas these parameters for cvs. "Katka" and "Luna" were 6.5 x 4.5 and 9.3 x 6.4 cm, respectively. Furthermore, it was also noted that the cv. "Zuzka" was much earlier to flower than other cultivars.

Morphogenetic studies of genetic stocks for breeding and phenological observations over the process of sprout emergence indicated that local lines were superior to introduced Czech cultivars with respect to the percentage of emergence (see Table 1).

Table 1 – Results of phenological observations: intermediate evaluation of percentages of emergence for Kazakhstan and Czech cultivars of common bean (30-th day after sowing)

No	Cultivar or line	Emergence, %%
1	Zuzka	53.33±0.15***
2	Katka	23.33± 0.10***
3	Luna	16.67 ±0.10
4	Nazym	78.26±0.25***
5	Talgat	50.00 ±0.20***
Footnote: *** P<0.001		

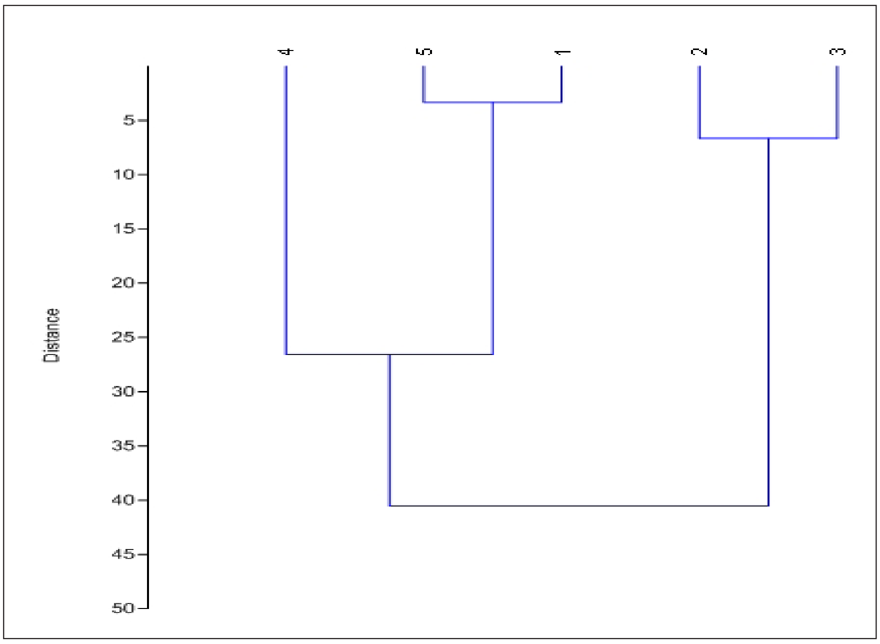
The percent emergence value for the cv. "Zuzka" was much greater than those for other Czech cultivars that were included in the study.

It has been shown that common bean leaves possess egg-like or transitional to wide egg-like form under local conditions. In addition, some cultivars and lines had silver-polished stipules and variations in leaf colour, which is known to be a characteristic genetic trait intrinsic for the cultivar. This trait is dependent on the vegetative stage of the plant, soil quality and amounts of fertilizer applied.

One of the tasks of this study was to determine superior lines by examining phenotypic data on percentage of emergence, or germination rate obtained from a mountain location in 2012 in comparison with elite Czech common bean cultivars. This kind of cluster analyses based on other phenotypic characteristics (branch angle, height, hypocotyls diameter, lodging, maturity, upper pods, pods per plant, and yield) was performed by Canadian researchers [10]. As shown in Fig. 1, with respect to the percentage of emergence, which was processed using computational cluster analysis, the local line "Nazym" is closer to the cv. "Zuzka", as is another local line "Talgat", which is more distant from two other Czech cultivars, "Katka" and "Luna". This output suggests that the line "Nazym" is unique by this morphogenetic character. This figure includes local and Czech lines only, as Czech cultivars were introduced into the mountain zone in 2012.

Noteworthy, similar approach was used for demonstrating genetic resemblance of the European and the North African faba bean germplasms which were closely associated with their geographical origins and ecological habits [13].

Propagation of common bean collection in Kazakhstan is in progress. Similar research towards the enrichment and analysis of national bean collections is being done by other researchers [14,15]. The objective of the Chinese investigation [16]. was to evaluate a collection of domestic landraces for the genetic variability, genepool identity and relationships within and between the groups identified among the genotypes. The landraces were clustered into two genepools. Polish researchers evaluated the genetic diversity among commercial varieties and local landraces of the *Phaseolus* dwarf common bean and the *Phaseolus* runner bean to reveal a considerable polymorphism of *P. vulgaris* and *P. coccineus* accessions which formed distinct groups [17]. One of the positive outcomes of present study is the amount of polymorphism in stocks and possibility of introducing foreign cultivars, the Czech collection in particular. In the mountain zone of the Almaty Region (mountain plot is in the Almarasan Gorge) it was established that three cultivars, cvs. "Zuzka", "Katka" and "Luna", among the four of Czech collection, introduced in 2012, have a highly desirable traits such as high yield and early maturity deserving further study. The fourth cultivar cv. "Jitka" didn't sprout at all and will not be included in future studies.



1, Zuzka; 2, Katka; 3, Luna; 4, Nazym; and 5, Talgat.

Figure 1 – Cluster analysis showing the germination rate (percentage of emergence) differences between Kazakhstan and Czech lines of common bean (30-th day after sowing) (see also Table1).

Seed material obtained from cvs. "Zuzka", "Katka" and "Luna" will be used for further propagation in the steppe zone, in fields of "Zhanga Talap" Agrobiocentre. However, all Czech cultivars have shown high susceptibility to bean weevil *(Acanthoscelides obtectus Sav.)* at room temperature. Cv. "Luna" was observed to be the earliest to reach maturity with a maturation period of 80 days after planting. Other cultivars reached the same stage of maturity 10-12 days later.

The data showed that the maximal size of mature pod was attained on the 92-th day after planting, and it belonged to cv. "Zuzka" (13.3±0.1 cm). The pod size values for cvs. "Katka" and "Luna" were 12.0±0.2 cm and 10.8±0.1 cm, respectively. The local line "Aktatti" had similar pod lengths in the range of 11.0±0.1 cm, whereas other local lines, "Nazym" and "Talgat" had pod sizes of 12.4±0.1 and 9.0±0.2 cm, respectively, at their technical maturity stage.

Pod length values for cv. "Zuzka" and line "Talgat" were clearly much greater than those of other cultivars and lines investigated.

In the steppe zone ("Zhanga Talap" Agrobiocenter) American, Polish and Russian common bean lines have been successfully propagated. These observations indicate that cvs. "Bijchanka", "Camelia", "Red Goya" and "Ufimskaya" would be most adapted to the steppe zone if they were introduced into that zone.

Using local "Aktatti" line, we investigated the effect of new domestic bioorganomineral fertilizer on morphogenetic traits of common bean plants. The results show that, the yield of this line can be increased by 19-25%, irrespective of climate conditions.

HPLC outputs considering differences in amino acid composition are shown below in Tables 2 and 3.

As indicated in Table 2, the bulk of amino acids would be presented by glutamatic (3980-2082 mg/100 g) and aspartic acids (2806-1045 mg/100 g), alanine (1405-928 mg/100 g) and proline (1273-694 mg / 100 g). Interestingly, domestic lines have appeared to take over external analogues by more than 91% by the glutamate content, more than 2.4 times by the aspartate content, more than 51% by alanine and 83% by proline.

In addition to abundant glucogenic amino acids forementioned, it has been noticed that the ketogenic amino acids (leucine, lysine and tryptophan) would remain in quite small quantities. This fact allows to recommending related "low-ketogenic varieties" for further manufacturing diabetic food products due to a minor risk of forming the ketone bodies.

Table 2 – Amino acids composition of common bean seeds (mg/100 g)

Amino acids	Aktatti	Djungarskaya	Zhuravushka	IFGBR- 48	Camellia	Karakoz
Alanine	1405,8±8,5	1144,5±5,1	1025,5±7,6	1248,3±5, 4	928,7±2,5	1352,7±5,8
Glycine	644,5±3,09	320±1,05	258±1	526±2	286±2	608±3
Leucine	420,7 ± 2,03	378,6±1,09	425,9±2,07	425,7±2,05	404,5±2,07	480,7±2,05
Isoleucine	390,3 ± 2, 02	265,3±1,06	304,5±1,06	384,0±2,03	295,6±1,02	425,0±2,04
Valine	304,8 ± 2,06	205,6±1,03	210,3±1,03	328,5±2,08	220,5±1,03	356,5±2,02
Glutamate	3980,7±11, 7	2213,4±7,2	2082,7±5,4	3245,7±9,6	2147,4±9,1	3828±9,2
Threonine	462,0 ± 2,07	214,4±1,08	192,5±1,09	448,2±2,07	218,0±1,06	483,3±1,09
Proline	1273,5±5,04	762,6±2,05	705,8±2,04	1064, 3±3,3	694,3±2,07	1256±5,2
Methionine	335,1 ± 2,03	118,9±1,03	130,7±1,02	290,0±1,09	142,9±1,05	350,0±2,00
Serine	628,9±3,06	416,8±1,02	378,5±2,09	702,7±2,03	415,5±2,08	780,9±1,02
Aspartate	2806,8±12,10	1045,6±2,8	1210,6±6,9	1948,7±8,5	1148,6±4,9	2344,6±9,3
Cysteine	55,5±0,03	18,0±0,01	25,6±0,02	42,1±0,03	24,2±0,03	62,7±0,02
Hydroxy-proline	6,0±0,002	3,1±0.005	2,2±0,001	5,5±0.002	2,7±0,001	7,3±0,001
Phenylalanine	692,0 ±3,07	282,2±1,04	303,5±1,04	556,0±2, 02	312,7±1,04	680,0±2,00
Tyrosine	729,6±3,09	304,6±1,09	342,5±1,07	608,5±2,03	356,4±1,09	735,4±2,07
Histidine	588,0 ±3,03	298,4±1,09	315,0±1,05	526,2±3,03	285,2±1,07	554,4±2,03
Ornithine	5,0±0,001	4,2±0,003	3,3±0,004	4,7±0.001	3,9±0,001	6,1±0,001
Arginine	738,6±3,04	587,5±1,07	538,4±2,02	640,3±3,05	515,2±2,08	715,6±1,08
Lysine	410,0±1,08	368,5±1,03	325,0±1,09	315,7±2,08	286,0±2,09	370,9±1,05
Tryptophan	78,5±1,08	120,4±1,02	112,6±1,08	226,4±1,05	98,5±1,03	268,6±1,08

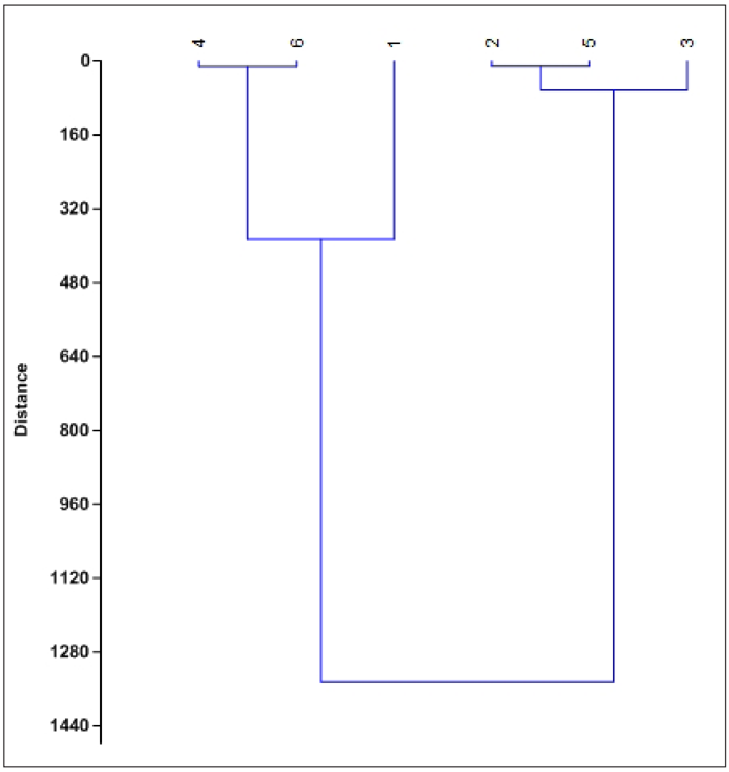
The amount of essential amino acids (Table 3) in the seeds has been recorded in the range of 2248-3879 mg/100g, or 25,5-29,8%, when compared with total content of amino acids shown in Table 2. Lysine, threonine and serine are biological substances enhancing the growth of human and animals. Interestingly, in contrast to other bean accessions usually sub-optimal in this respect, local lines "Aktatti" and "Karakoz" were shown to contain the greatest amount of sulfur-containing amino acids, methionine and cysteine, which level would be maintained in seeds of these lines in amounts varying from 335 to 350 mg/100 g and from 55 to 62 mg/100 g, respectively. In addition, the line "Aktatti" has appeared to be enriched by lysine (410 mg/100 g).

Studied accessions, varieties and lines could be classified by an Osborne classification presenting bulk of proteins as globulins (phaseolin, 60-90%) and albumins (10-20%).

Table 3 – Composition of essential amino acids in bean seeds (mg/100 g)

Essential amino acids	Aktatti	Djungarskaya	Zhuravushka	IFGBR- 48	Camellia	Karakoz
Leucine	420,7 ± 2, 03	378,6±1,09	425,9±2,07	425,7±2,05	404,5±2,07	480, 7±2,05
Isoleucine	390,3 ± 2, 02	265,3±1,06	304,5±1,06	384,0±2,03	295,6±1,02	425,0±2,04
Valine	304,8 ± 2,06	205,6±1,03	210,3±1,03	328,5±2,08	220,5±1,03	356,5±2,02
Threonine	462,0 ± 2,07	214,4±1,08	192,5±1,09	448,2±2,07	218,0±1,06	483,3±1,09
Methionine	335,1 ± 2,03	118,9±1,03	130,7±1,02	290,0±1,09	142,9±1,05	350,0±2,00
Phenylalanine	692,0 ± 3,07	282,2±1,04	303,5±1,04	556,0±2, 02	312,7±1,04	680,0±2,00
Histidine	588,0 ±3,03	298,4±1,09	315,0±1,05	526,2±3,03	285,2±1,07	554,4±2,03
Lysine	410,0±1,08	368,5±1,03	325,0±1,09	315,7±2,08	286,0±2,09	370,9±1,05
Tryptophan	278,5±1,08	120,4±1,02	112,6±1,08	226,4±1,05	98,5±1,03	268,6±1,08
Total amount	3880,9±1,6	2252,3±1,05	2320,0±1,17	3500,7±1,72	2263,9±1,3	3488,7±1,5

Cluster analysis of differences in essential amino acids across cultivars and hybrids chosen from Kazakhstan and some other (American and Russian) common bean cultivars and lines is presented in Fig. 2. This picture shows clearly that local lines (patterned in this case by the line "Aktatti") may appear to be of particular interest because of their abundance in essential amino acids exceeding chosen international accessions.



1, Aktatti; 2, Djungarskaya; 3, Zhuravushka; 4, IFGBR-48; 5, Camellia; and 6, Karakoz.
Figure 2 – Cluster analysis of differences for cultivars and hybrids by essential amino acids among Kazakhstan, American and Russian common bean cultivars and lines (see also Table 3).

Proper heat treatment of the seeds (to destroy heat-labile antinutritional factors) or cooking process (to remove testas containing tannins), mixture with other foods in the diet (mainly cereals), seed yield increase (with consequently a higher level of proteins) are all means to circumvent partially sometimes low biological value of beans [18]. Another interesting alternative to improve the biological value of the plant proteins is beans combination with other foods in the diet. A good mixture is provided by the cereal-based diets, combining adequately lysine (well represented in phabaceous species) with sulphur-containing amino acids (fairly represented in cereals). Supplementary alternative supposed to enhancing protein quality is genetic improvement of both protein content and amino acid balance. However, gene transfer at intra- and interspecific levels would be limited across grain legumes due to similar biochemical and nutritional deficiencies. Protein concentration as genetic trait is inherited quantitatively being subject to non-genetic factors,making it difficult to assess varieties and lines without extensive trials. Substantial genetic variation for total seed protein concentration and amino acid composition (especially sulphur-amino acids) exists in the gene pools of grain common bean. Although environment effects are large, genotype environment interactions are often insignificant, indicating that the relative differences between genotypes should be similar in several environments.There are substantial differences in amino acid composition of individual protein fractions; synthesis and accumulation of different fractions and the polypeptide composition of the fractions are under separate genetic factors. Heritability estimates for the percentage protein range from 0.25 to 0.60, according to species, genotypes within species, and environments. Genetic correlation between seed yield and protein percentage is quite small but positive, while correlation between seed yield and specific amino acid contents is once in a while significant. Occurrence of negative correlation between total protein concentration and sulphur-amino acid content is due predominantly to diverse accumulation of storage proteins, with different shares of amino acids.

Other authors, Pirman et al., 2001 [19] emphasized that amino acid composition of raw seeds, lyophilised cooked seeds and the water soluble matter crude protein contents in the seeds of three varieties of Slovenian common bean, namely Čeönjevec, Semenarna 22 and Cipro vary from 21.5, 23.5 and 26.2 g per 100 g. , whereas this parameter for French green lentil (Lens esculenta) Anicia was determined to be of 26.7 g per 100 g. However, non-protein nitrogen is higher in the lentil than in the beans. The contents of amino acids in beans are similar, whereas for the lentil concentrations of methionine and tyrosine are lower and the concentration of arginine much higher than for the beans. After cooking the amount of some amino acids (in 100 g of crude protein) increased, especially tyrosine, methionine and cystine, more in lentil than beans. The index of essential amino acids (*EAAI*) was higher in beans than in lentil and it has increased after cooking in common bean. Analysis of the material obtained by drying the cooking water showed that predominantly non-essential amino acids had been were released from beans.

Noteworthy, domestic lines have been determined in our experiments containing the highest quantities of sulfur-containing amino acids, methionine and cysteine (335-350 mg / 100 g and 55-62 mg / 100 g, respectively). Among them line "Aktatti" has appeared to be enriched by lysine (410 mg / 100 g). The data thereby confirm that the protein content is dependent on climate, applied breeding technologies, soil characters and genotypic features of the variety or line.

Conclusions

Based on the survey of morphogenetic traits of available seed stocks, a catalogue of main parental cultivars for common bean has been developed. It includes about 40 parental specimens of common bean and its relatives of diverse geographic origin. Out of the Czech bean collection introduced in the mountain zone, the cultivar to reach maturity earliest was cv. "Luna" (80 days of maturation), whereas other cultivars reached their technical maturity 10-12 days later than "Luna". As for germination percentages, tested by computational cluster analysis, the local line "Nazym" being closer by maturity date to cv. "Zuzka" and other local bean line "Talgat", appears to be more promising to be grown commercially in southeast regions of Kazakhstan on the basis of this and its other desirable traits.

Amino acid assessment undertaken in this study provides identification of best genetic types by nutritional value, accumulation of essential amino acids and sulfur-containing amino acids. Essential amino acids in common bean accessions under investigation have been determined to achieve 27.5-29.8%. Local lines have been determined to contain the greatest amount of sulfur-containing amino acids, methionine and cysteine (335-350 mg/100 g and 55-62 mg/100 g, respectively). Domestic line "Aktatti" has appeared to be enriched by lysine (410 mg/100 g). Essential and sulfur-containing amino acid analyses have been implied to the identification nutritionally valuable bean specimens. Accumulation of sulfur-containing amino acids may point to slowing down seed protein storage under sharply continental conditions. Earlier it was noticed that sulfur-containing amino acids may reflect seed protein deficiency [20].

In addition to Czech and local cultivars and lines, six French cultivars of grain and liana common beans ("Argus", "Coco nain blanc precoce", "Triomphe de Farcy", "Merveille de Venise", "Mistica", and "Phenomene" manufactured by Truffaut and Vilmorin companies), are currently being investigated. Five of these cultivars (except cv. "Coco nain blanc precoce") have occurred to possess high or average productivity. Investigations on domestic collection of cultivars and lines are also in progress with respect to biochemical, cytogenetic and other properties for further breeding activities.

References

1 Bodnar GV, Lavrinenko GT (1977) Grain legume crops. Kolos, Moscow, USSR (in Russian)

2 Zhukovsky P.N. (1971) Crops and their relations. Kolos, Leningrad, USSR (in Russian)

3 Popov V.P., Martynov OL (2001) Morphological and biological peculiarities of few cultivars for common bean in the South of Moscow Region. Proceedings of Russian Academy of Agricultural Sciences, Russia . No. 4, P. 21-23.

4 Zerfus VM, Schitov AG, Kozlova GY (1997). Factors determining the formation of symbiotic apparatus and its impact on grain legumes productivity in Western Siberia. Agrochemistry [Agrochimia]. 12: 27-31 (In Russian)

5 Zewail R.M.Y. Effect of seaweed extract and amino acids on growth and productivity and some bioconstituents of common bean (*Phaseolus vulgaris* L) plants (2014). J. Plant Production, Mansoura Univ., Vol. 5 (8): 1441 – 1453,

6 Rysbekova A.B. , Zhumabaeva B.A., Baiseyitova S.,, Urazova Z., Dzhangalina E., Tagaev Q., Aytasheva Z. Quantitative amino acid analysis of seeds from common bean university collection (2014) . Agriculture & Forestry,Vol. 60 Issue 4: 181-187, Podgorica

7 Korsakov N.I. (1975) Methodical Instructions on The Study of The Collection for Grain Legumes (compiled by N.I. Korsakov, O.G. Adamova, V.I. Budanova. Leningrad: All-Union Institute of Plant Research Publishers, 59 p.

8 Asfaw AA, Blair MW, Almekinders C (2009) Genetic diversity and population structure of common bean (*Phaseolus vulgaris L.*) landraces from the East African highlands. Theor Appl. Genet. Vol. 120, 1:1-12.

9 Catherine Cooper (2011) Amino Acid Analysis Protocols (Methods in Molecular Biology) Humana Press, 280 p.

10 Dospekhov BA (1985) Field experiment techniques (with fundamentals of statistic treatment of research data) Agropromizdat, Moscow, USSR (in Russian)

11 Bisgaard S (2008) Must a Process be in Statistical Control before Conducting Designed Experiments. Quality Engineering, ASQ. Vol. 20, 2: 143 – 176.

12 Beattie AD, Michaels TE, Pauls KP (2003) Predicting progeny performance in common bean (*Phaseolus vulgaris L.)* using molecular marker-based cluster analysis. Genome. Vol. 46, 2:259-267.

13 Wang HF, Zong XX , Guan JP et al. (2012) Genetic diversity and relationship of global faba bean (*Vicia faba* L.) germplasm revealed by ISSR markers. Theor. Appl. Genet. Vol. 124, 5:789-797.

14 Isemura T, Kaga A, Konishi S et al. (2007) Genome dissection of traits related to domestication in azuki bean (*Vigna angularis*) and comparison with other warm-season legumes. Ann Bot. 100(5):1053-1071

15 Kumar V, Sharma S et al. (2008) Genetic diversity in Indian common bean (*Phaseolus vulgaris* L.) using random amplified polymorphic DNA markers. Physiol.Mol. Biol. Plants. Vol. 14, 4:383-387.

16 Zhang X, Blair MW, Wang S (2008) Genetic diversity of Chinese common bean (*Phaseolus vulgaris* L.) landraces assessed with simple sequence repeat markers. Theor. Appl. Genet. Vol. 117, 4:629-640.

17 Nowosielski J, Podyma W, Nowosielska D (2002) Molecular research on the genetic diversity of Polish varieties and landraces of (*Phaseolus coccineus L.*) and (*Phaseolus vulgaris L.*) using the RAPD and AFLP methods. Cell Mol. Biol. Lett. Vol. 7, 2B:753-762.

18 Baudoin J-P, Maque A (1999) Improvement of protein and amino acid contents in seeds of food legumes. A case study in *Phaseolus*. Biotechnol. Agron. Soc. Environ. Vol. 3, 4: 220–224.

19 Pirman T, Stibilj V, Stekar JMA, Combe E (2001) Amino acid composition of bean and lentil. Zb. Bioteh. Fak. Univ. Ljubl., Kmet. Zooteh. V. 78, 1:57-68.

20 Taylor M, Chapman R et al. (2008) Seed storage protein deficiency improves sulfur amino acid content in common bean (*Phaseolus vulgaris L.*) redirection of sulfur from gamma-glutamyl- S-methyl – cysteine. J. Agric. Food Chem. Vol.56, 14:5647-5654.