Paper 14

[Accueil] [Remonter] [Intro 1] [Paper 2] [Paper 3] [Paper 4] [Paper 5] [Paper 6] [Paper 7] [Paper 8] [Paper 9]
[Paper 10] [Paper 11] [Paper 12] [Paper 13] [Paper 14] [Paper 15] [Paper 16] [Paper 17] [Paper 18]
[Paper 19] [Paper 20] [Paper 21] [Paper 22] [Paper 23] [Paper 24] [Paper 25] [Paper 26] [Paper 27]
[Paper 28] [Paper 29] [Paper 30] [Paper 31] [Paper 32] [Paper 33] [Paper 34] [Paper 35] [Paper 36]
[Paper 37] [Paper 38] [Paper 39] [Paper 40] [Paper 41] [Paper 42]

Agronomic, technological, culinary and nutritive Qualities of Rice Varieties and promising lines cultivated in Bulgaria

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Abstract

A series of Bulgarian rice varieties and perspective lines, cultivated under unified conditions and harvested in Bulgaria in 1996 have been studied. Agronomic, technological and culinary qualities have been investigated on the basic parameters for productivity, earlyness, yield, rice grain output, shape and size of the grains (unshelled and shelled rice), water absorption coefficient, boiling time, firmness etc. Samples of shelled grains have been subjected to chemical and biochemical analysis valid for qualifying cereals, namely : moisture, amylose content, mineral residue, etc.

Collected data have been analysed and discussed in comparison with the standard variety in Bulgaria and those of significant agronomic importance have been thoroughly examined for protein complex, amino acid and protein level in the seeds. The gross amino acid amount and the essential amino acid proportion have been reported and the biological value of the protein, according to Oser and Mitchel (Chemical score and EAA index) is estimated.

All this provided a possibility for pointing out those lines and varieties cultivated in Bulgaria, representative of complex of requested productivity, technological, nutritive and organoleptic properties. Suggestions for their use in breeding programs have been made.

Keywords

- Rice improvement, protein, and amino acids, biological value
- Bulgaria.

Introduction

Bulgaria is ranked among the European rice producing countries. In the country, rice is not the staple food but it has been

used in the diets of Bulgarians since ancient times. Traditionally, the Japonica type of rice, which is well adapted to the country's microclimatic conditions is produced (Chilikov I., 1984). An irrigation system for rice cultivation on a large area of 25.000 ha is available in the country. Unfortunately, rice production in Bulgaria by now is in a period of recession because of economical and political changes occurred in the region during the last 7-8 years. Nevertheless, since the last three years, private and co-operative farmers in rice cultivation showed increasing interest for rice production which consequently led to an increase of the rice-cropped fields.

Parallel with the rice production, research and breeding activities have been developed in different research centres in the country : Higher Agricultural Institute and Maritza Institute both in Plovdiv, Institute for Introduction of Genetic Ressources - Sadovo etc. In the course of the rice breeding and improvement work on rice, more attention is given to the high-producing lines and varieties, to their response to agroclimatic conditions and to the output obtained after industrial processing. Thus, much less attention is paid to qualitative traits, that are now given priority. In that aspect, a number of investigations have been carried out on rice quality, this later becoming of a particular importance for the European Union rice- producer countries (Faure, J., F. Mazaud, 1995). Because of that, new requirements for the new Bulgarian rice varieties are directed, not only toward the development of high yield varieties, but also to the production of high quality rice cultivars with oval-oblong grains type "Long A" according to French system of classification, with good firmness, non sticky at cooking etc. The nutritive qualities of the new cultivars are also of great importance. In that order, a number of investigations on starch (respectively amylose and amylo-pectine level, on protein content and quality, on amino acids levels and biological value of the protein in different rice genotypes must be achieved. According to Le Zoan Zien, (1984), the existing publication in that field including amino acids composition of the protein are limited.

Through the present work, we try to present our results about culinary and nutritive qualities of some rice lines and cultivars grown in Bulgaria, particularly the amino acids composition of the protein and its biological value, as well as some of their major agronomic and technological characters.

Materials and Methods

The selection material was obtained from the experimental field of the Higher Agricultural Institute in Plovdiv in 1996. The selected lines are stabilised, and of hybrid or mutant origin. Out of these lines, two varieties are included in this work, i.e. the variety "Krasnodarsky-424" used as the standard (St) in Bulgaria, and the variety "Louda Jana" (L.J.) which is widely used in the country since 1994. Biometrics values of quantitative parameters of agronomic importance have been analysed. Indexes characterising the polished grain have been established in the specialised laboratories of the Higher Agricultural Institute of Plovdiv in Bulgaria, and of the Centre de Cooperation Internationale en Recherche pour le Développement (CIRAD) in Montpellier in France.

The chemical analysis for total protein, amylose and mineral composition have been carried out according to Stanchev et al., (1968). The amino acids composition has been determined after hydrolysis in 6N HCl, using amino acids analyser according to Spackman et al., (1958), revised by Mashev et al., (1994). The determination of the limiting amino acid and the biological value of the protein - essential amino acids index (EAA-index) have been done according to Oser and Mitchel, revised by Sander S. (1979). The culinary indexes have been determined by CIRAD.

Results and Discussion

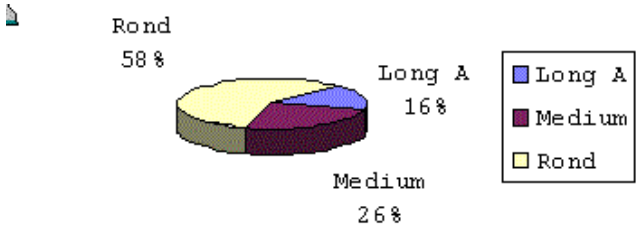
Table 1 concentrate the results of some agronomic analyses in term of output, dimension of the paddy and the polished rice grain. Except for line L377 which is with low percentage of brown rice - 77,50% in comparison with the paddy rice and line L375 with the highest percentage of the same parameter, the rest of the Lines including the standard (St) and cultivar L.J. have approximately the same amount of brown rice : around 81-82% . In term of whole grain (unbroken), the prevailing part of the selected lines have a high output of whole grain after husking, which is over 90%, at 91,30 % for the St. and 98,4% for L.J. Comparatively, low output of whole grain is observed for lines L8 - 74,4% and L371 - 80%. This could be due in part to the genotype and also to harvesting and drying conditions. We do think that, the low output of whole grain showed by lines L8 and L371 probably have a genotype cause because all the lines and varieties investigated have been harvested and processed under the same conditions of harvesting , drying and storage - 60% relative humidity at 20°C for three weeks before processing, leading to 12,50 - 13% moisture in the seeds. In the same table 1 we can see the collected data about the grain length and the ratio grain length/width for the paddy and for the polished grains.

Table 1

Lines and varieties	Brown rice (%)	Whole grains (%)	Paddy length (mm)	Length/width	Polished rice length (mm)	length/width
St.	82,70	91,30	6,90	2,00	5,09	2,50
L.J.	82,10	98,40	8,10	2,20	5,00	1,70
L2	82,20	90,70	7,40	2,00	5,11	1,70
L4	81,90	91,90	7,40	2,20	5,05	1,70
L6	81,70	91,20	7,50	2,10	5,19	1,70
L8	82,00	74,40	7,70	2,40	5,62	2,00
L10	81,70	89,00	7,30	2,20	5,13	1,70
L11	82,00	94,00	7,40	2,10	5,03	1,70
L13	81,90	89,30	7,60	2,00	5,13	1,70
L14	81,40	96,70	7,40	2,10	5,11	1,70
L18	81,10	94,50	7,10	1,90	4,72	1,60
L22	81,90	85,60	8,00	2,50	5,69	2,00
L369	82,70	90,40	7,10	1,90	6,84	1,80
L371	81,40	80,20	7,70	2,20	5,61	1,80
L372	81,10	90,70	7,10	2,00	5,05	1,80
L373	82,7 0	89,60	7,40	2,20	5,31	1,80
L374	81,50	91,40	7,60	2,20	5,14	1,70
L375	83,20	89,10	8,90	2,60	6,63	2,30
L377	77,50	89,60	9,30	3,00	6,83	2,70

According to these data and referring to the French system of classification, the examined Bulgarian lines and varieties could be classified as follows : 16% of the lines (L369, L375 and L377) are of type "Long A", 26% of type "Medium", i.e. oval-oblong (L6, L8, L22, L371 and L373) and 58% including the St and L.J. are of type "round" (fig. 1, table 1').

Fig. 1 and Table 1' Cultivars and lines classification according to French system



Round 58%	Medium 26%	Long "A" 16%
Krasnodarsky- 424 (St)	L6	L369
Louda Jana	L8	L375
L2	L22	L377
L4	L371	
L10	L373	
L11		
L13		
L14		
L18		
L372		
L374		

Regarding the weight of the grain (table 2), expressed in weight of 1000 grains, all the examined lines (except for L372) showed a higher result in comparison with the St. The weight of 1000 grains reaches values up to 37 g. for lines L369 and L375, which is according to us a good result.

Table 2: Agronomic characteristics II.

Lines and varieties	Plant height (cm)	1000 grains Weight (g)	Volume weight (g)	Yield (t/ha)	Yield/ standard (%)	Period of vegetation (days)
St	115,00	28,75	603,10	6,44	100,00	127,00
L.J.	112,00	30,50	545,00	6,25	97,00	122,00
L2	113,00	31,84	538,70	6,30	97,00	128,00
L4	111,00	31,41	527,70	7,38	115,00	125,00
L6	113,00	31,92	544,60	6,27	97,00	126,00
L8	98,00	31,56	584,70	6,43	100,00	128,00
L10	108,00	29,13	565,90	6,73	105,00	129,00
L11	98,00	32,25	531,60	7,15	111,00	127,00
L13	110,00	32,20	552,50	9,01	140,00	134,00
L14	121,00	30,95	535,60	6,10	95,00	127,00
L18	87,00	31,54	522,00	7,36	114,00	140,00
L22	87,00	31,57	594,70	7,71	120,00	127,00
L369	95,00	36,96	563,20	6,50	101,00	145,00
L371	101,00	33,50	592,30	5,92	101,00	119,00
L372	82,00	28,33	489,50	8,44	131,00	144,00
L373	119,00	30,62	583,90	7,02	109,00	119,00
L374	120,00	30,48	516,70	6,02	93,00	121,00
L375	85,00	37,15	549,70	7,30	113,00	140,00
L377	80,00	32,47	565,80	7,59	118,00	140,00

As we mentioned above, more attention is paid to the high-producing varieties. This parameter is of great importance in our selection work and we are satisfied to find out here some lines with very high yield such as lines L4, L11, L13, L18, L22, L372, L373, L375 and L377 with a performance over 7 tonnes per ha. The best performance is showed by line L13 with 9,01 t per ha. Many of the lines showed better result in term of yield when compared to the Louda Jana variety and even with the St.

Our observations showed that, except for line L13, the lines L18, L22, L372, L375 and L377 combined the lowest plant height with high yield, and are resistant to layer. That makes them particularly valuable for the wide rice production program. In addition, line L22 is an early one, completing its period of vegetation for the same period of time as that of with the St - 127 days. Lines L373 and L374 also deserve consideration for they are early maturing lines - 119 days in comparison with the St.

Because of some objectives causes, the analyses on the culinary qualities of our samples have been carried out only with seven lines. However this fact does not undermine the result reported in this paper because the collected data on this parameter allow some useful conclusions. In table 3, we can see that lines L371 and L377 distinguish themselves by their temperature of gelatinization which is the highest for L371 - 68°C and the lowest for L377 - 50°C. This seems to be in relation with the recovery of the elasticity of the grain after 15 mn boiling. The best recovery of elasticity is observed for the line L377 - 44% and the lowest for L371. At the same time, line L377 showed good performance with regard to firmness after boiling with 63%, followed by lines L369 and L375 with 48 % firmness. All investigated lines have the same water absorption coefficient, which is related to the quantity of water needed for their cooking.

Table 3: Culinary qualities

Lines	Temperature of gelatinisation (° C)	Water absorption coefficient	Firmness after boiling (%)	Elasticity after boiling (%)
L369	56	2,50	48	18
L371	68	2,50	38	8
L372	55	2,60	33	9
L373	56	2,40	39	12
L374	55	2,50	33	9
L375	55	2,50	48	19
L377	50	2,50	63	44

From the results shown in table 4 concerning the chemical composition of the grains, we can note that the amylose content of the line L371 is low - 14,2%, while that of the line L377 is the highest at 23,4%. This fact comes to confirm the data on the culinary qualities. That means that for the same boiling time, the line L371 becomes more soft with the less ability in recovering the original elasticity, while the line L377 remains firm.

With regard to protein content, the examined lines showed considerable variability. All the investigated varieties showed

higher protein content when compared to the St - 6,19%. The best values have been recorded with the lines L371 - 8,80%, L14 - 8,50%, L375 - 8,33% and L.J. - 8,03. Compared to the St, the grain of line L371 contains 44% more protein. This allows us to conclude that line L371 deserves consideration with respect to the content of protein in comparison to the St and some other lines (L372, L6, etc.).

Table 4: Chemical composition of the grains (in % toward dry matter)

Lines and cultivars	Dry matter	Total protein	Amylose	Mineral composition
St	88,41	6,19		0,32
L.J.	88,10	8,03		0,47
L2	88,65	7,20		0,64
L4	88,78	7,32		0,60
L6	88,43	6,66		0,51
L8	88,57	6,90		0,40
L10	88,74	7,38		0,42
L11	88,80	7,50		0,52
L13	88,31	7,32		0,43
L14	88,22	8,50		0,35
L18	88,66	7,62		0,51
L22	88,63	7,38		0,52
L371	88,46	8,80	14,20	0,36
L372	88,60	6,60	18,60	0,38
L373	88,86	7,08	19,60	0,22
L374	88,78	6,72	18,10	0,37
L375	88,06	8,33	18,30	0,28
L377	88,28	7,50	23,40	0,38

Compared to the St - 0,32%, some lines are characterised with twice as high content of mineral salt (L2 and L4 with respectively 0,64 and 0.60%). According to the data in tables 3 and 4, there is no correlation between the temperature of gelatinization and the content of mineral salt. At this level, we don't have enough data for discussion on this matter.

In table 5, we are publishing for the first time in the Bulgarian literature, the results concerning the amino acids composition of the total protein in rice grain. It is well known that part of the amino acids nitrogen could be found in the amide and ammonium fractions (except for the lost during the hydrolyse). Notwithstanding, there are cases like the ones with lines L375 and L18 when the total amino acids content differ considerably. It is worth noticing that in some of the analysed lines the regularity for the opposite connection between the content of protein and that of the amino acid lysine is not kept. The lines L6, L10 and L11 deviate from this regularity, as well as the St. Similar deviation is reported by Le Zoan Zien (1984) with Vietnamese rice varieties. This finding which is confirmed by our investigations with Bulgarian rice lines could be used as a marker for the selection of rice lines with high content of protein and lysine.

As far as plant breeding and improvement are concerned, the high proline content of some of the examined here lines (L374 and L18) is of great interest because it is well known that the amino acid proline is connected to drought resistance of plant species.

It is interesting to note that the content of the sulphur-containing amino acids is lowest when compared to the other amino acids group (table 6). High level of the amino acids in this group are found in lines L22, L11, L22 and L375. A pattern stability can be noticed among the totals of the amino acids in the aromatic group, totals which are close to that of the St.

Analysing the results presented in table 7, we note that in most of the cases, the data characterising the St. is the best in terms of content of essential amino acids. The exceptions are very few, which means that to increase significantly the amount of these amino acids in the new lines and varieties, a long way have to be walked and more investigations to be carried out. Nevertheless, the data in the table can be used as an indicator for identifying the perspective line in that way. Quantitatively, the biological value of the protein could be obtained through the calculation of the limiting amino acid and the essential amino acid index (EAA-index) according to Oser and Mitchel. We compared the percent content ratio of essential amino acids in egg protein with the one in rice protein (table 8) and the result is that the limiting factor in the frame of our investigations is the amino acid methionine, followed by amino acid isoleucine. This applies for all the lines and varieties included in this work. So further investigations should aim to enhance the level of methionine and isoleucine content in rice new varieties in order to increase the biological value of the protein.

At this stage, these results enable us to find out a number of perspective lines which to be included in our breeding program in term of morphology, quality and nutritional value. From Mr. Faure from CIRAD, the line L377 gather all the required quality for to be appreciated by French consumers, at the contrary of the line L371.

Table 5 : Amino acids content of the grains (in % of total protein)

Amino acids	St	L.J.	L4	L6	L10	L11	L14	L18	L22	L372	L373	L374	L375	L377
Lysine	3,72	3,24	3,28	3,60	3,25	3,47	2,94	3,93	3,39	3,03	2,97	3,12	2,88	2,80
Histidine	1,62	1,87	1,65	1,80	1,63	1,73	1,76	2,17	1,76	1,36	1,41	1,64	1,32	1,47
Arginine	8,40	7,72	8,06	7,81	7,18	7,87	7,06	9,35	7,99	7,27	6,36	7,59	7,08	6,93
Aspartic acid	8,72	7,72	7,38	8,71	8,27	8,80	8,12	8,94	8,81	6,97	6,92	7,44	6,36	8,27
Threonine	2,58	2,74	2,73	2,70	2,85	2,80	2,82	3,39	3,12	2,58	2,54	2,68	2,40	2,80
Serine	4,04	4,23	3,96	4,80	4,34	3,73	4,23	4,74	4,47	3,79	3,67	3,72	3,24	4,27
Glutamic acid	14,86	16,19	15,16	16,07	14,77	15,87	15,65	19,11	15,99	14,70	14,27	15,03	13,34	14,80
Proline	4,52	4,36	3,96	4,80	4,06	3,87	4,35	5,28	4,34	4,09	4,66	5,36	3,96	4,80
Glycine	3,07	3,49	3,55	3,60	3,39	3,60	3,65	4,47	3,52	3,33	3,11	3,72	2,88	3,60
Alanine	4,68	4,83	4,78	4,95	4,74	4,67	4,94	5,56	5,15	4,85	4,80	4,46	4,20	5,33
Cystine	0,48	0,37	0,41	0,60	0,41	0,53	0,47	0,54	0,54	0,45	0,42	0,59	0,48	0,40
Valine	4,04	3,86	3,82	4,09	3,93	3,73	4,00	4,34	4,34	3,79	3,67	3,57	3,36	4,13
Methionine	0,65	1,00	0,82	0,60	0,95	0,93	0,82	0,95	0,95	0,91	0,99	1,19	0,96	0,93
Isoleucine	2,58	2,49	2,46	2,70	2,44	2,93	2,47	2,85	2,71	2,42	2,40	2,23	2,40	2,67
Leucine	6,78	6,72	6,42	6,61	6,77	7,33	6,82	7,45	7,18	6,36	6,36	6,55	6,96	7,20
Tyrosine	2,91	2,74	2,87	2,70	3,12	2,80	3,06	3,39	2,85	2,88	2,97	2,68	3,00	2,80
Phenylalanine	4,04	3,49	3,96	4,20	4,06	3,73	4,12	4,88	4,34	3,77	3,95	3,87	3,48	4,40
Total	77,69	77,06	75,27	80,34	76,16	78,39	77,28	91,34	81,45	72,55	71,47	75,44	68,30	77,60
Total protein (% N x 5,95)	6,19	8,03	7,32	6,66	7,38	7,50	8,50	7,38	7,38	6,60	7,08	6,72	8,33	7,50

Table 6 : Group composition of total amino acids in protein

Lines and varieties	St	L.J.	L4	L6	L10	L11	L14	L18	L22	L372	L373	L374	L375	L377
Amino acids groups														
1. Monoaminocarbonic														
Alanine	4,68	4,83	4,78	4,95	4,74	4,67	4,94	5,56	5,15	4,85	4,80	4,46	4,20	5,33
Glycine	3,07	3,49	3,55	3,60	3,39	3,60	3,65	4,47	3,52	3,33	3,11	3,72	2,88	3,60
Valine	4,04	3,86	3,82	4,09	3,93	3,73	4,00	4,34	4,34	3,79	3,67	3,57	3,36	4,13
TOTAL	11,79	12,18	12,15	12,64	12,06	12,00	12,59	14,37	13,01	11,97	11,58	11,75	10,44	13,06
2. Dicarbonic														
Aspartic acid	8,72	7,72	7,38	8,71	8,27	8,80	8,12	8,94	8,81	6,97	6,92	7,44	6,36	8,27
Glutamic acid	14,86	16,19	15,16	16,07	14,77	15,87	15,65	19,11	15,99	14,7	14,27	15,03	13,34	14,8
TOTAL	23,58	23,91	22,54	24,78	23,04	24,67	23,77	28,05	24,80	21,67	21,19	22,47	19,70	23,07
3. Sulphur-containing														
Cystine	0,48	0,37	0,41	0,60	0,41	0,53	0,47	0,54	0,54	0,45	0,42	0,59	0,48	0,40
Methionine	0,65	1,00	0,82	0,60	0,95	0,93	0,82	0,95	0,95	0,91	0,99	1,19	0,96	0,93
TOTAL	1,13	1,37	1,23	1,20	1,36	1,46	1,29	1,49	1,49	1,36	1,41	1,78	1,44	1,33
4. Basis														
Arginine	8,4	7,72	8,06	7,81	7,18	7,87	7,06	9,35	7,99	7,27	6,36	7,59	7,08	6,93
Histidine	1,62	1,87	1,65	1,80	1,63	1,73	1,76	2,17	1,76	1,36	1,41	1,64	1,32	1,47
Lysine	3,72	3,24	3,28	3,60	3,25	3,47	2,94	3,93	3,39	3,03	2,97	3,12	2,88	2,80
TOTAL	13,74	12,83	12,99	13,21	12,06	13,07	11,76	15,45	13,14	11,66	10,74	12,35	11,28	11,2
5. β-hydroxymonocarbonic														
Serine	4,04	4,23	3,96	4,80	4,34	3,73	4,23	4,74	4,47	3,79	3,67	3,72	3,24	4,27
Threonine	2,58	2,74	2,73	2,70	2,85	2,80	2,82	3,39	3,12	2,58	2,54	2,68	2,40	2,80
TOTAL	6,62	6,97	6,69	7,50	7,19	6,53	7,05	8,13	7,59	6,37	6,21	6,40	5,64	7,07
6. Leucinic														
Isoleucine	2,58	2,49	2,46	2,70	2,44	2,93	2,47	2,85	2,71	2,42	2,40	2,23	2,40	2,67
Leucine	6,78	6,72	6,42	6,61	6,77	7,33	6,82	7,45	7,18	6,36	6,36	6,55	6,96	7,20
TOTAL	9,36	9,21	8,88	9,31	9,21	10,26	9,29	10,3	9,89	8,78	8,76	8,78	9,36	9,87
7. Aromatic														
Phenylalanine	4,04	3,49	3,96	4,20	4,06	3,73	4,12	4,88	4,34	3,77	3,95	3,87	3,48	4,40
Proline	4,52	4,36	3,96	4,80	4,06	3,87	4,35	5,28	4,34	4,09	4,66	5,36	3,96	4,80
Tyrosine	2,91	2,74	2,87	2,70	3,12	2,80	3,06	3,39	2,85	2,88	2,97	2,68	3,00	2,80
TOTAL	11,47	10,59	10,79	11,70	11,24	10,40	11,53	13,55	11,53	10,74	11,58	11,91	10,44	12,00

Table 7 : Essential amino acids content in egg protein (standard) and in rice grains

Sample	Lysine	Threonine	Valine	Methionine	Isoleucine	Leucine	Phenylalanine	Total
Egg protein	7,20	4,90	7,30	4,10	8,00	9,20	6,30	47,00
Cultivars								
St	3,72	2,58	4,04	0,65	2,58	6,78	4,04	24,39
L.J.	3,24	2,74	3,86	1,00	2,49	6,72	3,49	23,54
L4	3,28	2,73	3,82	0,82	2,46	6,42	3,96	23,49
L6	3,60	2,70	4,09	0,60	2,70	6,61	4,20	24,50
L10	3,25	2,85	3,93	0,95	2,44	6,77	4,06	24,25
L11	3,47	2,80	3,73	0,93	2,93	7,33	3,73	24,92
L14	2,94	2,82	4,00	0,82	2,47	6,82	4,12	23,99
L18	3,93	3,39	4,34	0,95	2,85	7,45	4,88	27,79
L22	3,39	3,12	4,34	0,95	2,71	7,18	4,34	26,03
L372	3,03	2,58	3,79	0,91	2,42	6,36	3,77	22,86
L373	2,97	2,54	3,67	0,99	2,40	6,36	3,95	22,88
L374	3,12	2,68	3,57	1,19	2,23	6,55	3,87	23,21
L375	2,88	2,40	3,36	0,96	2,40	6,96	3,48	22,44
L377	2,80	2,80	4,13	0,93	2,67	7,20	4,40	24,93

Table 8 : Content of essential amino acids and biological value of the protein in rice grain

Lines and Cultivars	Lysine	Threonine	Valine	Methionine	Isoleucine	Leucine	Phenylalanine	Limiting factor	EAA index
St	51,66	52,65	55,34	15,85	32,25	73,69	64,12	Methionine	44,66
L.J.	45,00	55,91	52,87	24,39	31,12	73,04	55,39	Methionine	44,66
L4	45,55	55,71	52,32	20,00	30,75	69,78	62,85	Methionine	44,66
L6	50,00	55,10	56,02	14,63	33,75	71,84	66,66	Methionine	44,66
L10	45,13	58,16	53,83	23,17	30,50	73,58	64,44	Methionine	45,70
L11	48,19	57,14	51,09	22,68	36,62	79,67	59,20	Methionine	46,77
L14	40,83	57,55	54,79	20,00	30,87	74,13	65,39	Methionine	44,66
L18	54,58	69,18	59,45	23,17	35,62	80,97	77,46	Methionine	52,48
L22	47,08	63,67	59,45	23,17	33,87	78,04	68,88	Methionine	48,97
L372	42,08	52,65	51,91	22,19	30,25	69,13	59,84	Methionine	43,65
L373	41,25	51,83	50,27	24,14	30,00	69,13	62,69	Methionine	43,65
L374	43,33	54,69	48,90	29,02	27,87	71,19	61,42	Isoleucine & Methionine	44,66
L375	40,00	48,98	46,02	23,41	30,00	75,65	55,23	Methionine	42,65
L377	38,88	57,14	56,57	22,68	33,37	78,26	69,84	Methionine	46,77

Conclusion

The results published in this article lead us to the conclusion that half of the examined Bulgarian rice varieties and lines have valuable qualities of importance for the selection. With comparatively highest complex selection results we could outline the lines L18, L22, L375 and L377. They are all highly productive, resistant to layer, with good culinary qualities and high biological value of the protein.

With regard to the period of vegetation, L22 does not differ from the St and the other three lines ripen 10 to 13 days later, which is quite acceptable for the country. It would be interesting if these lines can be investigated in other southern countries of the Mediterranean region (Greece, Italy, France etc.) where they could probably adapt well.

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Home

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