

Evaluation of yield quality and culinary characteristics of different potato varieties

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Abstract The paper proposes an analysis of 50 potato varieties of native and foreign origins in terms of yield quality, culinary quality, boiling behavior and cooking type. The material used in this analysis was obtained in the demonstration potato varieties field set up at NIRDPSB Brasov in 2017. The analyzed varieties come from the offer of Romanian and foreign varieties marketed or proposed for marketing as seed material on the Romanian market. All 50 varieties were cultivated under the same pedoclimatic conditions of Brasov depression, in a non-irrigated field. Basic fertilization with the NPK complex 15:15:15 of 600 kg/ha was ensured. The results obtained were quantitatively and qualitatively analyzed by determining the tubers starch content, the tubers enzymatic blackening, the tubers after boiling blackening and the appreciation of the culinary qualities of the potatoes, as well as their inclusion in the type of use depending on their boiling behavior. The evaluation of the culinary quality of potato tubers of all studied varieties made it possible to group them by type of use according to the culinary quality index obtained by summation of the given notes to qualitative attributes in the laboratory sensory analysis. Following the evaluations, the 50 varieties were classified as follows in three type of use classes: 16 A/B varieties, 32 B varieties and 2 B/C varieties.

Key words

potato, varieties, yield quality, culinary characteristics

There are more than 2600 potato varieties listed in the European Common Catalogue (17). Potato varieties have differences in tuber yield capacity, tuber starch content, tuber dry matter content, cooking quality, processing quality, storage characteristics (7). Potatoes are being consumed after cooking or processing. Consumers demand a multiple choice of potato varieties with different cooking type. There are distinct expectations on the part of consumers for certain types of potatoes to have specific cooking qualities (14). Cooking quality evaluation permits the best utilization of each cultivar according to different uses (2). Starch content is a quality attribute of major concern of potato growers as well as processors (12). Starch concentration of potato tubers is important property because quality of final products and efficiency of processing are directly linked to it (6). The starch content depends upon the potato variety (4) and influences the culinary quality. The starch content of a potato is the most significant differentiator of potato types and varieties making certain types better suited for some culinary purposes than others.

Qualitative properties of fresh and cooked potatoes are affected by cultivation site, genotype and interaction among these factors (10). For the potato sector, raw material quality became an important

criterion because it determines the type of use and the transformation ability of the tubers; the qualitative criteria of potatoes are for the most estimated via sensory tests (5). Sensory information based on few attributes can be used to describe culinary quality of potato varieties (13). Therefore, culinary quality of potato varieties is determined by sensory appreciation of traits related to the overall look of boiled tubers, taste, crushing on boiling, consistency pulp, mealiness, moisture, starch granulation, pulp color, tubers after-cooking darkening (1). After-cooking blackening is a qualitative factor that can depreciate the visual appearance of boiled potato. This non-enzymatic oxidation evolves over time when cooked potatoes are exposed to air and produces coloured areas ranging from grey through blue and purple to black and is especially damaging for salad products (5). It results from the oxidation of the ferri-chlorogenic acid in the boiled or fried potatoes and is dependent on the ratio of chlorogenic acid to citric acid concentration in the potato tubers; higher ratio normally results in darker tubers. The concentration of the chlorogenic and citric acids is genetically controlled and influenced by environmental conditions (16). Although is an unwelcome side effect of cooking, after-cooking blackening has no effect on the flavour or nutritional

value of potatoes. Potato flavour results from the combination of taste, aroma and texture. Plant genotype, production environment and storage environment influence the level of the flavour precursors synthesized by the plant (15).

Consumer appeal are also influenced by enzymic browning. This type of discoloration occurs when cut, sliced and bruised tubers are exposed to air for some time; it is caused by the oxidation of phenolic compounds by the enzyme phenolase; level of browning depends on cultivar (9).

Materials and Methods

The biological material subjected to the culinary analysis, represented by 50 potatoes varieties, was produced in the demonstration field of NIRDPSB Brasov in 2017. The climatic conditions were favorable for potato crops. Precipitations were evenly distributed during the growing season (April to September) reaching 451.2 mm, approaching the 457.4 mm multiannual average. Regarding the average air temperature during the vegetation period (16.0°C), it

exceeded by 1.4°C the multiannual average for potato growing period (14.6°C).

For the determination of starch was used Polikeit balance. The method is based on determining the specific weight of tubers with special scales (Reimann and Polikeit) and positive correlation between the specific weight and the dry matter content and starch respectively.

Culinary quality of potato tubers was determined by assessing their behavior to boiling. For each analyzed variety 6 tubers were peeled with a vegetable peeler and boiled at steam for 60 minutes. Culinary quality was determined based on the organoleptic evaluations carried out on boiled tubers. The determination of potato tubers cooking type of use was made by a jury composed by a panel of trained specialists who made sensory evaluation of the boiled potatoes and then they gave notes for each analyzed characteristics on a tasting sheet. Using the Lugt and Goodijk method (1959) and the scheme for appreciation of potato culinary qualities (3; 11) table 1, culinary characteristics were determined.

Table 1

The scheme for appreciation of potato culinary qualities (after Lugt and Goodijk 1959)

Culinary quality traits	Evaluation notes			
	1	2	3	4
Overall appearance	Very pleasing	Pleasing	Less pleasing	Unpleasing
Crushing on boiling	Stay entire	Crushing less	Crushing	Crushing more
Consistency	Very consistent	Consistent	Less consistent	Uneven consistency
Mealiness	Waxy	Less mealiness	Mealiness	Very mealiness
Moisture	Wet	Less humid	Rather dry	Dry
Structure of starch	Fine granules	Suitable fine granules	Large granules	Very large granules
Taste	Excelent	Very good	Good	Less good

The evaluation of the culinary quality of potato tubers made it possible to group the varieties by cooking type according to the culinary quality index obtained by summation of the given notes to culinary quality traits (crushing on boiling, consistency,

mealiness (flouriness), moisture and starch granulation). The varieties were classified into cooking types A, B, C, D and intermediate cooking types A/B, B/C (table 2).

Table 2

Potato cooking type based on cooking type index

Cooking type index	Cooking type	Characteristics – suitable for
5.0 - 7.5	A	The tubers of this type does not crumble, remain whole and have a fine structure. The taste is good and have a low starch content. Potatoes of this type are suitable for salad, but can also be used for other dishes.
7.6 – 10.0	A/B	
10.1 – 12.5	B	The tubers are firm enough, at boiling the tubers crush a little, they are a little wet and have a fine structure. Potatoes of this type are suitable for multiple uses.
12.6 – 15.0	B/C	
15.1 – 17.5	C	Includes potatoes which is crushes on boiling, they are mealy and have a quite dry texture; have a coarse structure. Potatoes of this type are suitable for french-fries, chips.
17.6 – 20.0	D	Tubers have a very dry texture; includes potatoes which shatters excessive at boiling, sometimes totally and have a very poor consistency. The potatoes are not used in human consumption; they are used in starch and alcohol industries.

The evaluation of enzymic browning. From each analyzed variety has been taken one center slice from three tubers. This three slices were left four hours at room temperature and then was used a reference scale from one to ten to give notes for raw tuber enzymic browning. 1 is the note for the lowest level of enzymic browning and 10 is the note for the higher level of enzymic browning.

The evaluation of potato after-cooking blackening. From each analyzed variety has been analyzed three boiled potato tubers who were left 24 hours at room temperature and then was used a reference scale from one to ten to give notes for after-cooking blackening. 1 is the note for the lowest level of after-cooking blackening and 10 is the note for the higher level of after-cooking blackening.

Statistical analyses of obtained data were accomplished using SPSS program used for statistical analysis with ANOVA, Duncan test and Pearson correlations for the values obtained by sensory analysis.

Results and Discussions

The evaluation of potato yield, tubers starch content, tubers enzymic blackening and after-cooking blackening for all 50 analyzed varieties were mediated in table 3. In the climatic conditions of 2017 and the non-irrigated field, the total yields for the 50 potato varieties ranged between 29.31 t/ha and 51.47 t/ha, with an average of 39.10 t/ha.

After the determination of the starch content from potato tubers were obtained values between 9.50% and 14.50% starch, with an average of 11.87% starch. The visual assessment of the degree of enzymic browning of potato tubers with a score of 1 to 10 resulted in satisfactory ratings with an average of 2.16 and a maximum of 3.67, indicating generally a low degree of enzymic browning for the analyzed varieties. Also the production of the studied varieties was tested in terms of the after cooking blackening degree of the tubers, the ratings obtained indicating a low degree of after cooking blackening with an average of 1.60 and a maximum of 2.50.

Table 3

Evaluation of potato yield, tubers starch content, tubers enzymic browning and after-cooking blackening
(Brasov, 2017)

Mean				
Varieties	Potato yield t/ha	Starch content %	Enzymic browning	After cooking blackening
01. Marvis	35.91	14.17	1.83	2.17
02. Castrum	41.64	13.17	1.33	2.33
03. Sarmis	33.88	13.08	1.00	1.33
04. Cayenne	40.83	12.50	3.00	1.33
05. Manitou	41.91	11.08	2.17	1.33
06. Ranomi	40.27	10.92	1.17	1.00
07. Spectra	49.47	11.75	1.50	2.50
08. Arizona	42.12	10.08	1.83	1.00
09. Classico	49.15	12.83	2.00	1.33
10. Esmee	41.43	11.42	2.00	1.33
11. Rudolph	44.15	14.42	1.50	1.50
12. Constance	38.85	12.58	3.50	1.33
13. Evolution	34.35	12.33	2.17	1.83
14. Vogue	43.95	10.00	1.17	1.17
15. Riviera	37.00	10.58	1.33	2.00
16. Celtiane	37.84	12.08	1.83	1.50
17. Accent	36.87	12.17	1.33	1.33
18. Esmeralda	34.84	12.33	1.50	1.00
19. Surya	39.28	10.67	1.33	1.33
20. Torino	41.65	14.17	2.00	1.83
21. Malice	36.95	13.50	2.00	1.83
22. Tornado	42.31	12.33	1.83	1.00
23. Louisiana	37.21	10.50	1.33	1.67
24. Burren	44.25	11.08	1.83	1.50
25. Electra	51.47	11.75	2.00	1.67
26. Cristina	38.56	12.25	1.50	1.50
27. Red Lady	43.05	14.67	2.67	1.83
28. Sunshine	36.51	11.75	1.83	1.33
29. Prada	32.73	11.67	1.50	1.00
30. Labella	37.67	13.92	2.50	1.50
31. Ultra	37.72	11.33	2.83	1.67
32. Laperla	42.97	10.25	3.50	1.83
33. Agila	36.32	13.33	1.33	1.50
34. Alegria	34.81	12.75	1.67	1.50
35. Baltic fire	43.53	14.50	2.50	1.83
36. Allora	29.31	11.17	2.00	2.00
37. Baltic rose	42.79	12.92	1.83	1.83
38. Soraya	35.28	10.58	2.67	1.67
39. Paroli	35.39	10.83	2.17	1.83
40. Orlena	39.95	9.58	2.83	1.83
41. Fortus	38.41	12.83	2.83	1.83
42. Noblesse	30.31	12.67	3.00	2.00
43. Sunita	33.43	11.08	3.50	1.83
44. Red Scarlet	33.33	9.83	3.50	1.67
45. Memphis	39.53	11.00	2.17	1.67
46. Colomba	35.75	9.50	3.50	1.33
47. Carrera	41.59	10.25	2.50	2.33
48. Primabelle	30.69	10.92	3.33	1.17
49. Sunred	44.20	11.58	1.67	1.83
50. Gioconda	43.77	11.08	3.67	1.50
Mean	39.10	11.87	2.15	1.60

Frequencies of potato varieties with different yield levels, tubers starch content, tubers enzymic browning

and after cooking blackening degrees are highlighted in figure 1.

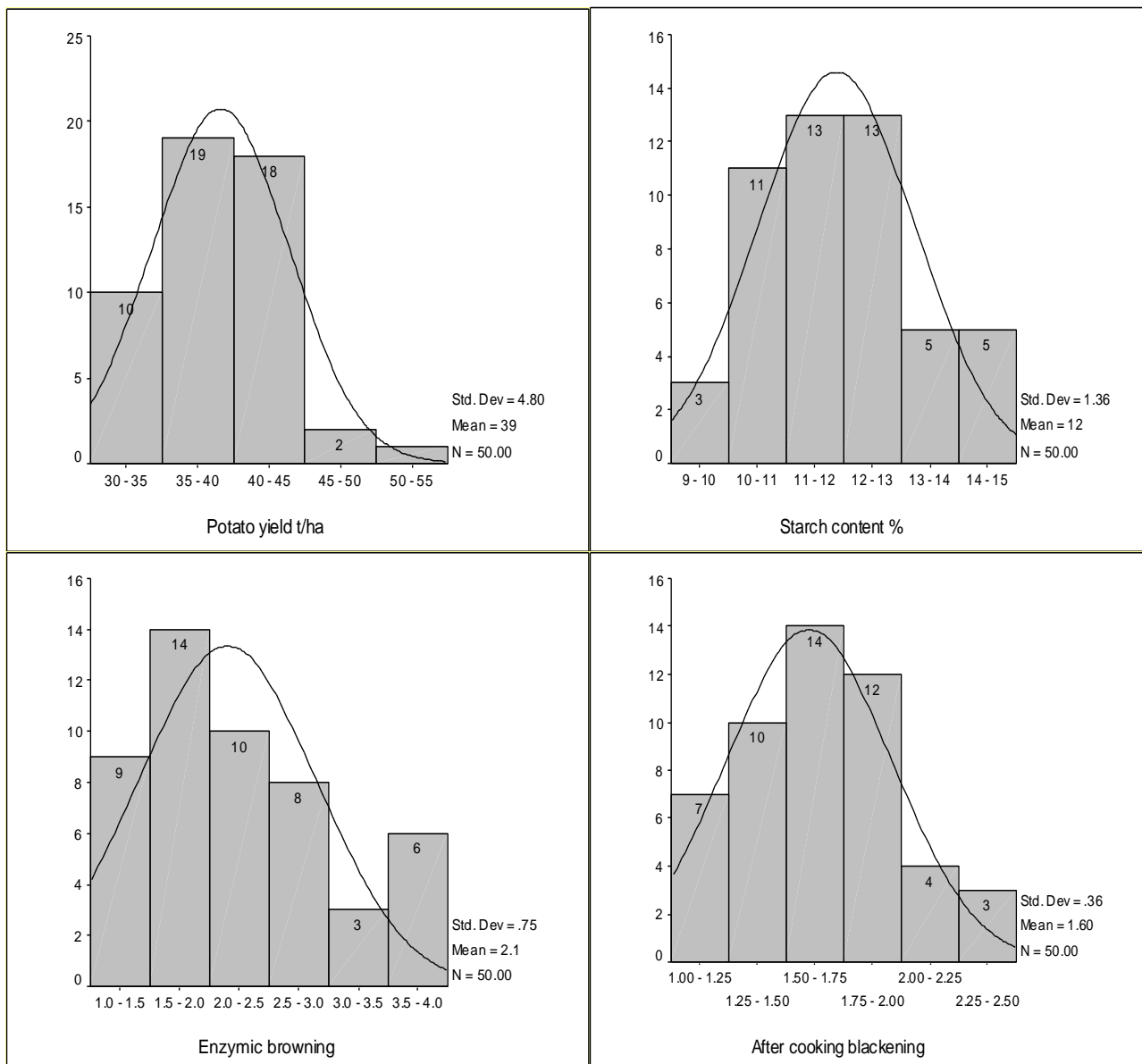


Fig. 1. Frequency of potato varieties with different levels of yield, tubers starch content, tubers enzymic browning and after-cooking blackening (Brasov, 2017)

To identify the differences in organoleptic attributes between varieties, boiled potatoes of these 50 varieties were submitted to sensory analyses. During this survey, we analysed and made appreciations on the appearance, taste, interior colour and several texture descriptors: crushing on boiling, consistency, mealiness (flouriness), moisture and starch granulation. The results of the sensory analyzes are presented in the table 4 with the average notes for culinary quality traits.

Boiled potatoes are traditionally preferred to be dry in some countries and waxy in others; they should not disintegrate even if slightly overcooked and this property is hard to combine with a dry texture (8).

Starchy potatoes have low moisture but a high starch content. This makes them the better potato for baked, mashed, fried and roasted potatoes. Mealiness is controlled primarily by the solids content of the tuber. Among the analyzed varieties predominate the waxy ones with high levels of moisture and low starch levels.

Analyzing the coefficients for Pearson correlations between the notes for culinary traits and starch content (table 5), significant correlations were observed for crushing on boiling with starch content, mealiness and starch granulation, for mealiness with moisture and starch granulation, for moisture with starch granulation.

Table 4

Appreciation of culinary quality to boiling for potato varieties
Average notes for culinary quality traits
(Brasov,2017)

Mean										
Varieties	Apperence	Taste	Interior color	Crushing on boiling	Consistency	Mealiness	Moisture	Starch granulation	Cooking type index	Cooking tipe
01. Marvis	2.3	2.0	4.0	2.3	2.7	2.3	2.3	2.5	12.2	B
02. Castrum	3.3	2.2	4.7	3.3	2.3	2.3	2.2	1.8	12.0	B
03. Sarmis	1.2	1.0	5.7	1.7	2.7	1.8	2.2	1.7	10.0	A/B
04. Cayenne	1.7	2.2	5.3	1.7	3.0	2.2	2.0	2.3	11.2	B
05. Manitou	2.3	2.2	2.0	2.0	2.2	2.8	2.7	2.2	11.8	B
06. Ranomi	1.0	1.7	5.3	1.2	2.0	1.8	1.3	1.5	7.8	B
07. Spectra	2.0	2.0	4.0	1.7	1.3	2.3	1.5	2.5	9.3	A/B
08. Arizona	1.5	2.2	4.0	1.3	2.0	1.7	1.5	2.5	9.0	A/B
09. Classico	2.3	1.8	4.3	2.8	2.5	3.0	1.7	1.7	11.7	B
10. Esmee	2.2	2.0	4.7	1.8	2.3	2.0	1.8	1.7	9.7	A/B
11. Rudolph	1.5	1.5	5.7	1.5	1.7	2.5	1.5	1.5	8.7	A/B
12. Constance	1.5	1.5	5.3	1.3	2.7	1.8	1.7	1.3	8.8	A/B
13. Evolution	1.2	3.0	3.7	1.2	1.3	2.3	2.5	2.0	9.3	A/B
14. Vogue	1.0	1.7	5.3	1.0	2.7	1.7	1.8	1.5	8.7	A/B
15. Riviera	2.2	2.2	3.3	1.8	2.3	2.5	2.3	1.8	10.8	B
16. Celtiane	2.0	3.5	3.7	2.0	2.2	2.3	2.2	2.2	10.8	B
17. Accent	1.2	2.3	4.7	1.3	2.3	2.8	2.7	2.2	11.3	B
18. Esmeralda	1.0	1.7	4.7	1.2	3.0	1.8	1.2	1.2	8.3	A/B
19. Surya	1.8	2.0	4.7	1.5	2.3	2.0	1.8	1.8	9.5	A/B
20. Torino	1.5	2.8	4.7	1.3	2.7	2.3	2.7	2.3	11.3	B
21. Malice	1.7	2.8	5.0	1.8	2.7	2.2	1.8	1.8	10.3	B
22. Tomado	2.0	2.7	3.0	1.8	2.2	2.2	1.8	2.2	10.2	B
23. Louisiana	2.0	2.3	4.3	2.0	2.7	2.2	2.0	2.2	11.0	B
24. Burren	2.0	2.7	4.3	1.8	2.2	2.7	2.2	2.7	11.5	B
25. Electra	2.2	3.0	4.0	2.2	2.3	2.7	1.8	2.3	11.3	B
26. Cristina	2.2	3.3	2.7	2.0	2.8	2.8	3.0	2.7	13.3	B/C
27. Red Lady	1.7	2.5	4.3	1.5	2.3	2.7	2.3	1.8	10.7	B
28. Sunshine	1.0	1.0	5.7	1.0	2.2	1.8	2.0	1.3	8.3	A/B
29. Prada	1.7	2.5	4.3	1.7	1.8	2.2	2.3	1.8	9.8	A/B
30. Labella	2.3	3.2	4.3	2.3	2.5	2.5	2.2	2.5	12.0	B
31. Ultra	2.2	2.2	4.7	1.8	2.2	2.8	2.3	2.2	11.3	B
32. Laperla	2.0	2.7	4.0	1.0	2.8	2.3	2.0	1.7	9.8	A/B
33. Agila	1.3	1.5	4.7	1.2	2.7	2.3	2.0	1.5	9.7	A/B
34. Alegria	1.7	3.0	4.3	1.2	2.8	2.7	2.0	2.0	10.7	B
35. Baltic fire	2.2	2.8	5.0	2.3	2.7	2.3	1.7	2.8	11.8	B
36. Allora	2.0	2.2	4.3	2.0	2.7	2.5	2.0	2.3	11.5	B
37. Baltic rose	2.2	2.0	5.0	1.8	3.0	2.7	2.2	1.8	11.5	B
38. Soraya	1.7	1.7	5.0	1.5	2.2	1.8	2.2	1.3	9.0	A/B
39. Paroli	2.5	2.7	4.0	2.5	2.3	2.7	2.0	1.8	11.3	B
40. Orlena	2.0	1.8	4.7	1.2	3.2	2.5	2.2	2.0	11.0	B
41. Fortus	2.3	2.7	4.0	1.7	1.8	2.5	2.5	2.5	11.0	B
42. Noblesse	1.8	2.5	4.3	1.3	3.0	2.3	2.0	2.2	10.8	B
43. Sunita	1.7	3.2	4.3	1.3	2.0	2.7	2.7	2.7	11.3	B
44. Red Scarlet	1.3	2.2	3.3	1.3	3.2	2.5	2.0	2.0	11.0	B
45. Memphis	2.3	2.7	2.7	1.7	2.3	2.7	2.8	2.8	12.3	B
46. Colomba	1.8	2.3	4.3	1.5	2.2	2.3	2.0	2.3	10.3	B
47. Carrera	1.8	3.0	4.3	2.0	1.7	3.0	2.2	2.3	11.2	B
48. Primabelle	1.0	1.5	5.3	1.2	2.5	1.8	1.3	1.3	8.2	A/B
49. Sunred	2.2	2.3	3.3	2.2	2.7	3.2	2.0	2.5	12.5	B/C
50. Gioconda	2.2	3.3	3.3	2.2	2.7	2.0	1.7	1.7	10.2	B
Average	1.8	2.3	4.3	1.7	2.4	2.4	2.1	2.0	10.5	***

Table 5

The coefficients for Pearson correlations between the notes for culinary quality traits and starch content

Correlations^a

		Starch content	Crushing on boiling	Consistency	Mealiness	Moisture	Starch granulation	Cooking type
Starch content	Pearson Correlation	1.000	.212**	.037	.093	.052	.043	.144
	Sig. (2-tailed)	.	.009	.649	.260	.531	.597	.079
Crushing on boiling	Pearson Correlation	.212**	1.000	-.039	.270**	.059	.219**	.489**
	Sig. (2-tailed)	.009	.	.637	.001	.471	.007	.000
Consistency	Pearson Correlation	.037	-.039	1.000	.024	.119	-.086	.373**
	Sig. (2-tailed)	.649	.637	.	.775	.146	.295	.000
Mealiness	Pearson Correlation	.093	.270**	.024	1.000	.356**	.496**	.706**
	Sig. (2-tailed)	.260	.001	.775	.	.000	.000	.000
Moisture	Pearson Correlation	.052	.059	.119	.356**	1.000	.456**	.681**
	Sig. (2-tailed)	.531	.471	.146	.000	.	.000	.000
Starch granulation	Pearson Correlation	.043	.219**	-.086	.496**	.456**	1.000	.706**
	Sig. (2-tailed)	.597	.007	.295	.000	.000	.	.000
Cooking type	Pearson Correlation	.144	.489**	.373**	.706**	.681**	.706**	1.000
	Sig. (2-tailed)	.079	.000	.000	.000	.000	.000	.

** . Correlation is significant at the 0.01 level (2-tailed).

a. Listwise N=150

Figure 2 presents mean values for culinary quality traits, crushing on boiling, consistency, mealiness, moisture and starch granulation by the sum of which the cooking type index was obtained. The frequency of

potato varieties with different cooking type shows that the 50 potato varieties fall into three classes of use: A/B cooking type – 16 varieties, B cooking type – 32 varieties, B/C cooking type – 2 varieties.

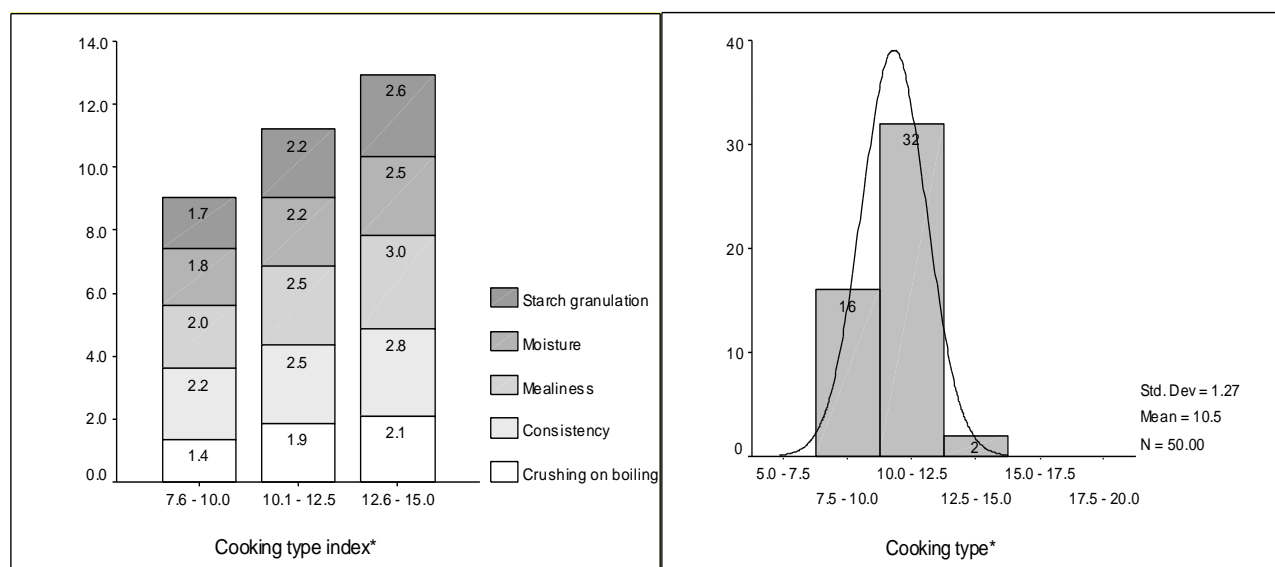


Fig. 2. Mean values for culinary quality traits which forms cooking type index and frequency of potato varieties with different cooking type

Conclusions

The total yields for the 50 potato varieties cultivated in a non-irrigated system ranged between 29.31 t/ha and 51.47 t/ha. The starch content

accumulated in potato tubers did not exceed 14.5% for all observed varieties.

The analyzed varieties generally showed low levels of enzymic browning and after cooking blackening, averaging 2.16 and 1.6, respectively.

The 50 varieties were classified as follows in three type of use classes: 16 A/B varieties, 32 B varieties and 2 B/C varieties. Most of the analyzed varieties tend to hold their shape when are boiled, are better for dishes with smooth texture, potato salads, soups, stews and even roasted dishes.

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