EVALUATION OF POTATO COOKING QUALITY IN ARGENTINA

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Abstract

Cooking quality of mature tubers was assessed for ten Argentine potato cultivars, two cultivars of foreign origin and three advanced clones.

Specific gravity, dry matter and starch content, as well as quality of boiled potatoes and chips were determined.

Pampeana INTA had the highest dry matter content with 21.8 percent and would appear to be a very good cultivar for dehydrated products. The lowest dry matter values were obtained for three of the four most widely planted cultivars: Spunta, Bonaerense La Ballenera and Kennebec.

Kennebec demonstrated its good quality for chipping with a score of 6.9 points. Primicia INTA and Sureña INTA with high dry matter content and good features for chipping can also be used to produce chips.

Breeding under high temperatures during tuberization has proven to be a successful strategy in developing cultivars that are superior in dry matter contents to the cultivars currently imported from the northern hemisphere.

Compendio

Se determinó la calidad culinaria de tubérculos maduros de diez cultivares de papa argentinos, dos cultivares de origen extranjeros y tres clones avanzados.

Se determinó el peso específico y el contenido de materia seca y almidón como así también la calidad de papas hervidas y fritas en rodajas.

Pampeana INTA tuvo el mayor contenido de materia seca con 21,8 por ciento y sería un muy buen cultivar para productos deshidratados. Los menores valores de materia seca fueron obtenidos por tres de los cuatro cultivares más plantados: Spunta, Bonaerense La Ballenera y Kennebec.

Kennebec demostró su buena calidad para freír en rodajas con un valor de 6,9 puntos. Primicia INTA y Sureña INTA con altos contenidos de materia seca y buenas características para freír, pueden también ser usadas para producir papas fritas en rodajas.

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El mejoramiento genético, bajo condiciones de alta temperatura durante la tuberización, ha probado ser una estrategia exitosa para el desarrollo de cultivares que son superiores en contenido de materia seca a los cultivares usualmente importados del hemisferio norte.

Introduction

The demand for potatoes with specific characteristics that meet consumer needs and/or the requirements of the processing industry, makes it necessary to have suitable cultivars under cultivation (8, 13). Introduction of foreign cultivars and local breeding are the complementary strategies followed in Argentina to cope with these needs.

The knowledge of tuber composition and cooking behavior of different cultivars or clones should predict their future performance under industrial conditions (5). Most processed products require raw potatoes with a high dry matter content (3, 4) to obtain high yields and better quality of product (4, 9, 10, 14) and to save energy. Cooking quality evaluation also permits the best utilization of each cultivar according to different uses (chips, french fries, dehydrated products, fresh consumption, etc.). This paper presents the results of cooking quality assessments obtained on breeding material over ten years and the methodology used in the evaluation. A comparison of specific gravity data from the United States and Argentina (Balcarce) is also given.

Materials and Methods

Cooking quality of ten national cultivars, two cultivars of foreign origin and three advanced clones was assessed in the Quality Laboratory at Balcarce, Argentina.

Five kilogram samples of mature tubers were taken from trial plots planted in the Southeast area of the Province of Buenos Aires during a period of ten years starting in 1979. Tubers were stored in a cool, shaded place at ambient temperature for 30 days after harvest. Then, analyses of two types were performed: 1) Composition: specific gravity, dry matter and starch content, and 2) Cooking quality: boiled potatoes and chips.

Specific gravity was obtained by weighing a sample in air and also immersed in water, using a scale that also gives a correlated measure of starch content (7, 15). Specific gravity data of Shepody, Kennebec and Russet Burbank in four years were also obtained from the National Potato Germplasm Evaluation and Enhancement Reports (11) utilizing eight regional sites of the U.S.A. These data were compared to Balcarce's values.

Dry matter content was obtained by drying in an oven at 105 C during 24 hrs. Two samples for each observation of dry matter were recorded.

Boiled potato tests were performed with a representative sample of tubers, which were peeled and steamed for about 30 minutes and tasted

unsalted by a skilled five person panel. The judges gave an overall score from 1 (undesirable) to 9 (desirable) to each sample, based on their evaluations of color, odor, firmness, moisture, mealiness, texture, and flavor. The boiling quality scores were averaged over the scores of five judges. The judges learned through experience to detect variations in cooked potatoes during previous years. None of them had less than two years and fifty sessions of experience in testing potatoes.

In the chip tests a 30 tuber sample was used. The tubers were cut from stem to bud end. One slice, approximately 1.2 - 1.3 mm thick, from the middle of each tuber was taken. The slices were washed, drained and dried. Then, a sample of 200 g was fried in hot oil at 170 C, until the oil stopped bubbling. A score from 1 (darker) to 9 (lighter) was given to chips according to color. The color score was assigned by means of a color chart developed by the Institute for Storage and Processing of Agricultural Products-I.B.V.L., Wageningen, The Netherlands.

Data were analyzed in two sets, corresponding to the number of years in which the cultivars were tested. The first set included the five older cultivars which were tested over ten years. To avoid bias due to lack of balance, years with less than five of those cultivars were not considered. Therefore, the resulting number of years was six for boiling, and nine for chipping and dry matter analysis. One determination per cultivar per year was taken and years were analyzed as replicates.

The second set included ten cultivars tested in two locations, over three years. The same strategy as before was used to balance data, resulting in two years and nine cultivars for boiling, and three years and ten cultivars for chipping and dry matter determinations. The locations were analyzed as replicates. In both sets, an ANOVA was performed and means were compared using Tukey's HSD Test at $\alpha = 0.05$.

Results and Discussion

Dry Matter Content

Table 1 shows the results obtained in the tests to determine composition. Pampeana INTA, showed the highest dry matter content with 21.8 percent and a range of 20.2 to 23.3 percent. The three advanced clones and Primicia INTA showed averages above 20 percent. Huinkul MAG, the cultivar used for dehydrating in Argentina, averaged 19.4 percent and Kennebec, primarily used for chipping averaged 18.7 percent.

Spunta, a Dutch variety extensively used in Argentina, had a significantly lower ($p < 0.05$) dry matter content when compared to Huinkul MAG and Primicia INTA over nine years. In the same period, Primicia INTA displayed significantly higher dry matter content than Kennebec (Table 2a).

TABLE 1.—*Composition data of cultivars and clones over a ten-year period (1979-1988).*

Cultivars	Number of years	Specific Gravity	Dry matter Content (%)	Starch Content (%)
Pampeana INTA	7(10)	1.080	21.8	14.5
B 78.501.131	4(6)	1.076	21.0	13.6
B 78.502.5	4(7)	1.078	20.9	13.5
B 79.540.180	3(6)	1.079	20.8	13.8
Primicia INTA	10(13)	1.072	20.4	12.5
Serrana INTA	7(9)	1.070	19.5	11.7
Huinkul MAG	10(13)	1.066	19.4	11.4
Achirana INTA	5(8)	1.070	19.2	12.3
Sureña INTA	9(11)	1.067	19.1	11.6
Latina INTA	5(8)	1.071	18.9	12.0
Araucana INTA	5(8)	1.071	18.9	12.0(6)
Chacay INTA	6(9)	1.067	18.7	12.1(6)
Kennebec	8(8)	1.069(5)	18.7	
B. La Ballenera	6(6)	1.064(5)	18.4	
Spunta	10(12)	1.064	17.7	10.9

()number of observations used to calculate a mean over all years of evaluation indicated.

TABLE 2a.—*Dry matter contents of five cultivars over a nine-year period.*

Cultivar	Dry Matter Content (%)
Primicia INTA	20.4[1] a[2]
Huinkul MAG	19.2 a b
Sureña INTA	19.0 a b c
Kennebec	18.8 b c
Spunta	17.7 c

[1]Nine observations were used to calculate each mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).

During a three year period, from 1986 to 1988, Spunta was also significantly lower ($p < 0.05$) than Pampeana INTA, Achirana INTA, Latina INTA, B 78.502.5 and B 79.540.180. Pampeana was significantly higher ($p < 0.05$) than Huinkul MAG (Table 2b).

From these results, the cultivars can be arranged in three groups according to their dry matter content:

TABLE 2b.—*Dry matter contents of ten cultivars and clones over a three-year period.*

Cultivar	Dry Matter Content (%)
Pampeana INTA	21.7[1]a[2]
B 78.502.5	21.1 a b
B 79.540.180	20.8 a b
Primicia INTA	20.7 a b c
Huinkul MAG	20.1 b c d
Achirana INTA	19.5 c d
Latina INTA	19.0 d
Araucana INTA	18.9 d e
Chacay INTA	18.9 d e
Spunta	17.8 e

[1]Six observations were used to calculate each mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).

I. High dry matter content (more than 20.0%)
Pampeana INTA, B 78.501.131, B 78.502.5, B 79.540.180 and Primicia INTA.
II. Intermediate dry matter content (from 18.0 to 19.9%)
Serrana INTA, Huinkul M.A.G., Achirana INTA, Sureña INTA, Araucana INTA, Latina INTA, Chacay INTA, Kennebec and Bonaerense La Ballenera.
III. Low dry matter content (below 17.9 percent)
Spunta

The lowest dry matters were obtained in Spunta, Bonaerense La Ballenera and Kennebec, which at present are three of the four (considering Huinkul MAG) most widely planted cultivars, according to recent surveys. (12, 2)

Specific gravity and starch content are also given in Table 1 as a comparison for researchers who use these measures routinely. Differences were found between the ranking of cultivars according to specific gravity and the ranking according to dry matter content, although the grouping was not altered. Evidence of inconsistency of the correlation between specific gravity and dry matter content for Argentinean cultivars has been reported (1).

The range of values presented here should be considered in relation to latitude, local growing conditions and cultivars. Northern hemisphere dry matter contents of European or American cultivars are notably higher than those obtained in the conditions of the SE area of the Province of Buenos Aires with the same cultivars (Table 3). Within Argentina, Serrana INTA and Huinkul MAG have shown a wide range of values : 17.4% at 26° 13' S to 24.3% at 51° 40' S. (6)

TABLE 3.—*Specific gravity of three potato cultivars grown in the U.S.A. and Argentina.*[1,2,5]

Region \ Year[3]	Shepody				Kennebec				R. Burbank			
	4	3	2	1	4	3	2	1	4	3	2	1
Idaho	92								85	80	86	80
Maine		85	80	94	77	87	76	88	87	85	85	99
Michigan	77	80	82	75					77	77	85	76
Upstate NY	83	80	87	88	76	75	87		81	83	93	
N. Dakota[4]		73			84	93	86	80	85	84	87	88
L. Island NY			71		62	72			63	82		
Minnesota			85	83			75	80			83	84
Oregon	79				81				85	76	85	81
U.S.A. av.	83	80	81	85	76	82	81	83	80	81	86	85
mean		82				81				83		
Argent. av.	73	70	66	70	67	84	76	62	67	67	78	74
mean		70				72				72		

[1]Specific gravity values are presented as two digit numbers i.e. 1.092 = 92.
[2]When two or more values were available, the mean of them was recorded.
[3]The years 1, 2, 3 and 4 are 1985, 86, 87 and 88 for the USA values and 1986, 88, 89 and 90 for the Argentina values.
[4]The values were converted from dry matter to sp. gr. by the Under Water Weight Table from I.B.V.L., Wageningen, The Netherlands.
[5]Source USA values : National Potato Germplasm Evaluation and Enhancement Report, U.S. Dept. of Agric., 1985, 1986, 1987 and 1988.

The results presented herein allow the potato processing industry to take more rational decisions concerning the use of potato cultivars under the Argentinean conditions, as compared to those found in the U.S.A. with the same cultivars. Also, Argentine bred cultivars may serve as an alternative when the standards cannot be reached with the traditional cultivars used by the industry in the Northern Hemisphere at higher latitudes (and hence longer day lengths) and presumably lower tuberizing temperatures.

Cooking Quality Evaluations

Table 4 shows the average in chipping and boiling quality of all the varieties and clones included in trials. B 78.502.5 obtained the highest chip score (7.6) followed by B 78.501.131 and Kennebec (both with 6.9).

For the five cultivars tested over nine years, Kennebec and Primicia INTA had significantly higher ($p < 0.05$) scores than Spunta, and Sureña INTA and Huinkul MAG did not differ significantly from the two former cultivars (Table 5a). Over a three year period, B 78.502.5 showed the highest score in a group of ten clones and cultivars, differing significantly ($p < 0.05$) from all of them except for B 79.540.180 which held the second place (Table 5b).

TABLE 4.—*Chip and boil scores of cultivars and clones in a ten-year period (1979-1988).*

Cultivar	Number of years	Chip Score[1]	Boil Score[2]
B 78.502.5	4 (7)[3]	7.6	5.1 (5)
B 78.501.131	4 (6)	6.9	3.4 (5)
Kennebec	8 (8)	6.9	4.4 (4)
Primicia INTA	10 (13)	6.3	4.0
Sureña INTA	9 (11)	6.1	4.1
Pampeana INTA	7 (10)	5.9	4.9
B 79.540.180	3 (6)	5.8	-
Archirana INTA	5 (8)	5.5	3.6
Latina INTA	5 (8)	5.4	4.1 (5)
B. La Ballenera	6 (6)	5.2	3.7
Huinkul MAG	10 (13)	5.2	5.5
Spunta	10 (12)	4.9	2.2
Chacay INTA	6 (9)	4.4	3.3
Serrana INTA	7 (9)	4.2	3.2
Araucana INTA	5 (8)	3.9	3.6

[1]1 darker color - 9 lighter color. 6 Acceptable score
[2]1 undesirable - 9 excellent. 5 Acceptable score
[3]( ) Number of observations used to calculate a mean over all years of evaluation indicated.

TABLE 5a.—*Chip scores of five cultivars over a nine-year period.*

Cultivar	Chip Score[3]
Kennebec	6.7[1]a [2]
Primicia INTA	6.7 a
Sureña INTA	6.3 ab
Huinkul MAG	5.4 ab
Spunta	4.9 b

[1]Nine observations were used to calculate a mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).
[3]1 darker color - 9 lighter color. 6 acceptable score

Huinkul MAG had significantly ($p < 0.05$) better boil scores than Primicia INTA and Spunta over a six year average but only outperformed Spunta, among nine cultivars, in a two year period. (Table 6a and 6b).

From the data presented here, it can be concluded that Pampeana INTA, with a high dry matter content, would be a very good cultivar to be used for dehydrated products.

Kennebec demonstrated its good quality for chipping. Of cultivars released to date, Primicia INTA and Sureña INTA with high dry matter content and good features for chipping, can also be used to produce chips.

TABLE 5b.—*Chip scores of ten cultivars and clones over a three-year period.*

Cultivar	Chip Score[3]
B 78.502.5	7.5[1]a[2]
B 79.540.180	5.8 ab
Primicia INTA	5.7 b
Pampeana INTA	5.1 bc
Huinkul MAG	5.0 bc
Achirana INTA	4.8 bc
Spunta	4.8 bc
Latina INTA	4.8 bc
Chacay INTA	4.3 bc
Araucana INTA	3.4 c

[1]Six observations were used to calculate a mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).
[3]1 darker color - 9 ligher color. 6 acceptable color

TABLE 6a.—*Boil scores of five cultivars over a six-year period.*

Cultivar	Boil Score[3]
Huinkul MAG	5.5[1]a[2]
Kennebec	4.1 ab
Sureña INTA	3.8 abc
Primicia INTA	3.3 bc
Spunta	1.9 c

[1]Six observations were used to calculate a mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).
[3]1 undesirable - 9 excellent. 5 Acceptable score

TABLE 6b.—*Boil scores of nine cultivars and clones over a two-year period.*

Cultivar	Boil Score[3]
Huinkul MAG	5.2[1]a[2]
B 78.502.5	4.9 a
Pampeana INTA	4.6 a
Archirana INTA	4.6 a
Araucana INTA	4.5 a
Latina INTA	4.1 ab
Primicia INTA	4.1 ab
Chacay INTA	3.0 ab
Spunta	1.5 b

[1]Four observations were used to calculate a mean.
[2]Means with similar letters do not differ significantly to Tukey's Test ($p < 0.05$).
[3]1 undesirable - 9 excellent. 5 Acceptable score

The breeding program has been successful in developing better cultivars for fresh consumption as well as for processing purposes. Breeding under local conditions has enabled us to obtain clones that yield tubers with high dry matter contents under temperate to warm soil temperatures during tuberization as compared with those obtained from imported cultivars.

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