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Short communication

Phenotypic, agronomic and nutritional characteristics of seven varieties of Andean potatoes

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ABSTRACT

Potatoes are part of the staple food of Andean populations. Although there are more than 200 Andean potato varieties, only a few are cultivated at present, which endangers the biodiversity of the region. The objective of this paper was to characterize seven varieties of Andean potatoes (Collareja, Runa, Churqueña, Señorita, Imilla Colorada, Imilla Negra and Revolución) and to determine their phenotypic, functional and nutritional properties. The different varieties of Andean potatoes show differences in their agronomic properties, such as area of production and altitude yield per hectare, pest resistance and sowing and harvesting seasons. They are adapted to different altitudes, which influence their agronomic characteristics. Yield varies between 8000 and 18,000 kg/ha according to the variety. They present a diversity of forms, sizes and colors. The energy content ranges from 315 to 424 kJ/100 g, with these values being higher than those of the reference variety (239 kJ/100 g). Vitamin C content ranges from 10.5 mg/100 g found in Revolución varieties to 15.6 mg/100 g in Collareja potatoes; the vitamin C content in Spunta lies within this range (13.3 mg/100 g of potato). Increased knowledge of the nutritional, agronomic and functional properties of Andean potato varieties will contribute to the preservation of a biodiversity that is part of Argentina's regional heritage.

1. Introduction

The nutrient content of potatoes is largely controlled by genetic factors. However, it is also affected by the age and maturity of the tubers, by the climate, soil and cultural practices during cultivation and storage and by technological processes (Lister and Monro, 2000). Then, the composition of potatoes will be influenced by factors such as production area, type of crops, soil and climate; agricultural practices, storage, processing and marketing conditions (Casañas Rivero et al., 2003).

Potatoes are the most important crop in the horticultural landscape of many countries. The most prominent production areas in Argentina are Cordoba, Buenos Aires, Mendoza and Tucumán (Gerlo and Goldman, 2002).

Andean potato varieties are among the staple food crops of the communities of the Puna Jujeña and of the Andean Valley of Salta. Varieties from the Andean region of South America (*Solanum tuberosum* ssp. Andigenum) have been planted and domesticated by its inhabitants for thousands of years. Stocks include many varieties with different physiognomic and organoleptic characteristics and adaptation to different ecological zones in the Andean region. The geographical area of origin in Argentina is confined to three regions distributed mainly in the provinces of Jujuy and Salta. These are the Quebrada de Humahuaca, Puna (highlands) and high valleys. In this area, altitudinal and abrupt changes in rainfall occur (C.A.U.Que.Va., 2004).

2. Materials and methods

Seven varieties of Andean potatoes (*S. tuberosum* ssp. Andigenum) were studied: Collareja, Runa, Churqueña, Señorita, Imilla Colorada, Imilla Negra and Revolution, purchased from C.A.U.Que.Va. The crops brought by local producers to plant this collection are classified and preserved in cold rooms. Six samples (two samples from each of the three varieties taken at two different periods) were selected and stored in a cold chamber until use. Analyses were conducted for a composite sample. All determinations were performed in triplicate. The Spunta (*S. tuberosum*) variety was used as a reference because it is the most widespread commercially. It was provided by the Estación Experimental Agrícola "Obispo Colombres", Tafí del Valle, Tucumán. Argentina.

Average weight, edible portion and phenotypic characteristics were determined using the INTA Balcarce catalog as a reference.

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Table 1
Average weight and edible portions of Andean potatoes.

Varieties	Average weight (g/unit)[a]	Edible portions (g/100 g potato)[a]
Spunta	127.26 ± 47.83	86.00 ± 0.24
Collareja	50.95 ± 22.42	75.10 ± 1.08
Revolución	57.43 ± 28.29	82.52 ± 2.97
Señorita	147.48 ± 66.56	87.07 ± 2.54
Churqueña	36.15 ± 15.29	80.90 ± 3.33
Imilla Negra	41.89 ± 25.91	78.76 ± 7.52
Imilla Colorada	11.44 ± 2.83	76.94 ± 2.03
Runa	31.53 ± 8.53	74.57 ± 1.13

[a] Average ± standard deviation; $n = 3$.

Proximate composition was determined using official AOAC methods (1995). *Moisture*: the sample, weighed exactly, was drained in a conventional oven at 105 °C to constant weight. *Protein*: calculated as the percentage of nitrogen × 6.25. Total nitrogen content was determined by the Kjeldahl method. *Ash*: the sample was burned in a muffle furnace at 550 °C to obtain white ash. *Total dietary fiber*: this was determined by the gravimetric method of Prosky et al. (1988). *Fat*: determined following Soxhlet technique. *Vitamin C* was determined by the Roe method (1943), based on the oxidation of vitamin C and dehydroascorbic acid formation of a colored complex with 2,4 dinitrophenylhydrazine (DFH).

3. Results and discussion

Table 1 shows the average weights and usable portion of the different varieties of potatoes studied. Fig. 1 shows photographs of the different varieties of potatoes in order to give a visual example of differences in their relative sizes and shapes. It should be noted that in the Andean varieties only Señorita presents an average weight greater than Spunta. This is also true of the usable portion, which is related to the average weight of potatoes: the smaller the potato, the greater the proportion discarded by peeling. According to Burton's studies done in 1974, quoted by Woolfe (1987), removing the shell to a uniform depth of 1.4 mm can mean the loss of about 20% weight of a 50 g tuber and about 10% of a 200 g tuber. In the case of Andean potatoes, losses for smaller varieties are 20–25% of tubers corresponding to an average size of 50–57 g, which agrees with Burton's findings. The smallest edible portion is presented by the Runa variety in which, although it does not have the lowest average size, the presence of eyes on the surface makes peeling the potatoes very difficult.

Table 2 shows the agronomic properties of the seven varieties of Andean potatoes obtained experimentally by the (C.A.U.Que.Va.). They differ in soil in which they are produced, resistance to pests, performance and production cycle. They are adapted to high altitudes (from 1800 to 3800 m above sea level), as evidenced by their agronomic characteristics. Yield varies between 8000 and 18,000 kg/ha, depending on the variety.

In some cases, there are also differences in yield within the same variety according to the altitude at which it was planted.

Table 3 shows the proximate composition of the different potato varieties. The Andean varieties presented lower moisture and higher carbohydrates and ashes contents than Spunta. All Andean varieties presented higher lipid contents than the Spunta variety. The protein percentage in the Spunta variety is only higher than those of the Revolution, Imilla Black and Runa varieties.

The moisture values are similar to those found by Kita (2002) for the Saturna and Aster varieties (76.53% and 80.54%, respectively). According to this author, the adequate amount of dry matter in potatoes suitable for the production of snacks is 20–25% because better yields are obtained.

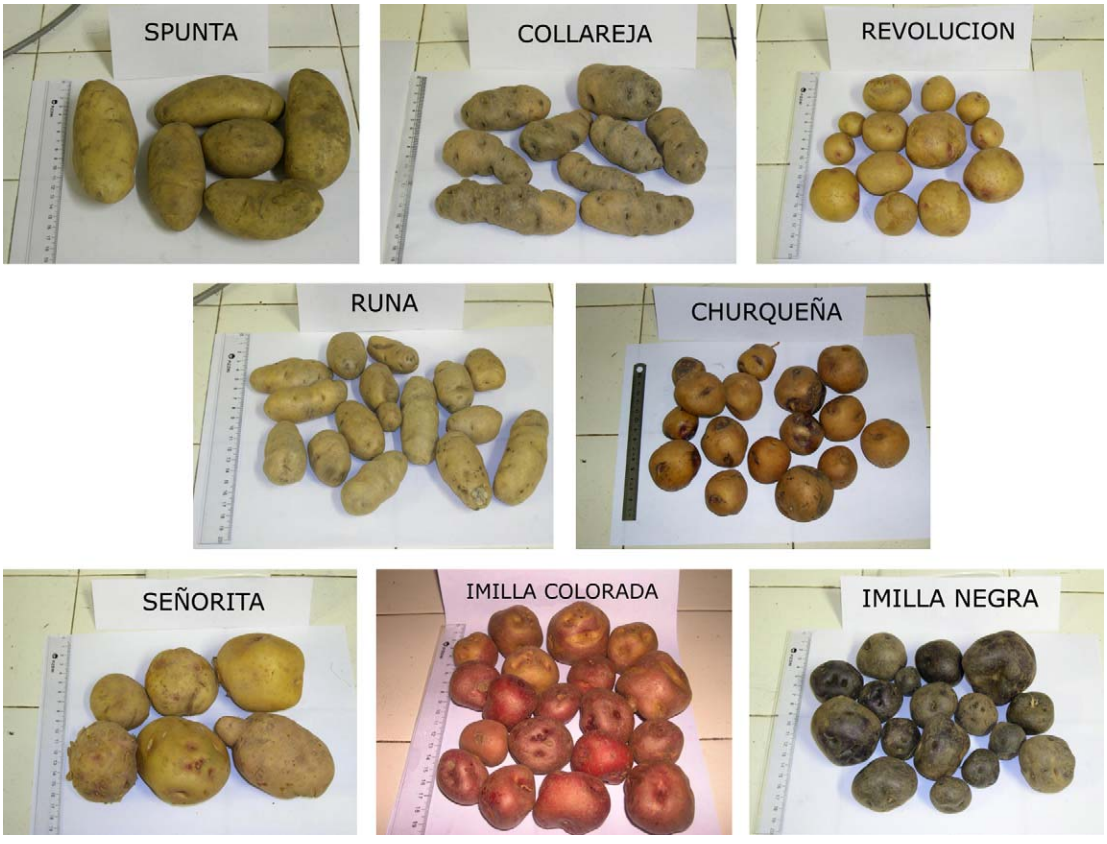

Fig. 1. Varieties of Andean potato.

Table 2
Agronomic properties of seven varieties of Andean potatoes.

Varieties	Production area	Yield (kg/ha)	Resistance to pests[a]	Sowing and harvest time	Cycle (days)
Collareja	Quebrada (Tumbaya, Tilcara y Humahuaca), Yavi, Cochinoca, Salta (Iruya, Colanzuli). Adapted to different environments and altitudinal levels	12,000	Weevil of the Andes Rizoctonia (black mange) T.L.:2	Sowing after the frost-free period	150
Revolución	Greater presence in the Puna, but expanding in all the Andean territory for better yields and shorter growth cycles	14,000–18,000	Nematodes and common mange (streptomyces) Weevil of the Andes T.L.: 2		120–130
Señorita	Quebrada (Tumbaya and Tilcara, from Purmamarca to Yacoraite).	12,000	Weevil of the Andes T.L.: 2. Very high sensitivity to tuber greening		135
Churqueña	Adapted to greater altitudes. Widely spread in the Puna and valleys of the Santa Victoria and Iruya departments. In the Quebrada, it can be found from Yacoraite towards the north (Dto. Humahuaca and high zones of the Tilcara department)	8,000 and 15,000 at 3000 m above sea level	Weevil of the Andes tolerance Rizoctonia (black mange) T.L.:2		135–150
Imilla Negra	Adapted to the highest zones; mainly found in the Puna (Yavi). Resistant to mild frosts	10,000 and 14,000 at 3000 m above sea level	Weevil of the Andes T.L.:3 Rizoctonia (black mange) T.L.: 3		135
Imilla Colorada	Adapted to the highest zones, it is found mainly in the Puna (Yavi). Resistant to mild frosts.	10,000 and 14,000 at 3000 m above sea level	Weevil of the Andes T.L.: 3		135
Runa	Similar to Collareja. Widely spread, with great adaptability	12,000	Weevil of the Andes T.L.: 2		135

Source: C.A.U.Que.Va. Ltda.—Cooperativa Agropecuaria y Artesanal Unión Quebrada y Valles.
[a] T.L.:tolerance level. Scale 1 (min) to 5 (min).

Table 3
Proximate composition of raw potatoes (per 100 g fresh weight), Andean potato varieties.

Varieties	Moisture (g)	Energy (kJ)	Protein (g)	Lipid	Ash	Dietary Fiber	CH[a]
Spunta	82.94 ± 1.49	240	1.98 ± 0.78	0.05 ± 0.03	0.84 ± 0.14	2.01 ± 0.10	12.18
Collareja	75.87 ± 3.69	345	2.47 ± 0.51	0.12 ± 0.04	1.16 ± 0.03	2.57 ± 0.14	17.81
Revolución	78.28 ± 1.82	317	0.85 ± 0.06	0.07 ± 0.03	1.01 ± 0.07	1.95 ± 0.03	17.84
Señorita	81.10 ± 3.03	267	2.28 ± 1.01	0.42 ± 0.15	1.08 ± 0.22	2.46 ± 0.07	12.66
Churqueña	73.58 ± 2.75	389	2.23 ± 0.73	0.47 ± 0.42	1.02 ± 0.03	2.84 ± 0.11	19.86
Imilla Negra	70.22 ± 3.40	423	1.92 ± 0.74	0.30 ± 0.13	1.73 ± 0.30	3.25 ± 0.09	22.58
Imilla Colorada	73.07 ± 0.63	407	2.55 ± 0.41	0.51 ± 0.28	1.35 ± 0.24	1.98 ± 0.02	20.54
Runa	74.91 ± 3.69	357	1.60 ± 0.50	0.26 ± 0.11	0.89 ± 0.23	3.30 ± 0.13	19.04

Average ± standard deviation; $n = 3$.
[a] Carbohydrates = 100 − (moisture + ash + protein + lipids + fiber).

As to dietary fiber, with the exception of the Revolution and Imilla Colorada varieties, the Andean varieties present higher values than the reference variety.

Vitamin C content was determined in raw potatoes. Lower values than the reference variety and also than the values found in the literature (16–42 mg vitamin C/100 g potato salad, Han et al., 2004) were obtained. However, Spunta presents values higher than those found by Tudela et al. (2002) for the same range (6.2 mg/100 mg potato) (Table 4).

Table 4
Content of vitamin C in Andean potato varieties.

Varieties	Vitamin C (mg/100 g raw potato)[a]
Spunta	28.58 ± 1.93
Collareja	14.45 ± 2.01
Revolución	9.68 ± 1.00
Señorita	7.54 ± 1.63
Churqueña	10.27 ± 2.92
Imilla Colorada	9.91 ± 0.31
Runa	9.97 ± 1.86

[a] Average ± standard deviation, $n = 3$.

According to Tudela et al. (2002), variations can be attributed to various post-harvest destinations and storage conditions. They could also be due to genetic variations or environmental growth conditions (Senesi et al., 2000).

4. Conclusion

- Andean potatoes present a wide diversity of shapes and colors but their size and edible portion are smaller than those of the Spunta variety.
- The total solids content of Andean potatoes was higher than the reference range, but the macronutrient content was variable in the seven varieties and did not show a uniform trend.
- The Andean Collareja potato, a staple food for Andean peoples, is an excellent source of energy and vitamin C.
- The Andean varieties studied are the ones most widely planted. Revolución is considered a Baluarte variety, Baluarte being those potato varieties with better agricultural and food prospects, important for the conservation of food biodiversity and therefore under international protection. They are virus-free and high-yield varieties in great demand because of their physical characteristics of size and color.

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