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The physicochemical properties of fruits and seed germination of *Campomanesia aurea* O. Berg

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ABSTRACT. *Campomanesia aurea* is a potentially ornamental native fruit shrub. There are no studies on the seed germination capacity and fruit properties of the species. Therefore, the main goal of this paper was to describe the seed germination and the physical and chemical properties of fruits from two *C. aurea* accession areas. The study was conducted with fruits collected from two native vegetation areas located in the Morro do Osso Natural Park and in the municipality of Barão do Triunfo, Brazil. Physical and chemical analyzes, seed counting and germination tests were performed. Results were submitted to ANOVA and the means were compared by t test at 5% error probability. *C. aurea* has oblong-shaped fruits weighting around 1.26 g with a high content of vitamin C. Each fruit usually has four intact seeds of which 3% are polyembryonic. Seed germination averaged 93% in 20 days. It is concluded that the *C. aurea* fruits collected from two different accession areas differ in the concentration of TSS, TSS/TA ratio and vitamin C content, but not physically. Seeds have shown a high germination rate.

Keywords: myrtaceae; chemical composition of pulp; polyembryony.

Características físico-químicas de frutos e germinação de sementes de *Campomanesia aurea*

RESUMO. *Campomanesia aurea* é uma planta nativa e frutífera de porte arbustivo com potencial ornamental. Ainda não foram encontrados trabalhos que abordem as características dos frutos e a capacidade de germinação das sementes dessa espécie. O objetivo deste trabalho foi caracterizar as propriedades físicas e químicas dos frutos e a germinação das sementes de dois acessos de *C. aurea*. O estudo foi conduzido com frutos coletados em áreas de vegetação nativa localizadas no Parque Natural Morro do Osso, em Porto Alegre, e em Barão do Triunfo, RS. Realizaram-se análises físicas e químicas, contagem de sementes e teste de germinação. Os resultados foram submetidos à ANOVA e as médias foram comparadas pelo teste t a 5%. Os frutos de *C. aurea* tem formato oblongo, pesam em média 1,26 g e apresentam elevado conteúdo de vitamina C. Cada fruto possui em média quatro sementes íntegras, sendo que 3% são poliembriônicas. A germinação média é de 93% e ocorre em 20 dias. Concluiu-se que os frutos de *C. aurea* coletados a partir de dois acessos diferem na concentração de TSS, na relação TSS/TA e no teor de vitamina C, entretanto, não há diferenças quanto às características físicas. As sementes da espécie possuem alta germinação.

Palavras-chave: myrtaceae; composição química de polpa; poliembrionia.

Introduction

Campomanesia aurea O. Berg is a subshrub reaching up to one meter in height (Stumpf, 2009). It is widely distributed around areas of the southern Brazilian highlands occupied by gramineous or shrub fields (Reitz, 1977). It belongs to the family Myrtaceae and is popularly known as guabirobinha-do-campo or araçá-rasteiro. Flowering is intense and occurs from october to january with fruits maturing from december to february. Fruits are globose or oblong berries ranging from green to yellow with a sweet-acidulated flavor juicy pulp (Lorenzi, Bacher, Lacerda, & Sartori, 2006).

There are several edible fruits species in the family Myrtaceae, but most of them have been little explored. Many species of the *Campomanesia* genus are reported to be locally appreciated and consumed *in natura*, besides being used in the production of candies, liqueurs, juices and jellies (Lorenzi, Lacerda, & Bacher, 2015). Species like *C. xanthocarpa*, *C. phaea*, *C. adamantium*, *C. pubescens* and *C. cambessedeana* have been recognized for their nutritional properties and the high content of phenolic compounds, antioxidants and vitamin C (Vallilo, Garbelotti, Oliveira, & Lamardo, 2005; Vallilo, Lamardo, Gaberlotti, Oliveira, & Moreno,

2006; Silva, Vilas Boas, Rodrigues, & Siqueira, 2009; Santos, Carneiro, Wosiacki, Petkowicz, & Carneiro, 2009; Pereira et al., 2012; Morzelle, Bachiega, Souza, Vilas Boas, & Lamounier, 2015).

Even with the increasing appreciation for regional products and interest in native fruits with nutritional and functional properties, little is known about such species. *C. aurea* is not only used for *in natura* consumption, but also for medicinal purposes. Due to its small size, it can be cultivated in containers and planted in small spaces for fruit production or ornamental purposes, since it has an intense and aromatic flowering (Stumpf, 2009).

Seed development is a complex process that starts with the formation of the flower, pollination, fertilization, fruit development and ends with reserve accumulation and seed dispersal. This process is influenced by the presence of pollinating agents as well as environmental, genetic and nutritional factors, etc. Among other factors, germination speed, percentage and uniformity are dependent on the environmental conditions, genotype and degree of maturation of seeds (Marcos Filho, 2015).

Despite being widely potentially used, no studies addressing to *C. aurea* fruit properties and seed germination capacity have been found. A variation in the fruits physical properties and chemical composition may be observed due to the different conditions of the data collection areas, as well as the genetic variability among plant populations (Bianchini et al., 2016). In this sense, fruit biometry is an important tool to detect genetic variability within populations of certain species as it can generate important information for genetic improvement programs (Gonçalves et al., 2013).

Likewise, the analysis of chemical properties of fruits, such as total soluble solids (TSS), titratable acidity (TA), and especially the relationship between them, provides information about fruit flavor and its suitability for *in natura* consumption and/or industrialization. In addition, its vitamin C content can be used as an indicator of food quality as it is nutritionally the most important component (Chitarra & Chitarra, 2005).

The absence of plant domestication along with allogamy causes high genetic variability and it has been pointed as the cause for the great variation in the germination process of seeds from Brazilian forest species (Santos et al., 2009). In this context, the physical and chemical properties of fruits associated to the species germination capacity are important to subsidize studies concerning fruit usage, plant propagation and even the species genetic improvement. Thus, the main goal of this study was to characterize the physical and chemical properties of fruits and seed germination of *C. aurea* collected from different accession areas.

Material and methods

This study was conducted in the Department of Horticulture and Forestry's labs, College of Agronomy, *Universidade Federal do Rio Grande do Sul*, Porto Alegre state, Brazil. *C. aurea* fruits were collected from native vegetation areas located in the Morro do Osso Natural Park (30º 07' S, 51º 14' W), Porto Alegre, Brazil, and in the municipality of Barão do Triunfo (30º 18' S, 51º 50' W), Brazil, in February and March 2016. Only light green-colored fruits and the ones with a softer pulp from more than 50 specimens were collected, since they are considered to be more mature.

Fruits were randomly separated into four subsamples of 30 fruits each. Subsequently, the physicochemical analysis of their properties was carried out followed by seed counting and germination tests.

Physical properties

The fruits' physical properties were determined by using the four subsamples of 30 fruits each. Fruit fresh mass (g) (FRFM) was obtained with a semi-analytical scale (0.01 g) and the longitudinal (LD) and equatorial (ED) diameters (mm) were analyzed with a digital caliper by taking the fruits individually. The LD/ED ratio was obtained by dividing data.

Chemical properties

Random samples of fruits from both collection areas were separated and frozen for chemical analyzes. Total soluble solids (TSS), titratable acidity (TA) and vitamin C content were then determined. After defrosted, the whole fruits (pulp and seeds) were grinded with a Turrax® processor for pulp homogenization. The juice obtained after centrifuging the fruits for five min at 3500 rpm was used to determine the TSS. The juice was deposited on the prism of a digital refractometer previously calibrated (Digimess digital 150 mm 6^{-1}) in order to obtain a direct reading corrected at a temperature of 20°C, which results are expressed as °Brix.

TA was determined by titration of neutralization with NaOH set at 0.1 until reaching pH 8.1, which was measured by potentiometer. Four replications were performed in duplicate for each sample of both collection areas. About 4 g of the homogenized pulp

were weighted for each sample then diluted in 50 mL of distilled water. Results are expressed as citric acid rates. Sampling initial pH was determined prior to the titration for determining TA with these same samples and procedures.

Vitamin C content was obtained through a procedure adapted from the DNPH (2,4-Dinitrofenilhidrazina) method developed by Tereda, Watanabe, Kunitoma, and Hayashi (1978). We have applied its steps and prepared the reagents as indicated. Approximately 2.5 g of freshly homogenized pulp were used per sample by performing four replications in each collection area. Results are expressed as mg ascorbic acid in 100 g of fresh pulp.

Seeds counting, thousand seeds weight and germination test

After determining their physical properties, the fruits were processed by hand for removing and counting their intact and malformed seeds. Seeds were considered as malformed when showing a bad physical quality or a very small size.

The methodology and criteria indicated by the rules of seed analysis (Brasil, 2009) were applied to determine one thousand seeds weight. Seeds collected from the Morro do Osso Natural Park were dried over a stand for two days, resulting in 10.06% moisture.

For the germination test, seeds were washed on a sieve in running water to remove the pulp and then superficially dried with paper towels so as to be immediately submitted to testing, which has considered 100 seeds divided into four replications of 25 seeds each for both collection areas. After that, fruits were disinfested by an initial dip in 70% alcohol for 1 min followed by a 15 min soak in 1% sodium hypochlorite (i. a.) and finally washed with autoclave deionized water. Once disinfested, seeds were stored in gerboxes with water-moistened blotting paper in the proportion of 2.5 times the dry paper weight (Brasil, 2009) and taken to the growth room at an average temperature of 25°C ± 2 and a photoperiod of 16 light hours.

Simultaneously to the germination test, the germination speed index (GSI) (Maguire, 1962, adapted by Santana & Ranal, 2004), the average germination time (AGT) (Borghetti & Ferreira, 2004) and the number of polyembryonic seeds have been analyzed. Samples were observed every two or three days to count the number of germinated seeds. The counting started as soon as the first seed was germinated and ended after 90 days. Seeds with a radicle protrusion visible to naked eyes were considered as germinated.

Data analysis

Results were submitted to analysis of variance and means were compared by the t test at 5% error probability. Data obtained from the vitamin C content have not met the assumption of normality, being therefore transformed into asen $\sqrt[2]{x/100}$ and expressed in their original values. For the germination test, data have not met the normality even after transformations, being analyzed by the nonparametric statistic by the means of the Kruskal Wallis test. In addition, the Pearson correlation coefficient was measured from the residuals for the analyzed variables.

Results and discussion

Physical properties

No significant statistical differences between the collection areas have been observed for the physical properties of the fruits. Both collection areas have shown the same result for the fruit fresh mass mean (1.26 g) (Table 1). However, fruits collected from the municipality of Barão do Triunfo have shown a lower standard deviation (±0.45) with a minimum and a maximum mass of 0.51 and 2.65 g, respectively. Those collected from the Morro do Osso Natural Park have shown a higher standard deviation (±0.58) with fruits ranging from 0.31 to 3.64 g.

Table 1. Fruit fresh mass (FRFM), longitudinal diameter (LD), equatorial diameter (ED) and LD/ED ratio of *Campomanesia aurea* fruits collected from two areas of the state of Rio Grande do Sul, Brazil. UFRGS, Porto Alegre, Rio Grande do Sul state, Brazil.

Collection area	FRFM (g)	LD (mm)	ED (mm)	LD/ED
Barão do Triunfo	1.26^{ns}	11.51^{ns}	14.08^{ns}	0.82^{ns}
Morro do Osso	1.26	10.84	13.82	0.79
Mean	1.26	11.17	13.95	0.80
CV	41.44	12.99	14.07	10.51
p-value	0.98	0.12	0.57	0.07

^{ns}Means do not differ by t test at 5% error probability.

Such variation in fruit mass has also been observed for other species from the same genus, such as *C. phaea* (Vallilo et al., 2005; Bianchini et al., 2016), *C. lineatifolia* (Balaguera, Álvarez, & Bonilla, 2009), *C. adamantium* (Melchior, Custódio, Marques, & Neto, 2006; Dresch, Scalon, Masetto, & Vieira, 2013) and *C. xanthocarpa* (Santos et al., 2009), since they are non-domesticated species possibly collected *in situ* from mother plants with a high genetic variability often located in areas of distinct edaphoclimatic conditions.

C. aurea fruits are smaller than those from other tree species of the genus, such as *C. phaea* (55 g), *C. lineatifolia* (24 g) and *C. xanthocarpa* (6 g) (Vallilo et al., 2005; Balaguera et al., 2009; Santos

et al., 2009) as well as those described for *C. adamanium* (8 g) (Santos, Megguer, Costa, & Lima, 2015), a species similar to *C. aurea* in size.

No significant differences have been observed for longitudinal and equatorial diameter data. The LD/ED ratio indicates that *C. aurea* fruits are oblong-shaped, that is, the longitudinal diameter is smaller than the equatorial diameter and has a slightly flattened shape (LD/ED < 1), which has also been reported for *C. phaea* (Vallilo et al., 2005). Yet for *C. adamantium* the ratio has reached very close to one (Santos et al., 2015), indicating that these fruits are more spherical when compared to *C. aurea* fruits. Fruit size and shape aspects may be important for differentiating some species.

Chemical properties

The *C. aurea* fruits collected from the municipality of Barão do Triunfo have shown a higher amount of TSS content (14.37 °Brix) than those collected from the Morro do Osso Natural Park (9.86º Brix) (Table 2). The different values may be related to the collection date, since fruits from Barão do Triunfo were collected almost one month later the collection carried out in Morro do Osso. Sugar content, the main chemical substance from the technological point of view in case of fruit industrialization, ranges according to species, cultivar, maturation stage and climate (Chitarra & Chitarra, 2005).

Table 2. Total soluble solids (TSS), titratable acidity (TA), TSS/TA ratio, pH and vitamin C content (Vit. C) of *Campomanesia aurea* fruits collected from two areas in the state of Rio Grande do Sul, Brazil. UFRGS, Porto Alegre, Rio Grande do Sul state, Brazil.

Collection area	TSS (°Brix)	pH	TA (%)*	TSS/TA	Vit. C (mg AA 100 g)**
Barão do Triunfo	14.37 a	4.18^{ns}	0.35^{ns}	40.73 a	50.99 b
Morro do Osso	9.86 b	4.15	0.38	25.49 b	96.74 a
Mean	-	4.16	0.36	-	-
CV	19.92	2.40	10.87	25.14	35.14
p-value	<0.01	0.63	0.11	<0.01	0.02

^{ns}Means do not differ by t test at 5% error probability. *Citric acid; **A.A.: Ascorbic acid.

TSS values similar to those we have found for *C. aurea* have also been observed in mature fruits of *C. xanthocarpa* (12º Brix), *C. pubescens* (higher than 13º Brix), *C. lineatifolia* (11.58 °Brix), *C. cambessedeana* (11.70 °Brix) and *C. phaea* (7.30-13.3 °Brix) (Santos et al., 2009; Silva et al., 2009; Balaguera et al., 2009; Morzelle et al., 2015; Bianchini et al., 2016). *C. xanthocarpa* fruits have been considered fully mature at a TSS content of 15.34º Brix. Researchers have pointed out that this amount is recommended for processing fruits since it provides adequate flavor, reduction in sugar addition and higher yield (Pereira et al., 2012). Even higher TSS values have been found for *C. adamantium*, reaching up to 18.9 °Brix (Santos et al., 2015).

The pH value of *C. aurea* fruits did not significantly differ between the two collection areas, ranging from 4.15 to 4.18. Values close to those we have found for *C. aurea* have been observed for *C. adamantium* (4.3) and *C. cambessedeana* (4.25) (Vallilo et al., 2006; Morzelle et al., 2015). *C. phaea* and *C. lineatifolia* have shown pH values below 3.0, which highly increases fruit acidity so as to restrict the *in natura* consumption (Vallilo et al., 2005; Álvarez, Balaguera, & Cárdenas, 2009). The pH values have remained practically constant during the development of *C. pubescens* and *C. lineatifolia* fruits even with the increased TSS content due to maturation (Silva et al., 2009; Balaguera et al., 2009). We have observed similar results for *C. aurea*, where the pH values have shown little variation even for different TSS contents.

The acidity of *C. aurea* fruits has shown from 0.35 to 0.38% citric acid. Similar values have been observed for *C. xanthocarpa* (0.34%) (Pereira et al., 2012). *C. adamantium* and *C. phaea* fruits have shown much higher TA values, reaching up to 1.2 and 3.0% citric acid, respectively (Vallilo et al., 2005; 2006). *C. cambessedeana* has shown lower TA values (0.19%) (Morzelle et al., 2015), indicating variability among species of the same genus.

The TSS/TA ratio provides information on fruit flavor being therefore more representative than isolated measures of acidity or sugars (Chitarra & Chitarra, 2005). Thus, the values found for *C. aurea* fruits collected from the municipality of Barão do Triunfo (40.72) indicate fairly sweet fruits, similar to what has been found for *C. xanthocarpa* (45.12) (Pereira et al., 2012). A TSS/TA ratio of 16 has been considered adequate for the fresh fruit market of *C. phaea* (Bianchini et al., 2016). Yet a ratio of 6.5 has been considered appropriate for the consumption of *C. adamantium* (Santos et al., 2015). In this sense, fruits collected from the Morro do Osso Natural Park would also be suitable for *in natura* consumption although showing a lower TSS/TA ratio (25).

The Ministry of Agriculture, Livestock and Supply, through the Normative Instruction n° 136, from March 31st, 1999, has established standard values for the chemical properties of pitanga fruits (*Eugenia uniflora*), a species of the same family, intended for pulp industrialization. Accordingly, the fruits must have a minimum of 6 °Brix, a total of 0.92% citric acid and a pH between 2.5 and 3.4 (Lira Júnior, Bezerra, Lederman, & Silva Junior, 2007).

Significant differences in Vitamin C content have been found between the collection areas

(50.99 and 96.74 mg of ascorbic acid in 100 g of fruit pulp collected from Barão do Triunfo and Morro do Osso, respectively). Results are similar and even higher than those found in oranges (56.9 mg 100 g^{-1}) (*Tabela Brasileira de Composição de Alimentos* [Taco], 2011), which are known for their high content of vitamin C. The content levels we have found are higher than those observed for other species of the same genus, such as *C. phaea* (33.37 mg 100 g^{-1}) (Vallilo et al., 2005), but lower than those observed for *C. xanthocarpa* (233.56 mg 100 g^{-1}), *C. adamantium* (234 mg 100 g^{-1}) *C. cambesedeana* (383.33 mg 100 g^{-1}) and *C. pubescens* (higher than 1000 mg 100 g^{-1}) (Vallilo et al., 2006; Santos et al., 2009; Silva et al., 2009; Morzelle et al., 2015).

Differences concerning the vitamin C content may have occurred due to the fruits maturation stage, the genetic variability among mother plants and the different edaphoclimatic conditions between the collection areas. A study carried out on *C. pubescens* has shown decreased vitamin C levels at the end of the maturation stage and the beginning of senescence (Silva et al., 2009). This fact may have influenced the results we have found once the collection in the municipality of Barão do Triunfo has been carried out a month after the collection of the Morro do Osso Natural Park. It is possible that the degree of maturation of fruits was higher, which is in accordance with the TSS data results. Furthermore, a study on 58 collection areas of *C. phaea* from seeds collected in the states of São Paulo, Minas Gerais and Rio de Janeiro, Brazil, has shown vitamin C content levels ranging from 25.62 to 127.4 mg of ascorbic acid in 100 g of pulp (Bianchini et al., 2016), indicating that both genetic and environmental aspects of the collection areas may influence this parameter.

Not only genetic and maturation factors, but also environmental factors, especially those related to luminosity, influence the size, brightness, color and chemical composition of fruits. Although light is not essential for synthesizing ascorbic acid, its intensity and duration along plant growth has an effect on the ascorbic acid concentration since it is synthesized from sugars formed during photosynthesis (Chitarra & Chitarra, 2005).

Seeds counting, thousand seeds weight and germination test

We have observed from zero to 10 intact seeds in the same *C. aurea* fruit. There were statistical differences between the collection areas for the total number of seeds but not for the number of intact seeds, which has averaged 4.5 seeds (Table 3). The literature about the *Campomanesia* genus states that this is a way to concentrate the reserves in the remaining seeds. The development of seeds in all locules is therefore not common (Landrum, 1982).

Table 3. Mean of intact, malformed and total seeds in *Campomanesia aurea* fruits from two collection areas. UFRGS, Porto Alegre, Rio Grande do Sul state, Brazil.

Collection area	Intact	Malformed	Total
Barão do Triunfo	4.45^{ns}	1.62^{ns}	6.07 b
Morro do Osso	4.73	2.18	6.91 a
Mean	4.59	1.90	-
CV	41.36	78.99	24.04
p-value	0.33	0.07	< 0.01

^{ns}Means do not differ by t test at 5% error probability.

The same has been observed for *C. adamantium* and *C. pubescens* fruits. A total of five locules have been observed in more than half (54%) of *C. adamantium* fruits and almost half of total locules (48%) has shown only one seed. Most *C. pubescens* fruits (36%) have also shown five locules, but around 38% of total locules have shown 2 seeds only (Oliveira, Santana, & Santos, 2011). *C. xanthocarpa* and *C. guazumifolia* have respectively shown 7 and 11 seeds per fruit (Santos, Ferreira, & Áquila, 2004) whereas *C. phaea* has shown from 6.1 to 18 seeds per fruit (Bianchini et al., 2016).

The number of intact and total seeds in *C. adamantium* fruits has increased with fruit size so those classified as large fruits have shown 4.3 intact seeds and 2.2 empty seeds each. The study on *C. adamantium* fruits also suggests that the environment causes the number of seeds to vary since there are fruits collected from different mother plants (Dresch et al., 2013). Such information is in agreement with the data we have found since there were significant differences in the total number of seeds between fruits from each collection area.

One thousand seeds of *C. aurea* have weighted 23.4 g (CV = 2,3) so that 1 kg contains approximately 42,735 seeds. Other species of the same genus have shown a higher thousand seeds weight, such as *C. phaea* (46 g at 5.2% moisture content) (Maluf & Pisciottano-Ereio, 2005), *C. guazumifolia* (31 g at 9% moisture content) and *C. xanthocarpa* (49 g at 33% moisture content) (Santos et al., 2004). Similar values to those we have observed for *C. aurea* seeds have been reported for *Blepharocalyx salicifolius*, a species of the same family, where one thousand seeds have weighted 20.87 g at 34.57% moisture content (Rego, Nogueira, Kuniyoshi, & Santos, 2009).

C. aurea seeds germination have averaged 93% and its mean time was approximately 20 days with no differences observed between the two collections areas (Table 4). A high germination capacity is

generally observed for the different species of the *Campomanesia* genus, especially when they are not stored. Germination rates higher than 85% have already been observed for *C. adamantium*, *C. pubescens* and *C. xanthocarpa* (Santos et al., 2004; Oliveira et al., 2011; Dousseau et al., 2011; Scalon, Oshiro, Masetto, & Dresch, 2013).

Table 4. Germination (G), germination speed index (GSI), average germination time (AGT), and polyembryonic seeds in *Campomanesia aurea* fruits from two collection areas. UFRGS, Porto Alegre, Rio Grande do Sul state, Brazil.

Collection areas	G (%)	GSI	AGT (days)	Poly (%)
Barão do Triunfo	97.0^{ns}	1.68 a	18.58^{ns}	2.0^{ns}
Morro do Osso	89.0	1.20 b	22.97	4.0
Mean	93.0	-	20.77	3.0
CV	6.80	19.49	17.87	94.28
p-value	0.11	< 0.01	0.09	0.35

^{ns}Means do not differ by t test at 5% error probability.

Although the germination rate provides important information, the evaluation of the mean time and germination speed index allow other interpretations of such physiological process. The mean time allows inferring about the germination strategy of particular species and whether the environmental conditions are favorable or not for the development of new plants. This characteristic is also associated with the seed germination speed, which reflects the vigor of a seed lot (Borghetti & Ferreira, 2004).

However, we have observed that seeds collected from the municipality of Barão do Triunfo have shown a GSI higher than those collected from the Morro do Osso Natural Park. Seeds of most species have the ability to germinate long before reaching physiological maturity, which is near or within the period of maximum accumulation of reserves so seeds are usually more vigorous. Seeds vigor influences the arising of a set of conditions determining the seedlings potential to emerge faster and in a uniform way (Marcos Filho, 2015). Even though there were no differences in germination, a higher GSI has been observed for seeds collected from the municipality of Barão do Triunfo. In this sense, a significant positive correlation of 0.92 was observed between the TSS content and the GSI, which means that the higher the fruit maturation the faster the seeds germination.

A similar result has been found in seeds of *C. adamantium*, where there was a correlation between the TSS content and seed germination. A tendency of increasing the germination rate from 80 to 100% as Brix changed from 14.18 to 20 was observed, therefore suggesting that Brix can be used as a parameter to guide the maturation stage of *C. adamantium* fruits for seed harvesting (Melchior et al., 2006). Yellow-colored and orange-colored *C. xanthocarpa* fruits, in a more advanced stage of maturation, have shown higher germination and GSI rates than dark green-colored fruits (Herzog, Malavasi, & Malavasi, 2012). This change in the color of the fruits as the maturation advances has not been observed in fruits of *C. aurea*, which have shown practically the same coloring even differing in TSS content according to the collection area.

By analyzing the seed germination of *C. aurea*, we have observed that fruits averaged 3% polyembryonic seeds forming up to two plants each. This information had not yet been reported for this species. Polyembryony is the formation of one or more asexually produced embryos, in addition to the sexual embryo, and it occurs in at least 250 species of 59 families (Lersten, 2004). Such characteristic is known for the genus *Myrciaria*, *Eugenia* and *Syzygium* of the family Myrtaceae (Gurgel & Soubihe Sobrinho, 1951). Recent studies have reported polyembryony in seeds of *Plinia jabuticaba* and *P. peruviana*, where 1.46 and 1.19 plants per seed have been respectively identified (Wagner Júnior, Silva, Pimentel, Santos, & Bruckner, 2011). The polyembryony rate of *P. cauliflora* is up to 37.5%, forming from two to five plants per seed (Danner, Citadin, Sasso, Ambrosio, & Wagner Júnior, 2011).

Gurgel and Soubihe Sobrinho (1951) have pointed out a variation between the collection years of a certain plant therefore indicating that environmental factors influence polyembryony. Danner et al. (2011) state that polyembryony appears to be mainly affected by genetics and environmental conditions during the somatic embryogenesis of mother plant seeds.

Based on the results we have found, a broader characterization including more years of analyzes as well as other populations is recommended for in future studies. We suggest analyzing the centesimal composition and phenolic compounds as well as a better sampling, mainly regarding the fruits degree of maturation, which we have not been able to obtain since the species fruiting was low and dispersed over time. Moreover, monitoring the development of fruits by the means of a phenological curve would bring about a greater homogeneity in the sampling and could therefore determine the most suitable point either for collecting fruits for *in natura* consumption or for obtaining seeds.

It is noteworthy that although *C. aurea* is a very important native species of the Pampa biome with potential for both fruit and ornamental usage, it has been little studied so that the results we have shown here are unprecedented. Studies on morphological,

physical and chemical characterization of *C. aurea* fruits and seed germination may also contribute to improve knowledge about the species so as to expand its utilization.

Conclusion

It is concluded that *C. aurea* fruits from two different accession areas differ in the concentration of TSS, TSS/TA ratio and vitamin C content, but not physically. Seeds have show high germination rates.

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