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# Contribuição para a caracterização de cultivares de arroz Carolino

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## Resumo

O arroz é consumido principalmente em grão, e a sua qualidade revela-se de grande importância. O conceito de qualidade do arroz varia de país para país e até entre regiões. A maior parte do arroz produzido em Portugal é do tipo Carolino, botanicamente classificado como *Oryza sativa* ssp. Japonica. Hoje em dia, este arroz desempenha um papel vital no comércio Português. Foram recolhidos e analisados treze tipos de arroz Carolino, sendo avaliadas as caraterísticas biométricas, a cor do grão, o teor de amilose, e as propriedades de gelatinização das respetivas farinhas.

O arroz Carolino está comercialmente classificado como grãos longos do tipo-A, uma vez que apresentam um comprimento superior a 6 mm e uma relação comprimento/largura inferior a 3 mm, verificando-se uma grande variabilidade nas medidas biométricas. Este tipo de arroz mostrou um elevado nível de área de gessada, significando que tem um aspeto pouco vítreo.

O teor de amilose variou entre 9.4 % e 15.2 %, com uma média de 12.4%, significando que o arroz Carolino apresenta um teor baixo de amilose, ou seja, que o arroz é essencialmente seco, pouco macio e rígido após a cozedura, mostrando uma expansão elevada de volume e uma elevada capacidade para formação de flocos.

As farinhas de arroz Carolino mostraram diferenças significativas de perfis de viscosidade no RVA. De um modo geral existem diferenças significativas nas temperaturas de empastamento, apresentando temperaturas semelhantes no pico de gelatinização, de 95ºC. Observou-se que os diferentes tipos de farinhas de arroz Carolino apresentam viscosidades elevadas (mínimo de 2.872 cP e 3797 cP máximo), com grandes diferenças de breakdown e setback.

Palavras chave: Arroz Carolino; biometria; morfologia; teor de amilose; viscosidade

## Contribution for the characterisation of Carolino rice cultivars

## Abstract

Rice is consumed mainly as whole grain, and quality considerations are much more important than for any other food crop. Rice grain quality preference varies from country to country and among regions. Most of the rice produced in Portugal is of the Carolino type, botanically classified as *Oryza sativa* ssp. Japonica. Nowadays, this rice is playing a vital role in Portuguese rice trading. Thirteen types of Carolino rice were collected and analysed for biometry characteristics, amylose content and gelatinization properties.

The Carolino rices are commercially classified as long grains type-A, because they present a length higher than 6 mm and the ratio length/width lower than 3 mm), and there was observed a high variability in biometric measurements. This type of rice showed a high level of plastered area, meaning low vitrea aspect.

The amylose content varied from 9.4% and 15.2%, with an average of 12.4%, meaning that Carolino rice presented low value, i.e. that the rice with low amylose content is dry, less tender and hard after cooking, also showing volume expansion and a high degree of flakiness.

Carolino rice flours showed significant differences of RVA viscosity profiles. Generally they presented significant differences in the pasting temperature, but similar pasting peak temperature, 95ºC. It was also

observed that the different types of Carolino rice flours showed high viscosities (minimum of 2872 cP and maximum 3797 cP), as well as great differences in breakdown and setback values.

Keywords: Carolino rice; biometry; morphology; amylose content; viscosity

## Introduction

Rice (*Oryza sativa* L.) is one of the most important cereals cultivated worldwide, constituting the basic food for large number of human beings, sustaining two-thirds of the world population (Zhout et al., 2002). Carolino rice is one of the most popular cultivars of rice widely consumed in Portugal.

Grain-type preferences vary among consumer groups. The marketing values of rice as an agricultural product depend on its physical qualities after the harvesting. The percentage of whole grain is the most important parameter for the rice processing industry (Marchezan, 1991), related with a common demand to all rice consumers, the grain, or head rice, must be well polished and unbroken. The geometric structure and weight of rice (*Oryza sativa* L.) kernels determine the physical characteristics and types of rice grains (shape, volume and density). Grain shape, considering the length and the ratio of kernel length to kernel width, is used by the rice industry in Portugal to classify rice into three types: round grain (length ≤ 5.2 mm and length/width ratio < 2.0), medium grain (length between 5.2 and 6 mm and length/width ratio < 3), and long grain rice type-A (length > 6 mm and length/width ratio of 2–3) and Type-B (length > 6 mm and length/width ratio ≥ 3) (DL n.º 62, 2000).

There are various types of rice. Different countries use different types of rice. The economic value of rice depends on its cooking and processing quality. Cooking quality of rice mainly depends on amylose content and gelatinization temperature.

Amylose content determines the texture of cooked rice, and it determines the indices such as water absorption, volume expansion, stickiness, gloss, colour, and firmness when cooked (Juliano, 1979; Kumar, Maruyam and Moon, 1994). Rice varieties are grouped on the basis of their amylose content into waxy (0–2%), very low (3–9%), low (10–19%), intermediate (20–25%) and high (>25%) (Hossaina, Singhb and Fasih-uz-Zamanb, 2009). Screening of world germplasm collection at IRRI and other Rice Research Centres has revealed the amylose content in rice to range from 0% to 35% (IRRI, 1966). Rice varieties with amylose content of more than 25% absorb more water and have a fluffy texture after cooking (Oko, Ubi and Dambaba, 2012). Intermediate amylose rices are moist and tender upon cooking, and waxy (low amylose content) rices do not expand in volume, are glossy and sticky, and remain firm when cooked. Moreover, amylose consists of linearly linked glucose molecules and is relatively resistant to digestion, hence the term “resistant starch”. This means that rice varieties with a greater proportion of starch in the form of amylose tend to have a lower glycemic index (Oko, Ubi and Dambaba, 2012).

The pasting properties of rice flour are key determinants of quality which significantly impact the final product texture. Rapid Visco Analyser (RVA) can be used for measuring the pasting properties of rice flours (Vongsawasdi, 2009).The pasting temperature, holding strength, peak and final viscosity can be measured during a very short cooking time.

The objective of this work was, therefore, to evaluate the commercial Carolino rices, one of the most popular types of rice widely consumed in Portugal, in relation to biometry characteristics, amylose content and gelatinization properties.

## Material and Methods

Thirteen types of Carolino rice grains were collected from the Portuguese trade market, and they were coded with a number (the cultivar list was not revealed due to confidentiality). Flours were produced

for RVA measurements using a SK 100 Cross Beater Retsch hammer mill with a 1 mm sieve. After they were sieved through a 0.5 mm sieve.

Biometric characteristics of all rice grains were evaluated, using an automatic S21(LKL, Brasil) biometric equipment and a C-300 (Kett, USA) colorimeter. An average of 670 grains for each cultivar was analysed.

Amylose content was determined by ISO 6647-1 (2007) reference method. Total of 100 mg of each sample was weighed into a 50-mL Erlenmeyer flask and 1 mL of 95% ethanol and 9 mL of 1 M NaOH were added. The mixture was heated for 10 min in a boiling water bath to gelatinize the starch, cooled, and transferred, with several water washings, into a 100-mL volumetric flask. The volume was brought up with water and then mixed well. A total of 5 mL of starch solution was pipetted into a 100-mL volumetric flask and 1 mL of 1 N acetic acid and 2 mL of iodine solution (0.2 g iodine and 2 g potassium iodine in 100 mL of aqueous solution) were added. The solution is made up to volume with distilled water, shaken, and allowed to stand for 20 min. Absorbance of the solution at 620 nm was measured with a Lambda 25 UV/VIS spectrophotometer (PerkinElmer, Mass., U.S.A.). Amylose content was determined by reference to standard rice flours with known content (Instituto Nacional de Recursos Biológicos, I.P., Portugal) standard curve. The standard rice flours Ariete, Gládio, Opale, Albatros and Waxy, with an amylose content of 12.5, 27.8, 19.1, 14.3 e 1.3%, respectively, were used.

Pasting properties were measured by Rapid Visco Analyser (Perten Instruments, Australia) using the AACC (2000) official method n.º 61-02.01. Sample (3 g based on 12% moisture) was added to 25 mL of water. The mixture was heated to 50 ◦C for 1 min and then ramped to 95 ◦C at a rate of 11.84 ◦C/min. After holding at 95 ◦C for 2.5 min, the temperature was decreased to 50 ◦C and held for 1.4 min. The mixture was constantly stirred and the total run time was 12.5 min. Viscosity was measured in CentiPoise (cP).

All of the data represents averages of at least three different determinations. Results were analysed using the SPSS® for Windows version 17.0 software. The data was subjected to one-way analysis of variance (ANOVA) test. The separation of means or significant difference comparisons of all parameters were tested by Tukey's HSD test. Pearson correlation coefficients (r) for the relationships between properties were also calculated. Cluster analysis of the rice properties were carried out to provide a ready mean of visualizing the differences and similarities among different samples. The level of significance used for all the statistical tests was 95%.

## Results and Discussion

All the samples analysed of Carolino rices are commercially classified as long grains type-A, because they present a length higher than 6 mm and the ratio length/width lower than 3 mm (Figure 1). The length and the width presented a correlation coefficient of 0.71.

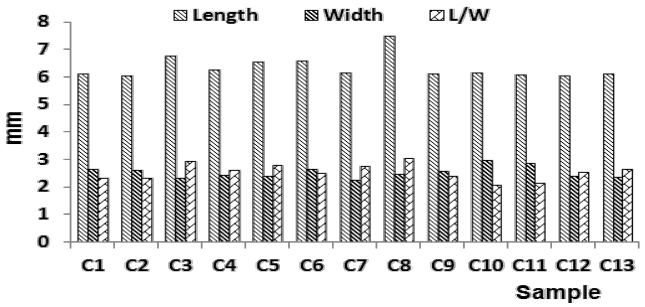



**Figure 1. Length and width of Carolino rice.**

This type of rice showed a plastered area of 15.6, meaning that they have not a high vitrea aspect (Figure 2). There is a stickily relationship between the total and vitrea whiteness ($r^2$=0.88), and there was observed a high variability in biometric measurements.

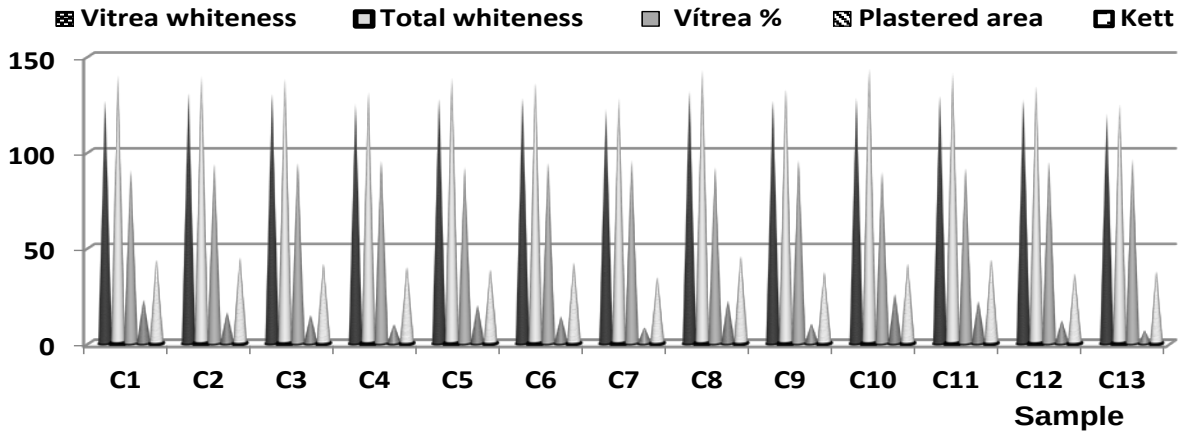
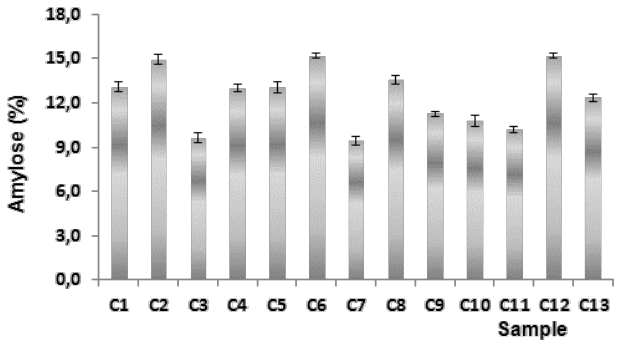



**Figure 2. Whiteness, vítrea, plastered área and kett of Carolino rice.**

Cooking quality of rice mainly depends on amylose content and gelatinization temperature. The amylose content varied from 9.4% and 15.2% (classified as low value) (Figure 3), meaning that the rice with low amylose content is dry, less tender and hard after cooking.




**Figur3 3. Amylose content of Carolino rice.**

The RVA viscosity parameters of rice flours are shown in Figure 4. Carolino rice flours showed significant differences of RVA viscosity profiles. Generally they presented significant differences in the pasting temperature, but similar pasting peak temperature, 95ºC.

It was also observed that the different types of Carolino rice flours showed high viscosities (minimum of 2872 cP and maximum 3797 cP), and great differences in breakdown and setback values. Breakdown was positively related with the peak consistency ($r^2$=0.71), and the setback was correlated with final consistency ($r^2$=0.88). The C11 sample presented high paste viscosities and this could be due to low amylose content and to the structure of starch. Paste peak viscosity measures the extent by which starch granules swell in the presence of water, heat and sometimes shear. Starch swelling is mainly due to the activity of the amylopectin, but this can be restricted by amylose and protein (Inouchi et al., 2000). The hot paste viscosity for all samples reduced markedly. Viscosities at the start of the holding period and during cooling reflect the ease of cooking starch and paste stability, respectively (Zobel, 1984). Breakdown viscosity measures the tendency of swollen starch granules to rupture when held at high temperatures and continuous shearing (Patindol et al., 2005), meaning that high values of breakdown are related with low paste stability. Rices presented high setback values. Thus, makes it useful for dishes involving boiled rice for grains that do not stick together, but with high gelling ability or retrogradation tendency of starch.

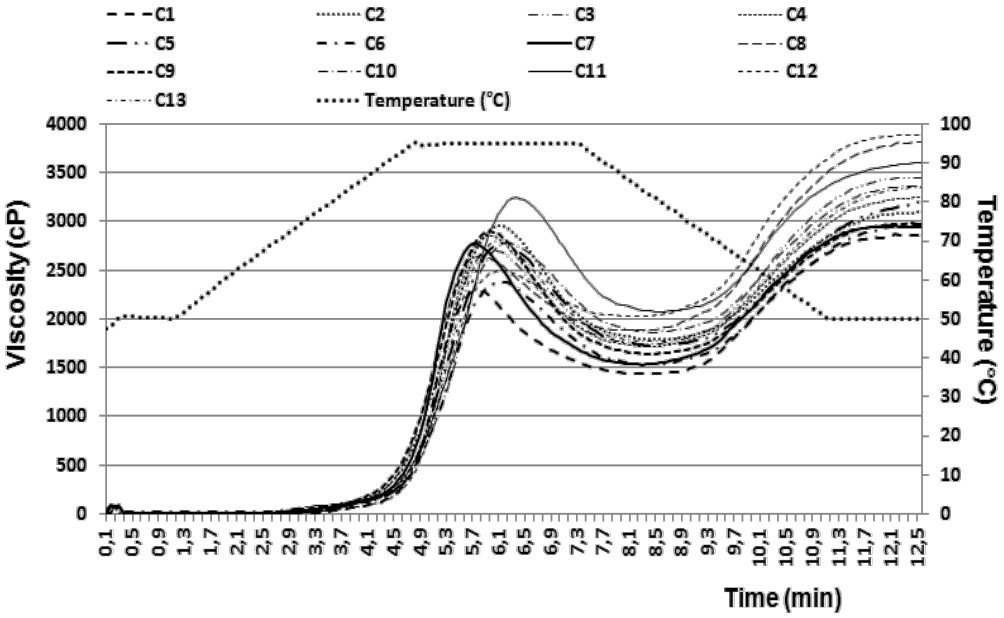



**Figure 4. RVA profiles of Carolino rice.**

The cluster analysis shows that are two main groups at 25 Euclidean distance (Figure 5). The C8 and C12 Carolino rices are quite similar, and they are significantly different from the other ones. Apart from that the C1 and C6 samples also presented similar characteristic. However at the end of the cooling period, the cold paste viscosities of all the samples showed an increase of their viscosities.

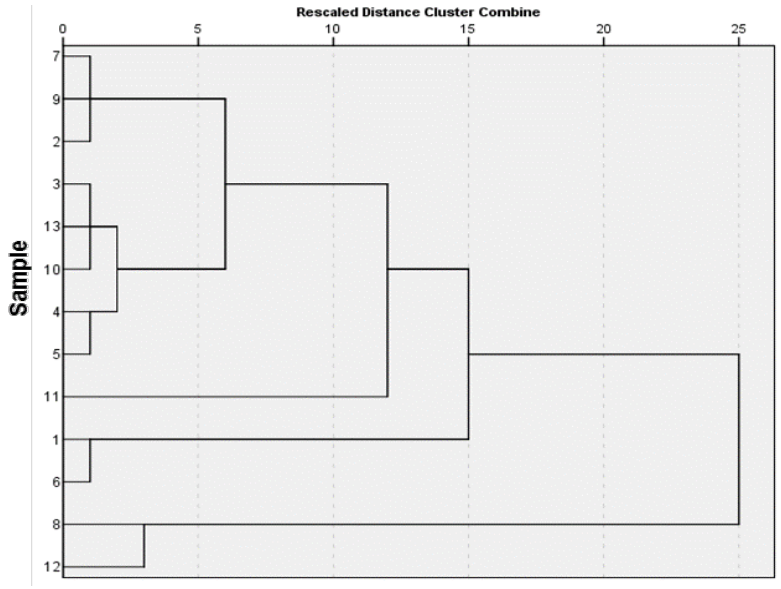



**Figure 5. Dendrogram of Carolino rice using average linkage (between groups).**

## Conclusions

Generally it could be concluded that Carolino rice is classified as a long type-A rice, with an intermediate level of plastered area. In general, the samples presented low amylose content and high

viscosities. In spite of this, the different types of Carolino rice showed to be different considering the biometric characteristics, colour, amylose content and viscoelastic properties. This could mean that Carolino rices could be used for different proposes.

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