

Starch content variation in cassava cultivars during four harvesting seasons in Marechal Cândido Rondon, Brazil

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ABSTRACT

Starch, the most important component in cassava, has been largely used by the food industry. This work aimed at evaluating the starch content variation (%) in six cultivars namely Fécula Branca, Olho Junto, Fibra, Verdinha, Espeto and Mico. Planting took place from October 1998 in Marechal Cândido Rondon, Brazil. Cultivars were sampled between the 7th and the 10th month of plant life. Starch content evaluation (%) was calculated by the hydrostatics scale method. Fécula Branca, Olho Junto and Fibra cultivars presented the largest amount of starch content, 29.7%, 29.1% and 29.1% respectively. The Mico cultivar, on the other hand, had the poorest performance regarding starch accumulation, 25.0%. As for the starch content profile along the periods studied, it was verified that the Fécula Branca, Olho Junto, Verdinha and Espeto showed a stable pattern, while the Fibra and Mico cultivars tended to develop more progressively.

KEY WORDS: *Manihot esculenta*, cassava, food industry.

INTRODUCTION

The cassava (*Manihot esculenta* Crantz) is important for the Brazilian agriculture. Cultivated throughout the country, it is easily adaptable to the country's edaphic-climatic conditions. It is consumed in many ways such as *in natura*, as human or animal feed, and as industrialized flour or starch.

The State of Paraná stands out as one of the biggest cassava producer in Brazil. The cassava culture and the number of starch industries have increased significantly in Western Paraná in the last years. In 1993, the Paraná Cassava Industry Union was founded, bringing together 19 starch industries from the West micro region.

The increase in the number of producers can be explained, at least partially, by one or more of the following attractive reasons: high productivity, all-year-round harvesting, easy production, better prices and great market demand. Climate, soil and temperature conditions have favored the development of the cassava culture in Western Paraná.

Due to its large applications to different sectors of human life as well as to the number of industrial by-products, starch is considered the most important product extracted from the cassava (Abam, 1997). It is also one of the most common first-rate dietary

energy substance found in vegetals, being widely applied and used in more than 300 modern industries (Ciacco and Cruz, 1982). The objective of the present work is to evaluate starch content (%) in six of the most common cultivars found in Western Paraná during different harvesting periods.

MATERIAL AND METHODS

This experiment was carried out in a clay-textured "Red Euryferric Latosol" (Embrapa, 1999), in Marechal Cândido Rondon, Brazil, from October 1998 to July 1999.

Six cultivars, were studied, namely:

Espeto: a productive, starch-rich cultivar with an 18-month development cycle. Characteristics: erect aerial part, light beige branches, prominent scars in the foliage, and purple petiole. Roots present average cyanic content and are covered with a bright and soft film when picked at 24 months. Used for industrial purposes and rarely cultivated in the Western Paraná region.

Olho Junto: a productive, starch-rich cultivar, with an 18 to 24 months development cycle. Characteristics: branchy aerial part, brown foliages, purple petioles and buds. Roots with high cyanic content (up to 400 ppm in the fresh pulp) and covered

with a dark and wrinkled film. Tolerant to the cassava bacterial blight.

Fécua Branca: a largely cultivated and productive cultivar, fair amount of starch content and an 18 to 24 months development cycle. Characteristics: branchy aerial part, light beige foliages, separate yolks, greenish yellow petiole and bud. Roots with a medium acid cyanic content and covered with a bright film.

Fibra: a productive, starch-rich cultivar, with a 12 to 24 months development cycle. Characteristics: erect aerial part, greenish yellow petiole and buds, and light beige foliages. Short roots covered with a bright film and without stalks. Acid cyanic content between 100 to 150 ppm in the roots fresh pulp (intermediate toxicity). The city of Palotina produced at one-cycle, 22.5% starch-rich, 14.5 t/ha cassava culture. This one-cycle culture developed rotten roots whenever left for 2 cycles. High ramification occupies 90% of the Northwestern cultivated region in Paraná (Paranavaí, Umuarama and Campo Mourão). This culture has recently been replaced due to great cassava bacterial blight incidence.

Verdinha: a productive, low starch content industrial cultivar, with an 18 months development cycle, high acid cyanic content and a white pulp. The one-cycle culture produced a 28.5 cm long cultivar with a 6.9 cm root diameter. It developed 9.6 roots per plant with an average of 3.3 kg/plant.

Mico: a productive cultivar with variable starch content and an 18 months cycle. Characteristics: young stem with red coloration. Roots covered with a dark film; intense ramification and low dry matter content. Normal root aspect and easy to harvest. Pulp coloration goes from white to light beige, high acid cyanic content. A one-cycle root productivity can reach up to 28 t/ha with 27% of starch. A two-cycle root productivity can reach up to 53 t/ha with 32% of starch. This cultivar is susceptible to a great number of diseases and root putrescence. Grows in sand and clay soils, during one to two culture cycles.

This experiment was carried out in October 23, 1998 in a soil where oat had been cultivated. The land was previously scarified (20 cm deep) and leveled without the use of any additional fertilization. The planting of the stem cuts was totally mechanized with the use of a Trevisan 3 lines, model RT - 1. Stem cuts were 20 cm long and planted 8 cm deep. The distance between the lines was 0.90 m and between plants was

0.85 m. The total experimental area was 2065.50 m² and treatments were disposed in a completely randomized design with four repetitions. The experimental unit had 112 plants and was 16 m² in size. Samples (two plants per replication) corresponding to four 30 - day periods (seventh, eighth, ninth and tenth month) were taken.

Three kg of roots were collected from the samples which were used for the starch content evaluation using the specific weight method or the Hydrostatic Balance Method for recently picked roots (Grossman and Freitas, 1950). A 1020 Marte scale was used, with capacity for 21100 g, and with an 1 g of precision.

Starch content data were submitted to an analysis of variance in a split plot design. Cultivars were considered as plots and harvesting times as sub-plots according to the procedure described by Gomez and Gomez (1987).

To verify cultivar starch content tendency along the four periods, a simple linear regression analysis was used. A functional relationship was established between the "starch content (Y)" dependent variable and the "number of months after planting" (X) independent variable, represented by the equation:

$$Y = a + bX$$

where:

- a: is the intercept of the regression line on the Y axis.
- b: is the linear regression coefficient representing the amount of Y changes in each X unity.

A t-test (t_b) was used to check if the tendency shown in the regression coefficient (b) was different from zero. This test indicates that if the tendency is not significantly different from zero, the starch content/tenor (%) was stabilized in the period evaluated. On the other hand, a significant t-test will indicate that a growing tendency exists in the starch content (%) during the evaluations.

The regression analysis and the test of (t_b) were calculated according to Gomez and Gomez (1987).

Linear regression comparisons regarding the coefficient (b_i) regression and the intercept of the line on the Y axis (a_i) were made in the Fibra and Mico cultivars, according to Snedecor and Cochran (1982) and Gomez and Gomez (1987).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences in starch content among the cultivars and the harvesting periods studied (table is not shown). The results also showed that the effects of the cultivars and the harvesting periods were independent. Cultivar x period source of interaction variation was not significant. The Duncan test for comparing averages was applied directly to the cultivars and period averages (Table 1).

Starch content (%) harvesting results in six cassava cultivars developed along the harvesting periods are shown in Table 1.

Cultivar starch content averages during the four harvesting periods varied from 25.0% to 29.7% while the starch content variation interval among harvesting periods was smaller, varying from 27.7 to 28.3%. According to starch content percentiles, the cultivars studied can be classified from the richest to the least rich as follows: Fécula branca, Olho junto and Fibra, Verdinha and Espeto and Mico.

As for the harvesting periods, the Duncan test revealed that, on average, greater starch content was found during the two first harvesting periods rather than the last two harvesting periods. However, this difference, although significant, was relatively low in magnitude. This suggests that early harvesting, in the cultivars studied, is possible without affecting starch content.

Ternes et al. (1981), found out in experiments with the Mico and Casca Roxa cultivars that the Mico cultivar developed 27.7%, 30.4%, 30.0% and 30.4% of starch content from the 7th to the 10th month of planting, during one to two development cycles and a biweekly starch content evaluation. Evaluation was conducted by the Lane-Eynon (1970) method using previous inversion in the chemical analysis of starch by-products. The total starch content average obtained

by Ternes et al. (1981), went up to 29.6%, however, any comparison between this value and that obtained by the present work (Mico = 25.0%) must be analyzed with some restrictions since the evaluation methods used were different.

Starch content was also evaluated by Schiocchet and Ternes (1996) from the 7th to the 10th month of harvesting in the years 1988/89. The Hydrostatic Balance demonstrated 27.5%; 26.5%; 25.1% and 25.3% of starch content in the Mico cultivar, with a 26.1% average.

This average can be compared with the 25.0% average obtained by the present study. Both studies were conducted at the same planting time and the starch content (%) were evaluated by the same Hydrostatic Balance Method. In addition, the Mico cultivar presented the lowest starch content (%) average value in both experiments.

It is known that the starch content concentration in the cassava roots, for being a variable characteristic, is different in each cultivar, however, this concentration inside the same cultivar is influenced by the culture practices and also by the environment.

Andrade (1989), in two repeated crops, in 1980 and in 1982, found the greatest starch content at 9 months after planting (29.3% and 31.7%, respectively) for cultivars Mantiqueira and IAC 7-127. A less variable starch content (%) performance was found in Bueno's works (1989), where 12 cultivars were evaluated during two harvesting times (12 and 18 months). Starch content at 18 months after the planting was smaller than the content observed at 12 months. Several cultivars such as Brava, Isabela de Souza, Canela de Urubu and Cigana presented stable starch content, while others such as Gigante, PI-86 and PI-90 showed a decrease in starch content at 18 months after planting.

Small changes were found in the starch content

Table 1. Starch content (%) in six cassava cultivars evaluated during four harvesting times in Marechal Cândido Rondon PR., 1999.

Harvesting periods	Fécula Branca	Olho Junto	Fibra	Verdinha	Espeto	Mico	Averages (time) ^{1/}
7 months	29.2	28.9	28.8	27.7	27.1	24.4	28.3 A
8 months	29.5	29.1	28.9	27.7	26.9	24.8	28.2 A
9 months	30.3	29.5	29.2	27.9	27.1	25.1	27.8 B
10 months	29.8	28.8	29.4	27.9	28.3	25.6	27.7 B
Averages (starch)^{1/}	29.7 a	29.1 b	29.1 b	27.8 se	27.4 c	25.0 d	

^{1/} Means followed by the same letter in the rows and the columns is not significant different by the Duncan test.

percentiles in the cultivars studied, along the four harvesting times (Table 1). The analysis of variance for each cultivar regression regarding starch content (Y) and the number of months per harvesting time revealed a linear relationship among these variables in cultivars Fibra and Mico. The t_b test confirmed the results of the variance analysis, and only the regression coefficients (b) for Fibra and Mico were significantly different from zero. The absence of significance in the regression coefficients in Fécula Branca, Olho Junto, Verdinha and Espeto reveals a constancy in starch content between the seventh and the tenth month after planting (Table 2).

The starch content (%) development in the Fibra and Mico cultivars, differently from the Fécula Branca, Olho Junto, Verdinha and Espeto, showed an increase in the starch accumulation percentage along the four harvesting times. A t-test regression analysis of the Fibra and Mico cultivars demonstrated that the inclinations of the regression straight line were significantly different from zero at 1% level of probability.

The starch content increase tendency (%) showed by cultivars Mico and Fibra, in the studied period, was also verified by Sarmiento (1997) who obtained, at the tenth month after planting, 29.5% of starch content from the Mico and 29.7% from the Fibra. The highest index of reserve accumulation (29.6%) was found at 12 months in the Mico cultivar and 31.4%, at the 20th month, in the Fibra cultivar.

A test for comparing regression lines (Snedecor and Cochran, 1982) was used to find out whether the increase tendencies (coefficients of regression bi) found in the Fibra and Mico cultivars were significantly different. The test showed highly significant differences in starch content development among these cultivars along the four harvesting times. Cultivar Mico showed a stronger tendency to

increment starch content ($b = 0.39$) against the less pronounced tendency ($b = 0.21$) found in cultivar Fibra. It seems that cultivar Mico is influenced negatively by the cold months, recovering gradually with the increase of temperature in the months of July and August.

Seib (1991), in an experiment conducted in Marechal Cândido Rondon, reported that, with the low temperatures registered in June and July of 1990, the fall of the leaves and, consequently, ending the vegetative cycle of the plant, caused a decrease in starch content.

Ternes et al. (1981), in a study on starch content variation in the cassava grown in the Upper Itajaí River valley and also in the Southern Coast of Santa Catarina, showed significant differences for the variable number of harvesting times. In the second cycle there was a decline in productivity and starch content in Mico, which reached an average of 26.0%. They stressed that not only age and culture should be taken in consideration during a starch content evaluation but also the cultural practices and the influence of the atmosphere, namely rain and temperature.

CONCLUSIONS

The starch content percentile of Fécula Branca, Olho Junto, Verdinha and Espeto, was stable (%), from the 7th to the 10th month after planting while Fibra and Mico showed an increase in starch content (%), although with different tendencies.

From the three cultivars with the higher starch content (Fécula Branca, Olho Junto and Fibra), Fibra was the only one that showed an increase in starch content (%), from the 7th to the 10th month after planting.

Table 2. t_b test for the regression line inclination comparison in six cassava cultivars.

Cultivar	Regression Equation $Y = a + bX$	t_b	Tabular t values	
			(2 gl; 0,05)	(2 gl; 0,01)
Fécula Branca	$27.44 + 0.26X$	2.05 ^{ns}	4.30	9.92
Olho Junto	$28.99 + 0.01X$	0.08 ^{ns}	4.30	9.92
Fibra	$27.29 + 0.21X$	11.23 ^{1/}	4.30	9.92
Verdinha	$27.12 + 0.08X$	4.0 ^{ns}	4.30	9.92
Espeto	$24.12 + 0.38X$	2.38 ^{ns}	4.30	9.92
Mico	$21.66 + 0.39X$	20.86 ^{1/}	4.30	9.92

ns: not significant. ^{1/} significant at 1% level.

RESUMO

Variação do teor de amido de cultivares de mandioca sob quatro épocas de colheita em Marechal Cândido Rondon, Brasil

O amido é o componente mais importante da mandioca, com inúmeras aplicações na indústria. Este trabalho objetivou avaliar a variação do teor de amido (%) das cultivares, Fécula Branca, Olho Junto, Fibra, Verdinha, Espeto e Mico. O plantio foi em outubro de 1998 em Marechal Cândido Rondon, Brasil. As cultivares foram amostradas em quatro épocas entre o 7º e 10º mês de idade. O teor de amido (%) foi calculada pelo método da balança hidrostática. Os cultivares, Fécula Branca, Olho Junto e Fibra, apresentaram os maiores teores de amido 29.7 %, 29.1 % e 29.1 % respectivamente. O cultivar Mico apresentou o menor desempenho no acúmulo de amido, 25.0 %. Quanto ao perfil do teor de amido, ao longo das épocas estudadas, verificou-se que as cultivares Fécula Branca, Olho Junto, Verdinha e Espeto permaneceram estáveis, enquanto que os cultivares Fibra e Mico mostraram tendência crescente.

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