Available online at www.sciencedirect.com
SCIENCE DIRECT®

Carbohydrate Polymers 54 (2003) 385–388

Carbohydrate Polymers

www.elsevier.com/locate/carbpol

Short communication

New starches for the food industry: *Curcuma longa* and *Curcuma zedoaria*

Magali Leonel[a,*], Silene B.S. Sarmento[b], Marney P. Cereda[a]

[a]*Centro de Raizes e Amidos Tropicais (CERAT)/UNESP, CP 237, Botucatu, SP, Brazil*
[b]*ESALQ/USP, Piracicaba, SP, Brazil*

Received 30 September 2002; accepted 20 June 2003

Abstract

The evolution of the food sector has increased interest in the identification of new starches with distinct properties. *Curcuma longa* and *Curcuma zedoaria* rhizomes, which are already used in industry to obtain food coloring and pharmaceutical products, may become commercially interesting as starch raw materials. This work aimed to characterize the starch of two *Curcuma* species. The results revealed that the rhizomes of two species showed low dry matter and high starch contents. The amylose contents of the starches (22% *C. longa* and 21% *C. zedoaria*) were similar to potato starch. The results of microscopic analysis showed flat triangular shape and the size was 20–30 μm for two starches. The final viscosity of *C. longa* was high (740 RVU) and the pasting temperature was 81 °C. In *C. zedoaria* the final viscosity was 427 RVU and the pasting temperature was 78 °C. These results differed from standard commercially used natural starches.

Keywords: Starch; Viscosity; Microscopy

1. Introduction

Food industry needs have become more complex with the processing of more elaborate dishes; this is forcing the starch sector to search for new products to meet new consumer and processor market demands. Modified starches are an alternative which have been used for sometime, however, the possibility of introducing new starch raw material sources with industrially interesting characteristics, has been attracting the attention of industrialists as it could influence the world market.

Common turmeric (*Curcuma longa*) has been used as a condiment for thousands of years. Its starch has not been widely used by industry, as its extraction is still considered secondary. The rhizomes are dried and ground and 2.5–5% essential oil, 2–8% curcumin, and 25–70% starch are extracted from the powder (He, Lin, Lian, & Lindenmaier, 1998; Scartezzini & Speroni, 2000). *C. zedoaria* is also commonly used in medicine but with high starch content (Matsuda, Morikawa, Ninomiya, & Yoshikawa, 2001).

The objective of this work was to evaluate the two *Curcuma* species already used as aromatic and medicinal plants as potential raw materials for food industry starches.

2. Materials and methods

Curcuma species were cultivated at CERAT, 22°5′47″ S, 48°25′12″ W, 810 m, where the climate is temperate with wet winter. The soil is a clay textured latosoil. The rhizomes were collected when the plants were 10 months old.

In the process for starch extraction, the rhizomes washed were extracted with two volumes water in an industrial liquefier and passed through a 60 mesh sieve. The residue was washed three times with two volumes of water. The combined were passed through a 200 mesh sieve and left to stand for 2 h and the supernatant liquid was decanted. The solids were washed three times and dried at 35 °C.

The rhizomes and extracted purified starch were characterized for pH, titrable acidity, ashes, total sugars, fibers, fat content, and protein (AOAC, 1980). The starch content was determined by the method of Rickard and Behn (1987). Amylose content in starch was determined as described by Willians, Kuzina and Hlynka (1970).

* Corresponding author.
E-mail addresses: pesq1cerat@fca.unesp.br (M. Leonel), sbssarme@carpa.ciagri.usp.br (S.B.S. Sarmento).

0144-8617/03/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S0144-8617(03)00179-6

For SEM analysis, starch samples were suspended in 10 parts (w/v) of ethanol, and two drops of this suspension were placed in the 'stubs'. Samples were then covered with 10 mm MED-010 metalized gold (BALZERS) and analyzed for starch granule shape and size using a 515 Phillips SEM at 12 kV. The size determination was made in Image System Analyzer (KS300-ZEISS)(Leonel & Cereda, 2000).

Apparent viscosity was measured using a Rapid Visco Analyser in suspensions of 2.5 g of starch in 25 ml water, corrected for 14% moisture. The procedure used was: 50 °C for 1 min, heating to 95 °C at 6 °C/min, maintained for 5 min, and cooling to 50 °C at 6 °C/min. Viscosity was expressed in RVU. The following parameters were taken from the graph: pasting temperature (the start of viscosity increase), maximum viscosity (peak), viscosity breakdown (difference between maximum viscosity and paste kept at 95 °C for 5 min), final viscosity, and retrogradation tendency (difference between final viscosity and paste at 95 °C for 5 min).

3. Results and discussion

The rhizomes showed low dry matter content and the main component was starch, 47.0% in *C. longa* and 57.7% in *C. zedoaria* (dry basis).They also showed considerable protein and ash content (Table 1).

The characterization of starches showed that these are within the limits established by Brazilian law (Brasil, 1978) (Table 2).

Two *Curcuma* species had similar amylose content. Their mean amylose content was higher than that found in cassava starch, 15–17% (Rickard, Asaoka, & Blanshard, 1991), and similar to potato starch, 20% (Ciacco & Cruz, 1982).

SEM showed that the starches granules were predominantly triangular, with visible thickness and varying granule size (Figs. 1 and 2), and with no differences between the species. Granule shape and size are a characteristic of the plant; they define mesh size for extraction and purification sieves and may influence the industrial application.

Table 1
Analysis of *C. longa* and *C. zedoaria* rhizomes

Analysis (%)	*C. longa*	*C. zedoaria*
Moisture	81.23 ± 0.47	84.71 ± 0.37
Ash	2.01 ± 0.03	1.86 ± 0.02
Fat	0.91 ± 0.02	0.43 ± 0.04
Protein	2.03 ± 0.04	1.51 ± 0.02
Starch	8.83 ± 0.27	8.82 ± 0.17
Fibre	1.77 ± 0.08	1.07 ± 0.10
Total sugars	2.01 ± 0.01	0.64 ± 0.02
pH	6.54 ± 0.04	6.11 ± 0.04
Acidity (ml 1N NaOH/100 g)	10.95 ± 0.19	11.18 ± 0.05

Table 2
Analysis of *Curcuma* starches

Analysis (%)	*C. longa*	*C. zedoaria*
Moisture	9.65 ± 0.40	8.82 ± 0.33
Ash	0.32 ± 0.02	0.33 ± 0.02
Fat	0.04 ± 0.01	0.03 ± 0.01
Protein	0.46 ± 0.03	0.52 ± 0.02
Starch	86.62 ± 1.15	86.84 ± 0.67
Fibre	0.05 ± 0.00	0.37 ± 0.02
Total sugars	0.25 ± 0.01	0.24 ± 0.01
Amylose (%)	22.32 ± 0.20	20.53 ± 0.63
pH	7.08 ± 0.01	7.55 ± 0.01
Acidity (ml 1N NaOH/100 g)	2.35 ± 0.04	1.39 ± 0.01

In *C. longa* starch, the predominant granule sizes were 20–25 μm and, for *C. zedoaria*, 20–30 μm (Figs. 3 and 4).

Viscosity profiles of *C. longa* and *C. zedoaria* starches (Fig. 5) were closer to corn and wheat than to other tubers

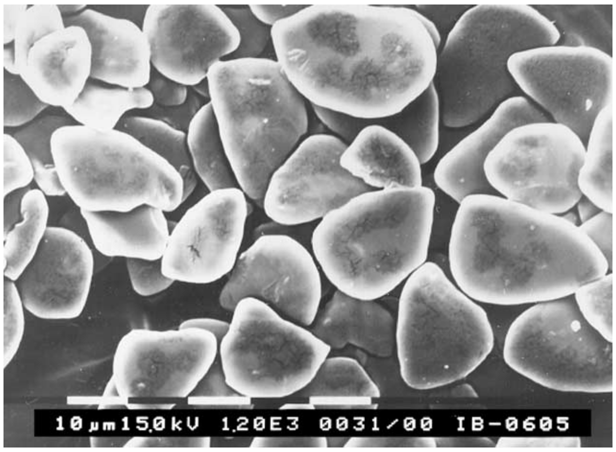

Fig. 1. Starch granules of *Curcuma longa*.

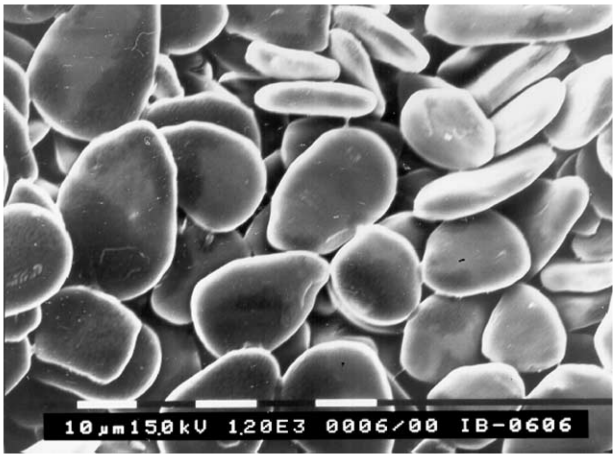

Fig. 2. Starch granules of *Curcuma zedoaria*.

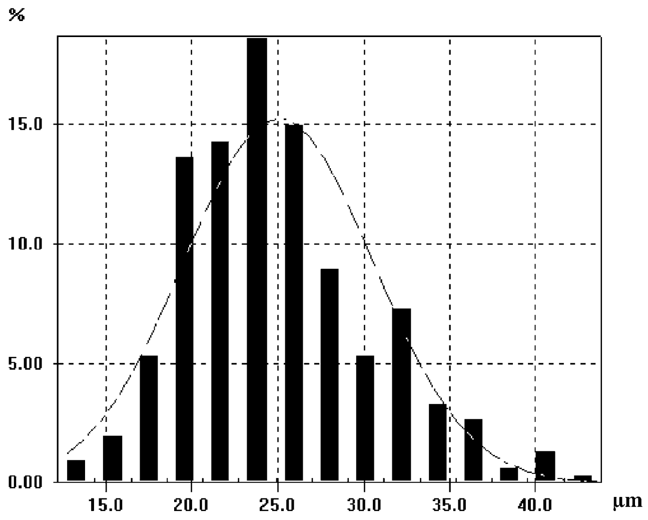

Fig. 3. Size distribution of *C. longa* granules starch (diameter µm).

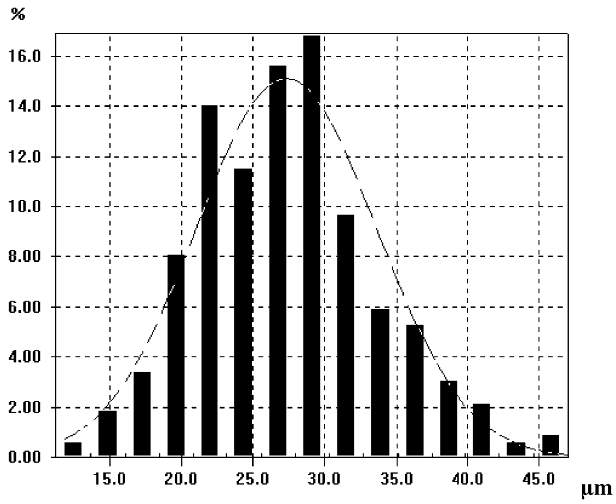

Fig. 4. Size distribution of *C. zedoaria* granules starch (diameter µm).

such as potato and cassava, the conventional starch sources. These similarities are mainly a less marked post peak decrease in viscosity and a high tendency towards re-crystallization. Viscosity values, however, are much higher than wheat and corn.

Differences in viscosity curve shape can be seen between *C. longa* and *C. zedoaria* starches. These can also be seen by the critical point values in Table 3.

C. longa starch showed higher viscosity values than *C. zedoaria*, with higher pasting temperatures, and a longer time to reach peak viscosity; breakdown, however, was lower.

Curcuma starches showed higher starting pasting temperatures than cassava (58–70 °C; Sarmento,1997), and potato starch (60–64 °C; Madsen & Christensen, 1996). They were similar to yam (74–86 °C), and cocoyam (75–80.2 °C; Rasper, 1969).

Viscosity peaks of *Curcuma* starches were lower than potato (764 RVU; Haase, Mintus, & Weipert, 1995), but higher than cassava starch (213 RVU; Garcia, 1996). *Curcuma* starches showed low post peak viscosity breakdown, especially *C. longa* showing starch paste stability with hot agitation. At the end of the procedure, *Curcuma* starch viscosities were reasonably high due to their strong retrogradation tendencies. Haase et al. (1995) reported a final viscosity of 232 RVU for potato starch, much lower than *Curcuma*. Retrogradation tendencies of *Curcuma* starches were higher than those of potato starch (49 RVU; Haase et al., 1995) and cassava (40 RVU; Garcia, 1996).

4. Conclusions

These *Curcuma* species maybe considered as starch sources of commercial interest having high starch content

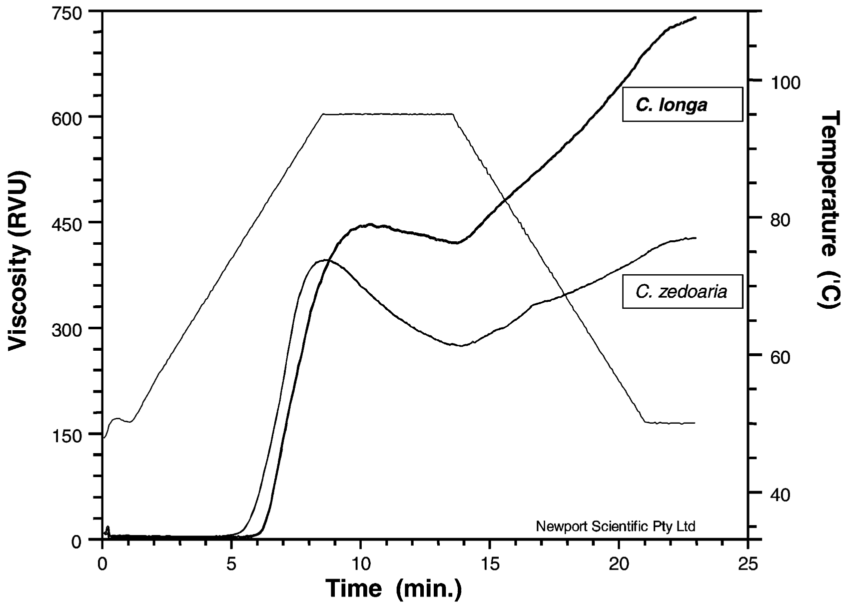

Fig. 5. Viscosity curves (RVA) for *C. longa* and *C. zedoaria* starches.

Table 3
Viscosity curve characteristics of *Curcuma* starches

	C. longa	*C. zedoaria*
Viscosity peak (RVU[a])	446.3	395.6
Breakdown (RVU)	26.5	121.6
Final viscosity (RVU)	739.8	427.2
Setback (RVU)	320.0	153.2
Pasting temperature (°C)	81.0	77.6
Peak time (min)	10.3	8.6

[a] RVU, rapid visco units.

and especially a particular viscosity characteristic, a determining parameter for their possible uses. Compared to starches from traditional commercial raw materials, *Curcuma* starches show a characteristic grain profile, but with higher viscosity values. The viscosity profiles showed that these *Curcuma* starches have high thickening and gelling properties, and high stability when agitated.

References

AOAC (1980). *Official methods of analysis* (13th ed.), Washington, DC.

Brasil Decreto no 12.486 (1978). *Normas técnicas especiais relativas a alimentos e bebidas* (p. 20). Diário Oficial do Estado de São Paulo.

Ciacco, C. F., & Cruz, R. (1982). *Fabricação do amido e sua utilização*. São Paulo: Secretaria da indústria, comércio, ciência e tecnologia, 152p.

Garcia, V. (1996). *Transitions thermiques de l'amidon de manioc em milleux peu hidrates*. Paris: Insitute Nacional Agronomique de Paris, 175p.

Haase, N. U., Mintus, T., & Weipert, D. (1995). Viscosity measurements of potato starch paste with the rapid visco analyzer. *Starch/Stärke*, *47*(4), 123–126.

He, X. G., Lin, L. Z., Lian, L. Z., & Lindenmaier, M. (1998). Liquid cromathography-electrospray mass spectrometric analysis of curcuminoids and sesquiterpenoids in tumeric (*Curcuma longa*). *Journal of Cromathography A*, *888*, 127–132.

Leonel, M., & Cereda, M. P. (2000). Avaliação da concentração de pectinase no processo de hidrólise-sacarificação do farelo de mandioca para obtenção de etanol. *Ciência e Tecnologia de Alimentos*, *20*, 220–227.

Madsen, M. H., & Christensen, D. H. (1996). Changes in viscosity properties of potato starch during growth. *Starch/Stärke*, *48*, 245–249.

Matsuda, H., Morikawa, T., Ninomiya, K., & Yoshikawa, M. (2001). Hepatoprotective constituintes from zedoariae rizoma: absolute stereostructures of three new carabrane-type sesquiterpenes, curcumenolactones A, B, and C. *Biorganic and Medicinal Chemistry*, *9*, 909–916.

Rasper, V. (1969). Investigations of starches from major starch crops grown in Chana II. Swelling and solubility pattern: amylolitic susceptibility. *Journal of the Science of Food and Agriculture*, *20*, 642.

Rickard, J. E., & Behn, K. R. (1987). Evaluation of acid and enzyme hydrolitic methods for determination of cassava starch. *Journal of the Science of Food and Agriculture*, *41*, 373–379.

Rickard, J. E., Asaoka, M., & Blanshard, J. M. V. (1991). The physicochemical properties of cassava starch. *Tropical Science*, *31*, 189–207.

Sarmento, S. B. S (1997). *Caracterização do amido de mandioca (Manihot esculenta C.) no período de colheita de cultivares de uso industrial* (162p). PhD Thesis, University of São Paulo, São Paulo.

Scartezzini, P., & Speroni, E. (2000). Review on some plants of Indian traditional medicine with antioxidant activity. *Journal of Ethnopharmacology*, *71*, 23–43.

Williams, P. C., Kuzina, F. D., & Hlynka, I. (1970). A rapid colorimetric method for estimating the amylose content of starches and flours. *Cereal Chemistry*, *47*(4).