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Monteiro Soares de OLIVEIRA, Eliana; Dutra de RESENDE, Eder
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Original

Yield of albedo flour and pectin content in the rind of yellow passion fruit

Rendimento de farinha do albedo e conteúdo de pectina da casca do maracujá-amarelo

Eliana Monteiro Soares de OLIVEIRA[1], Eder Dutra de RESENDE[1*]

Abstract

In this study, it was evaluated the influence of different shapes, sizes, and maturation stages on the yield of albedo flour and pectin content of yellow passion fruit rinds. Random samples of 40 fruits were used, and the data were compared using significance intervals at 5%. Weight, skin color, fruit size and shape, pulp yield, mesocarp thickness, amount of epicarp and mesocarp, moisture content, and pectin yield were determined. The maturation stages were defined according to measurements of the yellow color of the skin. The shape and size patterns were defined according to the length/width ratio (equatorial diameter) of fruits. It was found that the epicarp thickness was not correlated to fruit shape and size, but it was thicker in ripe fruits. The mesocarp was thiner in small ripe fruits, but it did not change with fruit shape. Pulp yield was higher in ripe fruits, and it was not influenced by shape and size of fruits. It was concluded that the content of albedo flour can account for 3.9% of the weight of processed fruits, whereas the amount of pectin powder can account for up to 0.9% of the fruit weight.
Keywords: *Passiflora edulis; waste yield; fruit size; fruit shape; maturation stages.*

Resumo

Neste trabalho, avaliou-se a influência de diferentes formatos, tamanhos e estádios de maturação dos frutos sobre o rendimento de farinha do albedo e o conteúdo de pectina da casca do maracujá-amarelo. Utilizaram-se amostragens aleatórias de 40 frutos e os resultados foram comparados por intervalos de confiança com 5% de significância. Foram determinadas as características de massa, coloração da casca, tamanho e formato do fruto, rendimento de polpa, espessura do mesocarpo, quantidade de epicarpo e mesocarpo, além da determinação do conteúdo de umidade e rendimento de pectina. Os estágios de maturação foram padronizados por medidas da quantidade de cor amarela na casca. O tamanho e o formato foram padronizados pala igualdade de comprimento e largura equatorial dos frutos. Foi encontrado que a quantidade de epicarpo não sofreu influência do tamanho e do formato dos frutos; essa quantidade de epicarpo mostrou-se, contudo, maior nos frutos maduros. A quantidade de mesocarpo foi inferior nos frutos maduros e menores, mas não se alterou com o formato. O rendimento de polpa foi maior nos frutos maduros, mas não foi influenciado pelo formato e pelo tamanho. Concluiu-se que a quantidade de farinha do albedo alcança 3,9% do peso dos frutos processados na indústria, ao passo que a quantidade de pectina desidratada rende até 0,9%.
Palavras-chave: *Passiflora edulis; rendimento de resíduos; tamanho do fruto; formato do fruto; estádios de maturação.*

1 Introduction

According to Brazilian Institute of Geography and Statistics (INSTITUTO…, 2009), the production of yellow passion fruit in Brazil reaches 664,286 t in an area of 46,866 ha with the average production yield of 14,174 kg.ha^{-1}. The major producer states are Bahia, Espírito Santo, São Paulo, Minas Gerais, Sergipe, and Rio de Janeiro. Approximately 60% of the total production of yellow passion fruits is used by consumers of fresh fruits in addition to supermarkets, free markets, and retailers (ROSSI, 2001).

Passion fruit is generally appreciated because of its especial taste and flavor as well as its vitamins and minerals content (SANDI et al., 2003). The main economic importance of this fruit is related to concentrated juice processing, but other products can be prepared using the pulp in confectionaries for the production of preserves, nectars, syrups, sorbets, and other jellied products (MELETTI; MOLINA, 1999).

According to Haendler (1965), the yellow passion fruits must have at least 33.0% of juice yield to be processed in the industry. The amount of waste reaches approximately 67.0% of the raw material used in the juice processing, and it is composed of 55.0% of rinds and 12.0% of seeds and arils (COELHO, 2008). Thus, the use of new technologies to add value to these by-products promotes economic gain to the productive chain and avoids environmental issues for the industry (FERRARI; COLOSSI; AYUB, 2004).

Functional compounds occurring in wastes have motivated its utilization as a nutritional source to sustain human health (MATSUURA, 2005). Fruit processing generates wastes that are rich in pectin, a compound that presents gelificant properties useful in the food industry and is commercially extracted from orange, lemon, and apple peel (OLIVEIRA et al., 2002). Other applications include the utilization of dried rinds to serve as animal chow, raw material to produce snacks, and as a source of fiber to enrich juices and yogurts (SANTANA, 2005).

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[1] *Laboratório de Tecnologia de Alimentos, Centro de Ciências e Tecnologias Agropecuárias, Universidade Estadual do Norte Fluminense Darcy Ribeiro – UENF, Av. Alberto Lamego, 2000, Parque Califórnia, CEP 28013-602, Campos dos Goytacazes, RJ, Brasil, e-mail: eresende@uenf.br*
**Corresponding author*

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According to Matsuura (2005), the yellow passion fruit rind albedo presents a moiture content of 90.8%, pH of 4.4, soluble solids content of 4.7 °Brix, and titratable acidity of 0.3% (citric acid). The centesimal composition analysis indicated a high level of fibers (67.5% dry basis) and considerable amount of protein (6.8% dry basis) and minerals such as potassium (25.5 mg.100 g^{-1} dry basis), iron (0.5 mg.100 g^{-1} dry basis), sodium (19.1 mg.100 g^{-1} dry basis), and calcium (14.6 mg.100 g^{-1} dry basis), as well as a high level of pectin (27.8% dry basis).

The main fibers found in the yellow passion fruit rind albedo are soluble and thus can be used to enrich foods in a dietary meal. The content of calcium (28.4 mg.100 g^{-1}) and sodium (51.7 mg.100 g^{-1}) in the rind is higher than that of the fruit pulp. It also presents a significant content of iron (1.5 mg.100 g^{-1}) enabling its utilization as mineral source (CÓRDOVA et al., 2005).

New products were successfully developed to make viable the use of passion fruit rinds in products such as cereal bars (MATSUURA, 2005), fiber enriched cakes (SANTOS, 2008), snacks (LEORO, 2007), and candies (OLIVEIRA et al., 2002).

The pectin extracted from the fruit rind albedo has been widely used in the food industry as a gelificant substance used to produce candy, jam, and jelly, or to be applied as a thickening agent (GOMES, 2004; YAPO; KOFFI, 2006; CAMARGO et al., 2007).

Dried rind flour has been produced and commercialized as a dietary supplement capable to regulate the levels of glucose and cholesterol in human blood (RAMOS; PEREIRA, 2004; RAMOS et al., 2007; MEDEIROS et al., 2009). The storage of this flour requires water activity of 0.25 to 0.35, which corresponds to a moiture content lower than 5.3%wb, necessary to guarantee product safety and quality (OLIVEIRA et al., 2006).

Considering the amount of waste generated during the juice extraction of yellow passion fruits and the wide range of applications of this fruit rind albedo, the content of albedo obtained in the processing of fruits of different shapes, sizes, and maturation stages frequently used in industries was evaluated. The content of pectin in the fruit rind albedo and the moisture content were measured as a function of maturation stages aiming to determine the amount of pectin and dried albedo flour expected for the total weight of fruits processed in industries.

2 Materials and methods

2.1 Raw material

Yellow passion fruits (*Passiflora edulis* Sims) were harvested from a commercial orchard located in Campos dos Goytacazes (RJ) during November and December 2008 and January, 2009. The weather in this season is characterized by temperatures of 23.9 ± 0.8 °C, relative humidity of 84.9 ± 1.0%, and precipitation of 339.0 ± 182.4 mm. The fruits were harvested in the morning and were taken to the laboratory where they were washed with tap water, immersed in cold distillated water, and dried with paper towel. They were stored in a cold room at 12 °C and 90%RH until processing.

The fruits were randomly selected at the orchard taking into account a pattern of length (L) and width (W): the 40 fruits selected had the same L/W ratio. Big ripe fruits of different shapes (oval and round) and different sizes for the oval ripe fruits (big and small) were selected. In addition, big oval fruits at three different maturation stages defined as clear green fruits (clear green skin color), intermediate stage of maturity (light yellow skin color), and ripe fruits (totally yellow) were also evaluated.

2.2 Physical characterization of fruits

Physical measurements of fruits were done using a caliper, and the results were expressed in centimeters. The skin colour was determined using a Spectrophotometer (Hunterlab MiniScan XE Plus, USA) calibrated using the spectral reflectance of a black and white calibration tiles as the standard. A standard illuminant D65 and a 10° standard observer were used. The measurements were taken at two equidistant points on the equatorial zone of sun-exposed and non-exposed side of the fruit. The results were expressed as the amount of the skin yellowness (%) defined by the ratio of the change in the Hunter *b* parameter with respect to the total range of yellowness after complete fruit ripening, according to Silva et . (2008). The fruit mass was measured using a semi-analytical electronic balance (Gehaka, model BC 2000, Brazil) and the results were expressed in grams.

2.3 Quantitation of mesocarp (albedo) and epicarp (flavedo)

The epicarp was removed using a fruit peeler with peel thickness adjusted to approximately 0.1 cm. The residual material remaining on the fruit surface was taken off using a stainless steel knife. The mass of epicarp was measured considering the difference in weight between the peeled and unpeeled fruit, and the results were normalized to 100 g of fruit. The mesocarp thickness was measured at four equidistant points on the equatorial zone of the fruits, and the results were expressed in cm. The mesocarp measurements were taken after fruit slicing and pulp removing weighing both portions of the fruits in a semi-analytical electronic balance (Gehaka, model BG 2000, Brazil), and the results were normalized to 100 g of fruit. The rind albedo of each fruit was packed in plastic bags and stored in a freezer at −18 °C.

2.4 Production of rind albedo flour

Each sample of the rind albed was defrost under running tap water and were weighed and processed in a commercial blender (Arno, Brazil) with 400 mL of distilled water at low speed for 15 seconds. This material was filtered using a synthetic filter and placed in a tray dryer (Pardal, Brazil) at 50 °C with forced air circulation for 9 hours. After 15 minutes in a desiccator, this material was weighed in a semi-analytical electronic balance (Gehaka, model BG 2000, Brazil). The yield of the dry albedo was obtained by the difference between the initial and final weight of the material and normalized to 100 g.

The dry albedo was then processed in a commercial blender (Arno, Brazil) at high speed until fine particles of flour were obtained. This material was sieved through a 50 mesh sieve for the pectin analysis.

2.5 Moisture content of natural albedo and albedo flour

Approximately 6 g of the natural rind albedo was homogenized (Arno, Brazil) for moiture analysis, according to AOAC (ASSOCIATION…, 1994). The determinations were made in triplicates using 1 g of the sample that was weighed in aluminum foil dish using an analytical electronic balance (Gehaka, model AG 200). The samples were kept in a drying oven (Quimis, model 164, Brazil) at 105 °C for 48 hours. After 15 minutes in a desiccator, this material was weighed in an analytical electronic balance and the moisture content was calculated by the difference of the sample weight, and the results were normalized to 100 g.

To analyse the moisture of the flour, a mixture of albed flour from 4 different fruits was used, and 1 g of this mixture was used in the analysis performed in triplicates. This material was also used to determine the pectin content. Therefore, 10 repetitions of the analyses were performed at different maturation stages of the fruits.

2.6 Pectin content

The pectin content was determined as a function of the fruit maturation stage using a sample containing the rind albedo flour from 4 fruits and performing 10 repetitions in triplicates.

Pectin was extracted from the albedo flour according to Scabio et al. (2007) with adaptations. Approximately 1 g was placed into a Pyrex® glass flask and weighed in an analytical electronic balance (Gehaka, model AG 200) adding 10 mL of deionized water slowly. Then, it deionized water was added (solid:liquid ratio of 1:50 (w/v)) to promote suspension homogeneity. It was heated to 80 °C under stirring, and then it was mixed with 50 mL of a preheated (80 °C) nitric acid solution (0.1 $mol.L^{-1}$) and allowed to react for 40 minutes at 80 °C. The reaction was then interrupted by immersion in ice-cold water. After cooling, the residue was removed by filtering through a synthetic fabric filter, rinsed twice with 100 mL of deionized water, and the filtrate was stored overnight in a refrigerator.

The acid soluble pectin was precipitated by adding cold ethyl alcohol 92.8 °GL slowly to the suspension with constant stirring up to a proportion of 1:2 (v/v), and after 30 minutes, the flocculated material was removed by filtering through a synthetic fabric filter. The material containing the alcohol-insoluble substances was immersed in alcohol and stored overnight to remove traces of acids. Next, after filtering, it was dried at 45 °C under air forced circulation for 8 hours. The pectin powder was determined on dry weight basis using an analytical electronic balance (Gehaka, model AG 200), and the results were normalized to 100 g.

2.7 Experimental design and statistical analysis

A random sample of 40 fruits of two different sizes and shapes and at three different maturation stages were used. The sample was dimensioned for an infinite population of yellow passion fruits considering 95% of probability and 10% deviation around the sample media. The results were compared by confidence intervals applying the t-test at 5% level of significance.

3 Results and dicussion

3.1 Physical characterization of the fruits

Samples of 40 fruits were representative of an infinite population when used to determine the physical characteristics of yellow passion fruits, their pulp yield, the amount of mesocarp and epicarp, and moisture and pectin content of the albedo (OLIVEIRA, 2009).

According to grading standards established by CEAGESP (SÃO PAULO, 1992), the big fruits of oval or round shapes used in this study are classified as Extra 3A fruits. Those of small size weighing 145.8 g are classified as Extra A fruits (Table 1).

The shape patterns were established by the same ratio L/W of oval fruits of different sizes and maturation stages (Table 1). With regard to the evaluations of size and shape at the same ripening stage, the big oval ripe fruits presented the same yellowness indexes on the skin when compared to the big round ripe fruits, reaching the average of 87.8% of skin yellowness. However, small oval ripe fruits presented higher values of skin yellowness (92.4 ± 2.5%) than those of the big oval ripe fruits (84.6 ± 4.3%). According to Vianna-Silva et al. (2008a), yellow passion fruits reach an adequate harvest point when they show at least 60.0% of skin yellowness during the summer season maintaining its best quality after that. Therefore, small differences in skin color detected in ripe fruits do not change the quality and juice yield. However, fruits at intermediate maturation stage presented only 28.9 ± 3.9% of skin yellowness, which is considered an immature stage to harvest the fruit.

The total green fruits presented lower mass than that at the intermediate maturation stage because of their higher amount

Table 1. Measurements of mass, length (L), equatorial width (W), L/W ratio, and skin yellowness as a function of maturation stage, shape, and size of yellow passion fruits. Values in brackets represent confidence intervals at $p \leq 0.05$.

Patterns	Mass (g)	Length (cm)	Equatorial width (cm)	Ratio L/W	Skin yellowness (%)
Clear green oval big	255.8 (± 9.0)	10.4 (± 0.03)	8.3 (± 0.03)	1.25 (± 0.01)	0.0 (± 0.0)
Intermediate oval big	275.8 (± 8.4)	10.4 (± 0.03)	8.3 (± 0.03)	1.25 (± 0.01)	28.9 (± 3.9)
Ripe oval big	260.5 (± 9.1)	10.4 (± 0.03)	8.3 (± 0.03)	1.25 (± 0.01)	84.6 (± 4.3)
Ripe round big	227.0 (± 7.1)	8.2 (± 0.03)	8.2 (± 0.03)	1.00 (± 0.01)	91.0 (± 2.8)
Ripe oval small	145.8 (± 6.3)	8.3 (± 0.04)	6.6 (± 0.03)	1.26 (± 0.01)	92.4 (± 2.5)

of fiber-rich rinds and less amount of pulp and seeds. However, fruits of round shape were the lighter among big fruits due to smaller L/W ratio (Table 1) although still being considered Extra 3A type fruits according to CEAGESP grading. Fruits of smaller weight presenting the same L/W ratio were classified as Extra A fruits.

According to Farias et al. (2005), yellow passion fruits have such a high genetic diversity that leads to a large variation in the measurements of pulp and weight, varying from 92.0 g to 179.0 g, as well as of weight and rind thickness. The coefficient of variation are 22.7, 14.3, 13.2, and 11.5%, respectively. Investigating 20 passion fruit progenies, Nascimento et al. (2003) found an average fruit weight of 161.6 g with an average weight very close to that described by Machado et al. (2003). Fruits harvested in the summer season had higher size and weight than those harvested during the winter season. Negreiros et al. (2008) found that the oval shape of yellow passion fruits prevailed in more than 90% of 39 progenies with a ratio L/W varying from 0.98 to 1.14. These values were lower than those found by Farias et al. (2005) varying from 1.14 to 1.27.

3.2 Determination of epicarp (flavedo), mesocarp thickness, and albedo yield in fruits

The amount of epicarp in clear green fruits was the same as that found in fruits at intermediate maturation stage with an average of 8.4 ± 0.5%. For the ripe fruits, it was higher (11.0 ± 0.8%). The size and shape of the fruit did not influence the amount of epicarp in the fruits with an overall value of 11.0 ± 0.8% (Figure 1).

Measurements of mesocarp amount indicated a decrease during ripening in thefruit, and the highest value was found in clear green fruits (79.2 ± 2.4%) and the lowest value in ripe fruits (39.1 ± 2.5%). The fruit shape did not influence the mesocarp amount, and the average value for the round and oval fruits were 39.7 ± 2.4% (Figure 1). Thus, summing the mesocarp and the epicarp of big fruits of different shapes reach an average value of 50.7%. Considering the confidence intervals of the media, this results corroborate those found by Coelho (2008), which were 52.7% of rinds in big ripe fruits of 11.0 cm of length, 8.4 cm of equatorial width, and a L/W ratio of 1.31.

However, fruits of small size presented a lower amount of mesocarp (34.5 ± 2.1%); reaching 45.4% of rind weight (Figure 1), which is not in accordance with the results obtained by Coelho (2008), who found 66.0% of rind yield in small fruits, weighing 144.6 g and with a L/W ratio of 1.32. Such difference may have been influenced by the harvest season since the fruits used by Coelho (2008) were grown and harvested in the winter.

In a study with 39 progenies of yellow passion fruits, Negreiros et al. (2008) found an average of 61.0% of rind yield in fruits weighing an average of 80.4 g and weight range of 56.6 to 116.3 g. Nevertheless, Negreiros et al. (2007) found the value of 46.9% of rind yield in 42 progenies of yellow passion fruits presenting a weight range of 26.6 to 155.1 g and an average weight of 78.0 g.

With regard to the fruit pulp, it was observed an increase in the pulp yield of ripe fruits, reaching values of 50.0 ± 2.3% (Figure 1). The shape and size of the fruits did not influence the amount of pulp with an average value of 51.1 ± 2.3%. Negreiros et al. (2007) and Fortaleza et al. (2005) noted that the correlation between pulp yield and L/W ratio was not significant refuting the belief that oval fruits have more pulp. Investigating 39 progenies of yellow passion fruits harvested after natural abscission, Negreiros et al. (2008) found lower values of pulp yield, reaching values at the range of 39.6 to 45.8%. Higher values were observed by Costa et al. (2001), who found that the pulp yield varied from 45.7 to 53.2%, with an average of 49.7%.

According to Coelho (2008), bigger fruits produce higher pulp yield (47.3%) than that of smaller fruits with the same L/W ratio (1.31) presented in this study showing pulp yield of 33.5%. This is in contrast with the findings of the present study, in which no effect of the fruit size on the pulp yield was found (Figure 1). This may have been caused by the harvest season since in the study of Coelho (2008) the fruits were harvested in the winter, when there are lower temperatures and pluviometric precipitation.

Measurements of mesocarp thickness indicated higher values (1.2 ± 0.1 cm) in clear green fruits when compared to intermediate stage and ripe fruits, which presented an average of 0.4 cm (Figure 2), which is in agreement with the findings of Vianna-Silva et al. (2008b), in which the rind thickness of yellow passion fruits decreased in the beginning of the ripening. Considering the sum of the epicarp and mesocarp thickness (0.1 cm), the rind thickness of ripe fruits was smaller than the average rind thickness (0.7 cm) of 42 progenies of yellow passion fruits studied by Negreiros et al. (2007), which varied from 0.2 cm to 1.6 cm. However, the measurements of rind thickness was similar to those found by Fortaleza et al. (2005) in yellow passion fruits genotypes harvested after natural abscission, 0.5 cm. Nascimento et al. (2003) described measurements of

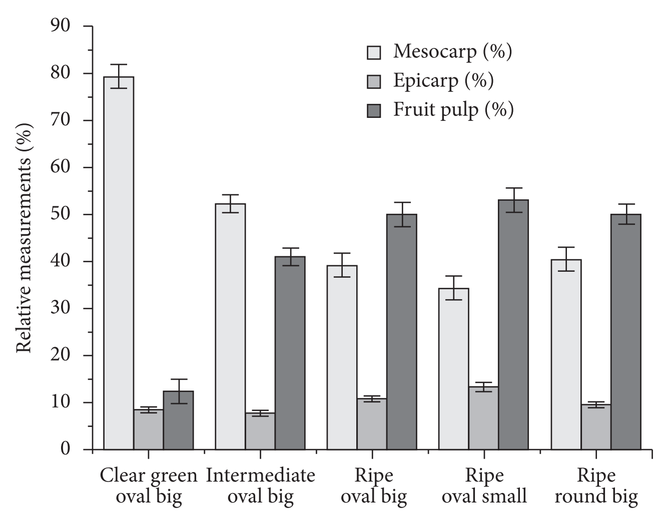

Figure 1. Amount of epicarp, mesocarp, and fruit pulp as a function of maturation stage, shape, and size of yellow passion fruits. Vertical bars are represented with confidence intervals at p ≤ 0.05.

rind thickness in progenies of passion fruits varying from 0.3 to 0.6 cm, with average of 0.5 cm.

According to Nascimento, Ramos and Menezes (1999), fruits harvested in seasons of low temperatures and low rainfall presented lower rind thickness than those harvested in a season of higher temperature and pluviometric precipitation. This behavior was credited to the water absorption capability of the rind that increases its thickness serving as an adequate water sink to be drained to the pulp. Silva et al. (2008) verified that fruits harvested during the summer season presented higher rind thickness, which was similar to that of the fruits harvested during the winter season as ripening progressed increasing the juice yield.

Fruits of different shapes presented the same mesocarp thickness, with an average value of 0.4 cm (Figure 2). Considering the sum of the epicarp and mesocarp thickness, the rind thickness reaches 0.5 cm, which is in agreement with the rind thickness measurements reported by Coelho (2008), an average of 0.5 cm.

With regard to fruit size, it was observed that small fruits had a smaller mesocarp thickness, with an average of 0.3 cm (Figure 2). The sum of the epicarp and mesocarp thickness, reached a higher value than those obtained by Coelho (2008) who found a rind thickness value of 0.3 cm in fruits with the same size pattern as those used in this study. This may be related to the harvest season since the fruits used in the present study were harvested during the summer season, when there are higher temperatures and intense pluviometric precipitation contributing to moisture retaining in the rind. Moreover, Coelho (2008) also found smaller values of rind thickness for smaller fruits reinforcing the direct relationship between fruit size and rind thickness.

3.3 Moisture content and pectin yield in the albedo and dried flour

Fruits of clear green and intermediate maturation stages presented the same moisture content in the mesocarp, with an average value of 93.2 ± 0.3% e 93.1 ± 0.6%, respectively (Figure 3). However, the moisture content in the mesocarp of ripe fruits was lower (91.1 ± 0.8%) indicating moisture loss with ripening. This result agrees with that found by Matsuura (2005) for ripe fruits (90.8%). Oliveira et al. (2002) obtained 88.4% of moisture in the mesocarp, in agreement with that result obtained by Córdova et al. (2005), 88.4%. According to Kliemann (2006), the yellow passion fruit rind containing flavedo presented 91.2% of moisture, whereas that without flavedo presented 91.6% of moisture.

The albedo flour from fruit rinds of fruits at the clear green and intermediate maturation stage had the same moisture content of that of the mesocarp , an average of 11.5 ± 0.8% and 13.0 ± 1.0%, respectively (Figure 3). Ripe fruits had a lower moisture content value (9.7 ± 0.6%). In fact, this was expected since all materials were kept in the dryer for the same amount of time (9 hours). According to National Agency for Sanitary Surveillance (ANVISA), the highest moisture content allowed in flours is 15.0% (BRASIL, 2005).

Santos (2008) obtained 11.3% of moisture for the mesocarp flour. He verified that the highest temperature used in the drying process of yellow passion fruit rind must be lower than 70 °C to preserve its sensorial quality and to avoid enzymatic browning.

The pectin yield in the albedo flour from fruit rinds at the three different maturation stages did not change its value with an average of 26.4 ± 1.5%db (Figure 3). These results are in contrast to those found by Reolon, Braga and Salibe (2009), who found 28.5% of pectin yield in albedo flour of green fruits, 24.8% in albedo flour of intermediate ripening fruits, and 20.7% in albedo flour of ripe fruits.

According to D'Addosio et al. (2005), measurements of pectin are influenced by the extraction agent, and thus the

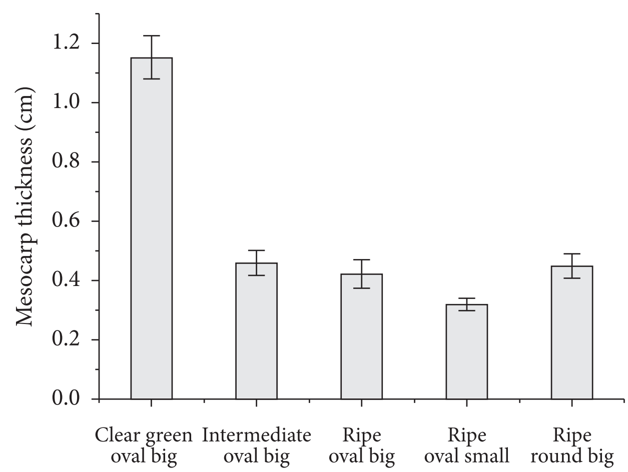

Figure 2. Mesocarp thickness as a function of maturation stage, shape, and size of yellow passion fruits. Vertical bars are represented with confidence intervals at $p \leq 0.05$.

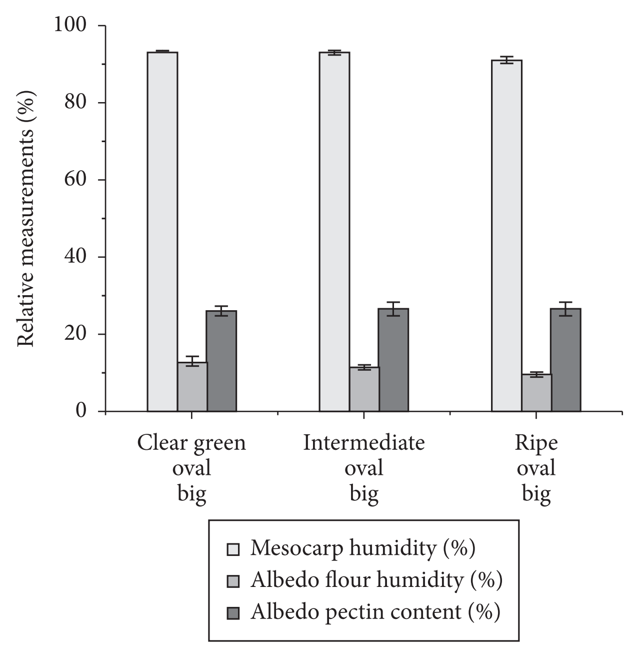

Figure 3. Moisture content and pectin yield of the albedo and dried flour as a function of maturation stages of yellow passion fruits. Vertical bars are represented with confidence intervals at $p \leq 0.05$.

procedure using HCl yielded 14.1, 12.4, and 11.1% for the albedo of fruit rinds at green, intermediate ripe, and ripe stages, respectively, but it did not differ among themselves. When using H_3PO_4 the authors found 15.9, 13.4, and 12.6%, respectively for the three maturation stages. However, when H_3PO_4-$(NaPO_3)_6$ was used, they obtained 13.4, 18.0, and 18.4% for the respective maturation stages. They stated that the pectin extracted from yellow passion fruit rinds is of great importance to the food industry due to the fast gelification and a good gelling property of the pectin gel.

The albedo pectin yield of yellow passion fruits can be considered one of the better sources of pectin. Fishman et al. (2000) found a pectin yield of 20.0% in dried orange albedo, but it can reach the highest values depending on the varieties and extraction methods (THAKUR; SINGH; HANDA, 1997). In lemon albedo, it reached the value of 22.9% (MENDONÇA et al., 2006). For dried mango rinds, Berardini et al. (2005) identified a pectin yield of 18.0%, and for apple pomace it reached 9 g/100 of dried pomace (around 15.0%), as observed by Scabio et al. (2007). The results of the present study are in agreement to those found by Matsuura (2005), who found a pectin yield of 27.8% in yellow passion fruit rinds. However, it was higher than the value described by Yapo and Koffi (2006), 19.0%.

4 Conclusions

The processing of ripe fruits with different shapes and sizes yields 10.9% of epicarp wastes in relation to the total fruit weight used in the yellow passion fruit juice industry. The fruits can produce less epicarp wastes (8.4%) when processed in greener stages. The amount of mesocarp (albedo) can reach the value of 39.1% of the total fruit weight when processing big ripe fruits with different shapes. For greener fruits, it can yield 79.2% of the total fruit weight, whereas for smaller ripe fruits, it yields less amount of albedo (34.5%). Ripe fruits of different shapes and sizes produce 50.0% of fruit pulp , which is drastically reduced in greener fruits.

The moisture content of the mesocarp of greener fruits is higher (93.2%wb) than that of in ripe fruits (91.1%wb). After the drying process at 45 °C for 9 hours, the albedo flour obtained from these fruits presents a moisture content of 12.2 and 9.7%, respectively. Therefore, after the processing of bigger ripe fruits, 3.9% of dried albed flour can be produced based on the weight of the fruits used by industries. Nevertheless, after the processing of smaller ripe fruits, it can be obtained, proportionally, 3.4% of dried albedo flour.

Alternatively, the rind albedo can be used to produce pectin powder since the fruit mesocarp contains 26.4% of pectin. In this case, after the processing of bigger ripe fruits, 0.9% of pectin powder can be produced in relation to the weight of pectin powder obtained from the weight of fruits used by industries. Nevertheless, after the processing of smaller ripe fruits, 0.8% of pectin powder can be produced proportionally.

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