Physical and chemical characterization of frozen mango pulps sold in Machado, Minas Gerais state, Brazil

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Abstract

The use of frozen fruit pulps has gained prominence in food trade, as it provides a convenient alternative with adequate nutritional characteristics. Thus, this study was developed in order to evaluate physical and chemical characteristics of frozen mango pulps sold in Machado, state of Minas Gerais, Brazil, to verify if the product complies with the identity and quality standard established by current Brazilian legislation. Four brands (A, B, C, and D) of frozen mango pulps were selected, with five replicates of each, from the same batch and expiration date. The following analyses were performed: color (L* value, hue angle, and chroma), pH, titratable acidity (g citric acid/100 g), soluble solids (°Brix), total solids (g/100 g), and ascorbic acid (mg/100 g). A higher L* value (lighter color) and chroma were identified for brand A when compared to the others. Meanwhile, the brand B pulp had the highest hue angle (88.98), close to 90°, corresponding to yellow. Results for titratable acidity, soluble solids, total solids, and ascorbic acid comply with those specified by the Brazilian legislation for frozen mango pulps—except for pH, which three of the four brands registered values below the permitted level. It was concluded that only one brand of frozen mango pulp sold in Machado complied with the standards specified by current legislation, while pH values lower than the permitted level were registered in the others.

Keywords: *Mangifera indica* L. Freezing. Identity and quality standard. Vitamin C.

Introduction

Mangos (*Mangifera indica* L.), known as queen of fruits, have an attractive flavor and aroma, as well as high nutritional value. Its pulp is a source of micronutrients, including calcium, phosphorus, iron, and vitamins A and C. Mango pulps contains 75 to 85 % water (LEBAKA et al., 2021). It is one of the most sought-after fruits worldwide, mainly consumed fresh, and can be processed into numerous products: plain pulp, juice, ice cream, jellies, jams, among others (FONSECA et al., 2006).

The frozen fruit pulp market is an excellent alternative to avoid waste and losses. It adds economic value to fruits and is promising for the food sector, as it enables the use of different pulp flavors, regardless of seasonality (COSTA et al., 2022).

According to current legislation, mango pulp is a non-fermented, non-concentrated product, obtained from the edible part of mangos by an appropriate technological process, meeting the minimum suspended solid content. Mango pulps must comply with the Identity and Quality Standards (IQS) established by Normative Instruction No. 37, of October 1, 2018, of the Brazilian Ministry of Agriculture, Livestock, and Supply (MAPA). This regulation specifies minimum values of soluble solids of 11° Brix, total solids of 11.5 g/100 g, pH of 3.5, total acidity of 0.3 g of citric acid/100 g, and ascorbic acid of 6.1 mg/100 g (BRASIL, 2018).

Quality control of physical and chemical parameters of frozen fruit pulps—such as color, pH, soluble solids, titratable acidity, and vitamin C—must be considered, as they

are crucial to standardization and to analyze changes that occur during processing and storage (CASTRO et al., 2015). The characterization of quality control parameters, as well as bioactive compounds in fruit pulps, adds nutritional value and ensures quality, aiming to meet not only standards established by the Brazilian legislation, but also consumer demands (SOUSA et al., 2020). According to Brasil et al. (2016), factors such as quality of raw material, distribution, storage, and marketing can also affect the quality of frozen pulps.

Given this context, this study was developed in order to assess physical and chemical characteristics of different brands of frozen mango pulp sold in Machado, Minas Gerais State, to identify whether the analyzed brands met standards specified by current legislation.

Material and methods

Frozen mango pulps were purchased in supermarkets located in the municipality of Machado (21° 39' S, 45° 55' W, 850 m above sea level), totaling four different brands, with samples from the same batch and expiration date. The experimental plot consisted of a frozen mango pulp package (100 g), from the same brand and batch.

Samples were transported in polystyrene boxes with ice to the Bromatology Laboratory of the Federal Institute of Education, Science and Technology of Southern Minas Gerais (IFSULDEMINAS) – Machado Campus. Pulps were thawed in a refrigerator at 7 °C for the following analyses:

Color: The L* value, hue angle (h°), and chroma (C*) were measured using a Minolta colorimeter, model CR-400, with illuminant D_{65}, an observation angle of 2°, in the CIELAB color space (MINOLTA, 1998).

pH: Determined using the Tec-3MP pH meter (Tecnal) (INSTITUTO ADOLFO LUTZ, 2008).

Titratable acidity: Determined by titration with 0.1 mol L NaOH solution^{-1}, with phenolphthalein as an indicator. Results were expressed in g of citric acid/100 g (INSTITUTO ADOLFO LUTZ, 2008).

Soluble solids: Determined in a digital refractometer of the Atago brand, model Smart-1, with automatic temperature compensation at 20 °C and results expressed in °Brix (INSTITUTO ADOLFO LUTZ, 2008).

Total solids: Determined by the gravimetric method of oven-drying at 105 °C until a constant mass was reached. Results were expressed as g/100 g (INSTITUTO ADOLFO LUTZ, 2008).

Ascorbic acid: Determined by titration with Tillman's solution, a methodology proposed by Strohecker and Henning (1967). Results were expressed in mg of ascorbic acid/100 g.

The experiment was conducted using a completely randomized design, consisting of four treatments (brands) with five replications (different packages). Statistical analyses were performed using the Sisvar software (FERREIRA, 2011). After analysis of variance, means were compared using the Scott–Knott test at 5 %. Results were also compared with standards established by Normative Instruction No. 37 of October 1, 2018 of MAPA (BRASIL, 2018).

Results and discussion

The results of the L* value, hue angle, and chroma of the four brands are presented in Table 1. There was a statistical difference between L* values, with brand A having the highest value compared to the others, which did not differ. Therefore, the frozen mango pulp of brand A was lighter in color, since the L* value varies from zero (black) to one hundred (white).

Table 1. Mean values for color analysis (L* value, hue angle, and chroma) of four brands of frozen mango pulp sold in Machado, Minas Gerais state, Brazil. Machado – MG, 2024.

Brand	L* value	Hue angle	Chroma
A	48.21 a	87.31 b	37.87 a
B	45.21 b	88.98 a	34.50 b
C	44.41 b	85.89 c	33.47 b
D	45.71 b	84.82 d	35.11 b

Means followed by different letters in the column differ from each other by the Scott–Knott test ($p<0.05$).
Source: authors (2024).

In the study by Benevides et al. (2008), mango pulps of the Ubá variety were characterized in two different harvests of the same year, in which L* values were higher than those of this study. In the first harvest, the average L* value for mango pulps was 57.99, while in the second harvest it was 56.96, indicating the pulps were lighter. In another study, Silva et al. (2012) observed L* values of 39.23 in whole, pasteurized, and frozen mango pulps (*Mangifera indica* L.), a value lower than that found in this study.

A significant difference was found between the studied brands of mango pulps regarding hue angle, in which they all differed (Table 1). The brand B had the highest hue angle (88.98), close to 90°, corresponding to yellow. Santos, Figueiredo Neto, and Donzeli (2016) found hue angle values of 87.32° and 90.03° for brands A and D, respectively, of frozen mango pulps sold in the municipalities of Petrolina, Pernambuco state, and Juazeiro, Bahia state, both located in the São Francisco Valley. For the B and C brands, lower values were found: 66.11° and 72.40°, respectively.

The highest chroma value was identified for brand A, statistically differing from the others, i.e., greater color intensity (saturation) (Table 1). All chroma values are higher than those found by Santos, Figueiredo Neto, and Donzeli (2016), in which values ranging 14.14–26.03 were recorded, demonstrating that pulps in this study had greater color intensity than those found by the authors.

Color differences between mango pulps may be mainly related to ripeness, as well as particular characteristics of each crop, processing, and standardization. Color analysis is crucial, as it is the first attribute evaluated by consumers.

Table 2 shows mean value results for pH, titratable acidity (g/100 g), soluble solids (°Brix), total solids (g/100 g), and ascorbic acid (mg/100 g) of the four brands analyzed, in addition to the IQS according to current Brazilian legislation for this product. Regarding pH values, only brand C met specifications of the current legislation (minimum pH of 3.5) (BRASIL, 2018), with an average of 3.6. Meanwhile, values below stipulations were found for the other brands (Table 2).

Santos, Figueiredo Neto, and Donzeli (2016) observed higher pH values, ranging from 3.80 to 4.75, among brands of frozen mango pulps. Oliveira et al. (2014), in turn, found pH values between 2.96 and 4.06 in six brands in the municipality of Mossoró, Rio Grande do Norte tate, in which some did not comply with quality standards. Bueno et al. (2002) found a 3.3 pH value for frozen mango pulps sold in São José do Rio Preto, São Paulo State.

Overall, acidity decreases with ripening (CHITARRA; CHITARRA, 2005). These different pH found may be related to distinct ripening stages of the fruit used to make pulps, since unripe fruits or those in early ripening stages, have a lower pH. Thus, ripeness, extraction methods, and incorporation of additives heavily influence the final quality of frozen mango pulps.

Table 2. Mean values for pH, titratable acidity (g citric acid/100 g), soluble solids (°Brix), total solids (g/100 g), and ascorbic acid (mg/100 g) of four brands of frozen mango pulp sold in Machado, Minas Gerais state, and minimum values of Identity and Quality Standards (IQS). Machado – MG, 2024.

Brands	pH	Titratable acidity (g/100 g)	Soluble solids (°Brix)	Total solids (g/100 g)	Ascorbic acid (mg/100 g)
A	3.30 b	0.42 b	13.44 a	14.60 a	30.46 b
B	3.26 b	0.50 b	12.65 b	13.65 b	33.29 b
C	3.60 a	0.44 b	13.40 a	14.96 a	34.17 b
D	2.78 c	0.77 a	13.03 b	13.66 b	88.54 a
IQS*	3.5	0.3	11.0	11.5	6.1

Means followed by different letters in the column differ from each other by the Scott–Knott test ($p<0.05$).

*IQS: Identity and Quality Standards (minimum values) specified by Normative Instruction No. 37/2018 (BRASIL, 2018).

Source: authors (2024).

According to Bezerra et al. (2023), beyond organic acids common to fruits, many companies include additives such as acidulants and preservatives permitted by the Brazilian National Health Surveillance Agency (ANVISA), which may justify pH decrease. However, these authors observed pH values for mango pulps in accordance with the established standard.

Nazareno et al. (2019) also recorded a pH value (3.10) below the standards for mango pulps; the products were sold in the southwest of Piauí State, Brazil. The authors concluded that certain parameters failed to meet the minimum characteristics as per legislation. Therefore, manufacturers should adopt good manufacturing practices and standardize raw materials in order to achieve quality fruit pulp production.

Therefore, to improve quality, it is essential to be rigorous when choosing suppliers and carefully selecting raw materials. This approach ensures homogeneity in all quality parameters by quickly processing raw materials and freezing the final product. It is also noteworthy that qualified labor in production and good manufacturing practices (GMP) are also essential to meet quality standards (MACHADO et al., 2007).

Titratable acidity levels in line with the legislation were found in all pulp brands (Table 2), i.e., acidity above 0.3 g of citric acid/100 g (BRASIL, 2018). Only the brand D differed significantly ($p<0.05$ %) from the others, with the highest titratable acidity content (0.77 g/100 g) and, consequently, a lower pH value (Table 2). Compared with the study by Oliveira et al. (2014), the titratable acidity content of frozen mango pulps also varied according to manufacturers, from 0.38 to 1.03 % of citric acid, aligned with the established standard. Sample G had the highest acidity content (1.03 % citric acid) and the lowest pH (2.96) among the brands these authors evaluated.

There was a significant difference between soluble solid contents of the frozen mango pulps (Table 2). However, all brands studied complied with current legislation (BRASIL, 2018). Oliveira et al. (2014) observed variations in soluble solid contents of mango pulps from 10.90 to 18.23 °Brix, in which one brand did not meet the Brazilian legislation, which establishes a minimum of 11 °Brix.

Soluble solid values found in this study are close to those observed by Santos, Figueiredo Neto, and Donzeli (2016), who found levels ranging from 13.20 to 16.45 °Brix for four different brands of frozen mango pulp sold in the cities of Juazeiro, Bahia State and Petrolina, Pernambuco State.

Total solid contents of frozen mango pulps also differed from each other, with the highest values recorded for brands A and C and the lowest for brands B and D. However, all brands complied with current legislation, which stipulates a minimum of 11.5 % (BRASIL, 2018). Bueno et al. (2002) also found total solid contents of 14.9 % for frozen mango pulps sold in São José do Rio Preto. Machado et al. (2007), in turn, observed total solid contents of 35.49 to 41.98 % among four brands of frozen mango pulp sold in Recôncavo Baiano — values higher than those found in this study.

The frozen mango pulp of brand D differed statistically ($p<0.05$ %) from the others in terms of ascorbic acid content, with an average of 88.54 mg/100 g (Table 2), which was higher than the other brands. All brands contained ascorbic acid contents in accordance with Brazilian legislation, which specifies a minimum of 6.1 mg/100 g (BRASIL, 2018).

According to the results, it was possible that the vitamin C content (ascorbic acid) was retained by the frozen mango pulps studied— even with processing, commercialization, and storage, as levels were higher than those specified by the legislation.

Vitamin C is water-soluble and thermolabile, and rapidly oxidizes when exposed to air. Due to its high sensitivity to degradation during processing and storage, it is used as a marker of nutritional quality of fruit products (DANIELI et al., 2009). Therefore, during commercialization, adequate levels of ascorbic acid were observed, minimizing vitamin C loss.

Oliveira et al. (2014), in turn, observed vitamin C levels ranging from 2.48 to 32.94 mg/100 g in six brands of frozen mango pulps. Machado et al. (2007) found levels ranging from 10.78 to 67.67 mg/100 g between four different brands. Finally, Brunini, Durigan, and Oliveira (2002) assessed that vitamin C contents decreased from 56.11 mg/100 g to 23.72 mg/100 g and 16.04 mg/100 g in 20 and 26 weeks, respectively, in crushed and frozen pulps of Tommy Atkins mangos stored at -18 °C.

Farina et al. (2020) analyzed the ascorbic acid content in six different mango cultivars, in which Maya and Tommy Atkins mangos (12.69 and 12.99 mg/100 g, respectively) contained the highest levels of this vitamin among cultivars analyzed. All these values are lower in relation to the brands studied in this study, but they also comply with Brazilian legislation.

Nazareno et al. (2019) found soluble solids, titratable acidity, and vitamin C contents of 11.00±0.1 °Brix, 0.51±0.06 %, and 82.02±0.02 mg/100 g, respectively, in mango pulps traded in the southwest of Piauí State, with only pH being lower. The vitamin C content observed by these authors was close to that of brand D in the present study (Table 2), around 88.54±14.48 mg/100 g. Considering that ascorbic acid is unstable and progressively lost (MACHADO et al., 2007) at a pH above 4.0, brand D had the lowest pH and the highest ascorbic acid content (Table 2).

Soares and José (2013) observed 89.44 mg/100 g of ascorbic acid in unbleached Rosa mango pulps at time zero. This value is close to that verified in brand D (88.54 mg/100 g) in this study, i.e., there was greater vitamin C retention in this frozen mango pulp during commercialization.

Conclusion

Only one brand of frozen mango pulp sold in the municipality of Machado, Minas Gerais State, complied with current legislation, while pH values below the permitted level for the others brands were registered.

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