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Physico-chemical and organoleptic characterization of a pear variety grown in Morocco

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Abstract

The pear is one of the most widely consumed fruits in the world. The aim of this study is to characterize the physico-chemical and organoleptic properties of a Portuguese variety of pear grown in Morocco. We worked on fresh and frozen pear cuts. The results showed a mean Brix of 11.46 (B°), a mean pH of 4.22, and a mean oxidation time of 53.62 min, with a significant difference in the means of the different cuts. Furthermore, Tukey's test showed that the highest pH and Brix were for pulp, while the highest oxidation time was recorded for fresh pear. Principal Component Analysis showed that frozen pear pulp cuts are characterized by low acidity and medium sugar content, in contrast to fresh pear cuts. These results could encourage industries to invest in these excellent varieties.

Keywords: Pear, Organoleptic quality, Physicochemical quality, Industry, Morocco

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1. Introduction

The pear tree is one of the oldest cultivated plants. Pear trees belong to the Rosaceae family and are often referred to as pome fruits. Pears have been used as a traditional remedy in China for over 2,000 years, due to their anti-inflammatory, antihyperglycemic and diuretic activities [1]. The pear tree tolerates broad edaphic conditions: Clayey to sandy texture, acidic or basic pH. However, it is demanding regarding soil moisture and does not tolerate dry soils [2]. The pear tree generally has a high need for winter cold. It grows in climatic zones where the winter temperature remains below 7°C [3]. In general, pear trees thrive in cold, humid climates, where a cold winter is followed by a cool summer. It needs between 1,200 and 1,500 hours of cold, with temperatures below 7.2°C. When dormant, pear trees can withstand temperatures as low as -26°C [3]. Like most fruits, pears are concentrated in water and sugar. Pears are a source of many nutrients, including fiber, fructose, vitamin C and potassium. Pears are also a source of phytochemicals, particularly antioxidants and provide between 27 and 41 mg of phenolic compounds per 100 g [1].

In Morocco, pear trees occupy an area of 4,000 ha, with a production of 40,000 t. As with apples, the main production regions are the Middle and High Atlas (Azrou-Ifrane), the Saïs plain (Meknès-Fès), Khénifra-Midelt and Gharb [3]. Pear trees are subject to a number of viral and mycoplasma diseases, including: Vein yellow, ring mosaic, pear stony pit, pear decline and rubbery wood. The last two diseases are caused by mycoplasma. A bacterial disease, floral wilt caused by Pseudomonas syringae, has been reported in Azrou orchards [3]. The diversity of tastes and flavors gives this fruit a quite particular appeal for the enthusiast, but pear preservation is often difficult and ends with a ripening or sometimes very rapid rotting. The ripening process of pears is evaluated by several criteria: pH, Brix degree and titratable acidity. The objective of our study is to evaluate the

physicochemical and organoleptic quality of a Portuguese variety of pears grown in Morocco.

2. Materials and methods

2.1 *Study environment*

The study was carried out at Frulact Maroc, an industrial unit located in the Larache area. This unit, which focuses on secondary processing, serves the domestic market, as well as markets in the Middle East and North Africa (MENA) through exports. Frulact Maroc's mission is to ensure the primary processing of fruit from the region, mainly strawberries, apricots and pears.

2.2 *Vegetable material*

The study focused on the Rocha pear variety, discovered in 1836 in the central-western region of Portugal. Rocha has not undergone any genetic manipulation and therefore retains all its original natural properties. It is a small-caliber variety (60-65 mm) with an average weight of 130 g. The skin is smooth, yellow and/or light green, sometimes with a slight russeting on the side exposed to the sun, typical of this variety. The pulp is white, soft and melt-in-the-mouth, granular, non-acidic and juicy, with a slightly marked aroma [5].

2.3 *Quality parameters*

The variables selected for the study are:

- The Brix scale is used to measure the sucrose fraction in a liquid in degrees Brix (°B). The higher the Brix, the sweeter the sample. One Brix degree is equivalent to 1 g of sucrose per 100 g of solution. Sugar content (°B) was measured using a digital refractometer (HI, 96801 from Hanna Instruments, USA).
- Measurement of pH gave a value for the acid-base content of the samples. This value was obtained using a manual pH meter (Knick, Portamess), calibrated daily with pH buffers of 7.00 and 4.00. The accuracy of this method is ±0.01.
- Oxidation time in min;
- Quantity of pear received in Kg.
- Quantity of pear retained in Kg.
- Quantity of pear rejected in Kg.

2.4 *Sample preparation*

Pear slices were cut into small cubic pieces as follows:
Aseptic Rocha Pear 10x10x10 mm (PRA)
Fresh Rocha Pear 10x10x10 mm (PRF);
Frozen Rocha Pear 10x10x10 mm (PRS);
Rocha Pear frozen pulp 10x10x10 mm (PRP).

2.5 *Statistical tools*

The data collected were entered into Excel and then transferred to SPSS. Quantitative variables were expressed as mean ± SD. Analyses were applied such as Fisher test, Pearson correlation test and comparison of means test (Tukey). Principal Component Analysis (PCA) was explored, and the significance error was set at 5%.

3. Results and Discussions

3.1 *Sample collection*

The quantities of pears received by the industrial unit were supplied by 353 growers over the period from 2020 to 2023. The months of reception are mainly those of the autumn and winter seasons. The average quantity received is 5724.62±26.591 Kg/month, with a maximum average of 5814.13 Kg displayed in the month of September, although Fisher's test showed no significant difference ($F=1.70$; $p<0.149$) between the months of collection. However, the distribution of quantities received by year showed a significant difference (Fisher=78.08; $p<0.000$) between the study years. This difference translates into a 13.63% increase in quantities received between 2021 and 2023. Furthermore, the coefficient of variation, which reflects the dispersion within each month, is close to 8% (quantities close to the mean) (Table 1).

3.2 *Physico-chemical and organoleptic characteristics*

3.2.1 *pH*

pH is a parameter determining the suitability of foods for conservation, and is one of the main obstacles that microbial flora must overcome in order to proliferate [6, 10]. Table 2 shows the results for the distribution of acidity (pH) in fruit cuts. The Fisher test shows a significant difference ($F=76.42$; $p<0.000$) between the mean pH values of the different sections. The mean pH value fluctuated between 4.14 and 4.22, and comparison of the means enabled us to classify them into two groups. Group 1 comprises the PRA, PRF and PRS sections, with pH values of 4.14, 4.15 and 4.19 respectively. The second group consists of the PRP cut with a pH of 4.22.

3.2.2 *Brix degree (°B)*

Dissolved sugar in the fruit is measured in terms of Brix [11]. Table 3 shows the distribution of Brix (°B) according to fruit cut. The Fisher test shows a significant difference ($F=32.62$; $p<0.000$) between cuts. Comparison of means by Tukey shows that Brix (°B) is almost equal in the three cuts PRA (11.41); PRF (11.39) and PRS (11.22), while Brix in the pulp is 12.00. However, the average Brix level is 11.47, with a minimum of 10 and a maximum of 12.70.
However, the variation in Brix depending on the harvest months shows a significant difference ($F=5.16$; $p<0.000$). Indeed, the comparison of the means made it possible to distinguish two groups. The first includes the months of September, October and November with Brixes between 11.32 (°B) and 11.39 (°B). While the second group is made up of the months October, December and January with Brix fluctuating between 11.39 (°B) and 11.69 (°B).

3.2.3 *Oxidation time (min)*

Table 4 shows the variation in oxidation time according to fruit cut. The Fisher test shows a significant difference

(F=19.15; p<0.000) between cuts. A Tukey comparison of means shows that the average oxidation time is almost equal between the PRS (52.22 min), PRA (52.71 min) and PRP (54.18 min) cuts, while the oxidation time for PRF is 57.16 min. However, the average oxidation time is 53.62 min (min=45 min and max=60 min). The variation in oxidation time according to harvest month shows a significant difference (F=401.51; p<0.000). Comparison of the averages enabled us to classify them into two groups: the first comprises the months December (47.44 min) and January (47.68 min), and a second group comprises the months September (56.99 min), October (56.30 min) and November (56.87 min).

3.2.4 *Quantity of pears validated*

The percentage of validity of the quantities retained compared to the quantities received is presented in the Figure 1. Indeed, the average retention percentage is 75.63±0.01% (min=26.56% and max=95.60%). The average excluded quantity is 1421.07±63.51 kg (min=220 kg and max=4406.40 kg). The distribution of excluded quantities by month shows a highly significant difference (F=12.97; p<0.000). Comparison of means shows three overlapping groups (Table 5). The first group is made up of months where the quantity excluded is low, such as October (941.29 Kg), September (1120.87 Kg) and January (1158.96 Kg). The second group is made up of January and November (1689.19 Kg) and the third group includes November and December (2046.18 Kg). Figure 1 presents the results of the projection of quantities received, validated and rejected. It shows that the quantity received is almost constant (R^2=0.0014) according to the years of the study. However, the quantity validated decreases with each year, with R^2=0.3985.

3.2.5 *Global analysis*

Figure 2 shows the results of the principal component analysis (PCA). The two components alone absorb 66% of the total variation. Projection of the parameters according to the cuts enabled us to distinguish two groups:

- Group 1 is defined by the parameters of acidity and excluded quantity. Indeed, frozen pear pulp cuts are characterized by low acidity and a similarly low quantity withheld, as well as a medium sugar content.
- Group 2 presented by fresh pear cuts is characterized by fairly high retained quantities and conversely to the first group with fairly low parameters (pH, excluded quantity and Brix).

The average Brix degree in our sample is 11.4674 (°B), this value falls between 0 and 20 (°B), indicating that the fruit juice is not concentrated (light syrups) [7]. The average oxidation time is 53.62 min in the pear variety 'Rocha'. This oxidation can occur as long as the PPO (polyphenol oxidase) is active. According to [8], there are three main categories of phenolic compounds found in pears: phenolic acids, tannins, and flavonoids. Additionally, the average pH value fluctuates between 4.14 and 4.22. These results indicate that the fruit is acidic.

The nutritional quality of the pear fruit does not only depend on climatic hazards but also on phytosanitary/pest problems such as the Asian stink bug (Halyomorpha halys), black spot (Alternaria alternata or Stemphylium vesicarium), bacterial blight (Erwinia amylovora) , psylla (Cacopsylla pyri in Europe and Cacopsylla pyricola in North America), pear scab (Venturia pyrina for the European pear and Venturia nashicola for the Asian pear) and valsa (Valsa ceratosperma) [9]. According to our study, the percentage of validated fruit exceeds 75% and therefore less than 25% were excluded. This difference is mainly due to certain biotic or abiotic factors. Therefore, mitigating pests and increasing the level of production and quality of fruit are fundamental objectives for maintaining the vitality of the pear industry. This could be achieved by scaling up breeding programs to obtain cultivars resistant or tolerant to some of these biotic adversities.

Table 1: Quantities of pears received (Kg) at the industrial unit according to the months.

Month	N	Mean (kg)	CV (%)	Standard Error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
January	38	5657.89	8.50%	77.993	5499.87	5815.92	5000	6000
September	78	5814.13	10.52%	69.261	5676.21	5952.04	3200	7800
October	79	5788.48	7.21%	46.963	5694.99	5881.98	5000	6200
November	77	5662.34	8.41%	54.247	5554.30	5770.38	5000	6000
December	81	5666.67	8.37%	52.705	5561.78	5771.55	5000	6000
Total	353	5724.62	8.73%	26.591	5672.33	5776.92	3200	7800

CV %: Coefficient of variation in %.

Table 2: Variation of pH according to pear cuts.

Cuts	N	Mean (pH)	Standard Error	95% confidence interval for mean		Minimum	Maximum
				Lower Bound	Upper Bound		
PRA	34	4..14(a)	0..015	4..11	4..17	4..00	4..28
PRF	61	4..15(a)	0..012	4..12	4..17	4..00	4..30
PRS	169	4..19(a)	0..008	4..17	4..21	4..00	4..53
PRP	89	4..37(b)	0..012	4..35	4..39	4..15	4..55
Total	353	4..22	0..007	4..21	4..24	4..00	4..55

Means with the same letter do not differ significantly.

Table 3: Variation of Brix (°B) according to pear cuts.

Cuts	N	Mean (Brix)	Standard Error	95% confidence interval for mean		Minimum	Maximum
				Lower Bound	Upper Bound		
PRA	34	11.41(a)	0.08	11.23	11.59	10.58	12.43
PRF	61	11.39(a)	0.07	11.24	11.55	10.52	12.38
PRS	169	11.22(a)	0.05	11.11	11.33	10.00	12.70
PRP	89	12.00(b)	0.03	11.92	12.07	11.50	12.70
Total	353	11.47	0.03	11.39	11.53	10.00	12.70

Means with the same letter do not differ significantly.

Table 4: Variation of oxidation time (min) according to pear cuts.

Cuts	N	Mean (Oxidation time)	Standard Error	95% confidence interval for mean		Minimum	Maximum
				Lower Bound	Upper Bound		
PRA	34	52.71(a)	0.942	50.79	54.62	45	60
PRF	61	57.16(b)	0.361	56.44	57.89	45	60
PRS	169	52.22(a)	0.348	51.54	52.91	45	60
PRP	89	54.18(a)	0.515	53.16	55.20	45	60
Total	353	53.62	0.256	53.11	54.12	45	60

Means with the same letter do not differ significantly.

Table 5: Comparison of mean excluded quantities (Kg) by month.

Tukey's Significant Difference				
Month	**N**	**Subset for alpha = 0.05**		
		1	2	3
October	79	941.290494		
September	78	1120.866731		
January	38	1158.956767	1158.956767	
November	77		1689.192857	1689.192857
December	81			2046.185979
Sig.		.803	.057	.366

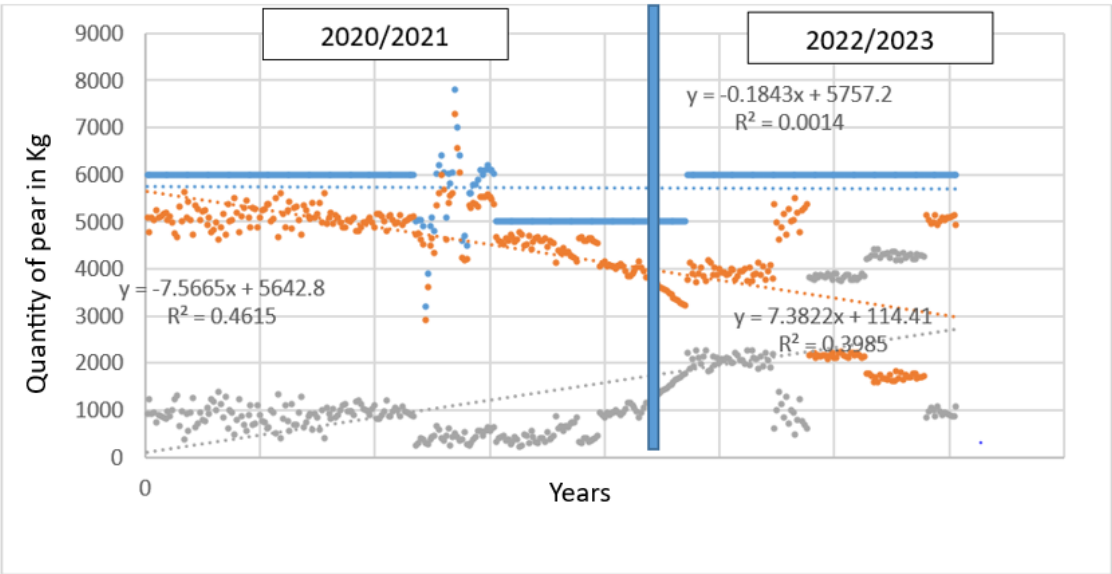

Figure 1: Distribution of received, validated, and excluded quantities of pears by year.

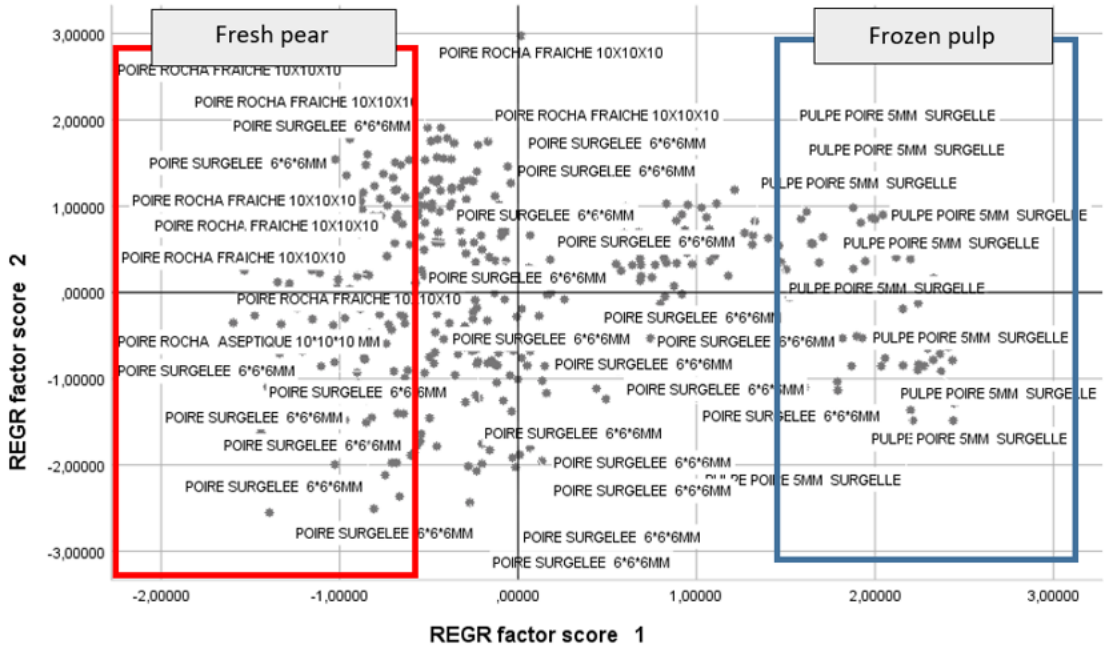

Figure 2: Presentation of pear cuts in PCA.

4. Conclusion

The aim of this study was to enhance the value of a Portuguese variety of pear, "Rocha", grown in Morocco. We worked on aseptic (PRA), fresh (PRF), frozen (PRS) and frozen pulp (PRP) pear cuts. The results showed a 13.63% increase in the quantity received between 2021-2023, which was almost constant over the years of the study. However, the validated quantity decreased, and the average percentage retained exceeded 75%. This result is essentially due to certain biotic or abiotic factors. Mitigating pests and increasing production levels and fruit quality are therefore fundamental objectives for maintaining the vitality of the pear industry. This can be achieved by stepping up breeding programs to obtain cultivars that are resistant/tolerant to some of these biotic adversities. Physico-chemical analysis showed a significant difference in the means of the different cuts. Furthermore, Tukey's test showed that the highest pH and Brix were for the pulp (PRP), while the highest oxidation time was recorded for the PRF. The months in which the pears were received also influenced these parameters. The PCA showed that frozen pear pulp cuts are characterized by low acidity and medium sugar content, in contrast to fresh pear cuts. This result would certainly encourage manufacturers to invest in these excellent varieties.

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