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Evaluation of Texture of Packhams Pears

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Abstract—The textural parameters, together with appearance and flavor, are sensory attributes of great importance for the product to be accepted by the consumer. The objective of the present study was the evaluation of the textural attributes of Packhams pears in the fresh state, after drying in a chamber with forced convection at 50 °C, lyophilized and re-hydrated. In texture analysis it was used the method of Texture Profile Analysis (TPA). The parameters analyzed were hardness, cohesiveness, adhesiveness, elasticity and chewiness. From the results obtained is possible to see that the drying operation greatly affected some textural properties of the pears, so that the hardness diminished very much with drying, for both drying methods.

Keywords—Drying, pear, texture, hardness.

I. INTRODUCTION

THE dried pear is a product that has unique organoleptic characteristics. Its texture and color are modified, it contains more calories compared to the fresh pear and also contains more nutrients per unit of mass [1]. The dried pear is a product with good characteristics and with a texture appreciated by consumers. The flavor of the pear is influenced by the volatile aromatic compounds present and by the sugar/acid ratio. The pH is in the range of 2.6–5.4, being citric and malic acids the major organic acids present. Its bitter taste is normally associated with the rind, due to the phenolic and polyphenolic compounds. The color of the peel depends on the amount and type of pigments present, being mainly chlorophyll (green) and carotenoid (yellow) [2], [3].

The Packhams pear is a variety of Australian origin and was established in 1896 by Henry Packham as a result of crossing two varieties of pears: pear Williams (Bartlett) and pear Yvedale Saint-Germain. It is subject to softening and yellowing after storage, according to the temperature between harvest and storage [4].

Texture results from complex interactions between food components, and is affected by cellular organelles and biochemical constituents, water content as well as and cell wall composition. Hence, external factors affecting these qualities can modify texture [5]. In fact, the changes in texture that

occur during the processing of plant materials or certain physiological events have been related with tissue and cell micro-structural changes [6].

Several authors have studied the changes of the mechanical properties of food during drying and observed that they changed from a predominantly plastic behavior to a more elastic behavior [7].

Instrumental measurements of texture have become essential for the assessment of quality in the food industry [8] and, among the methods used to determine texture, instrumental texture profile analysis (TPA) is the most frequently used to calculate the textural properties, and intend to imitate the repeated biting or chewing of a food [9].

The present work aimed to study the effect of convective and freeze-drying on the texture of Packhams pears, by measuring their textural attributes (hardness, adhesiveness, springiness, cohesiveness, and chewiness) by texture profile analysis.

II. EXPERIMENTAL PROCEDURE

A. Sampling

For each test performed, 3 pears were used, each of which was divided into 4 equal pieces (quarters 1 to 4). From each quarter two cylindrical tubes were extracted and finally each tube produced two samples, corresponding to the outer layer (which included the pear skin and was designed as peel) and to the interior of the pear (designated as pulp). This procedure was adopted equally for the fresh pears and for the pears after drying, after lyophilization and after re-hydration.

B. Processing

The convective drying was made in an electrical FD 155 Binder drying chamber with ventilation (air flow of 0.5 m/s), operated at constant temperature (50 °C). Two essays were done, the first to obtain pears with a moisture content between 30% and 40% (wet basis) which lasted for 48 hours and the second essay to obtain pears with a moisture content between 20% and 30% (wet basis), the later lasting 60 hours. For the freeze drying, the samples were frozen in a conventional kitchen freezer for about 24 hours at a temperature ranging from - 18 °C to - 20 °C, and then left in the freeze-drier (model Table Top TFD5505) for 38 hours at a temperature between - 47 °C and - 50 °C, and a pressure of 0.7 Pa). In this case the final moisture content reached was of about 3% (wet basis). In all cases the pears were dehydrated in quarters.

The lyophilized samples were further submitted to a process of re-hydration by immersion in a bath with distilled water at

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room temperature for a few seconds so as not to reach excessive moisture. The re-hydrated samples showed an average moisture content of about 55%.

C. Moisture Determination

The moisture content of the samples in all different states (fresh, air dried, lyophilized and re-hydrated) was evaluated by means of a HG53 Halogen Moisture Analyzer from Mettler Toledo. The operating parameters were: temperature set to 115 °C and speed set to medium (3 in a scale from 1 = very fast to 5 = very slow).

D. Instrumental Texture Measurement

The textural properties of the pears were determined by texture profile analysis, which was carried out on the samples of the peel and the pulp. Texture profile analysis (TPA) to all the samples was performed using a Texture Analyzer (model TA.XT. Plus from Stable Micro Systems). The textural properties: hardness, adhesiveness, springiness, cohesiveness, and chewiness were calculated after equations (1) to (5) (see Fig. 1):

$$\text{Hardness (kgf)} = F_1 \quad (1)$$

$$\text{Adhesiveness (kgf.s)} = A_3 \quad (2)$$

$$\text{Springiness (\%)} = 100 (t_2/t_1) \quad (3)$$

$$\text{Cohesiveness (dimensionless)} = A_2/A_1 \quad (4)$$

$$\text{Chewiness (kgf)} = (F_1) (t_2/t_1) (A_2/A_1) \quad (5)$$

The texture profile analysis was carried out by two compression cycles between parallel plates performed using a flat 75 mm diameter plunger, with a 5 second period of time between cycles. The parameters that have been used were the following: 5 kg force load cell and 0.5 mm/s test speed.

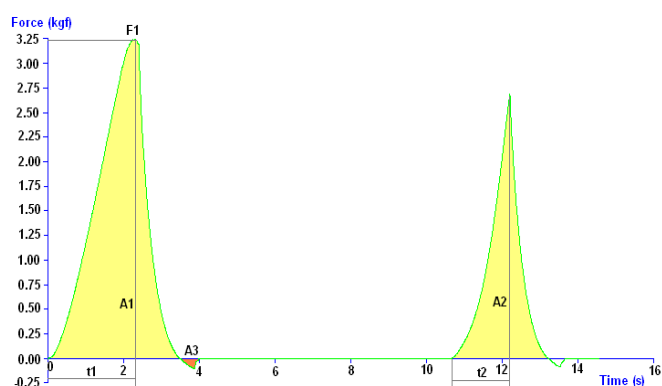


Fig. 1 Texture profile analysis

III. RESULTS AND DISCUSSION

A. Evaluation of Texture in the Fresh Pears

The hardness of the samples taken from the fresh pears (peel and pulp) is presented in Fig. 2. This property corresponds to the maximum force recorded during the first cycle of compression, and represents the force required between the molars for chewing a food, being in most cases related to the tensile strength of the sample. The results show that the three pears analyzed are quite homogeneous, with maximum values of hardness around 3.5 kgf in the case of the peel and slightly lower in the case of the pulp. The values for hardness are therefore higher in the samples from the peel when compared to the values for the pulp, although the differences are in general small. These results are expected, because the peel is constituted by cells with the function of protecting the fruit, therefore being in a more rigid structure. The results of hardness found in the present case are between 2.2 kgf and 3.7 kgf, being in average $3.11(\pm 0.42)$ kgf for the peel and $2.90(\pm 0.32)$ kgf for the pulp. These values are in accordance with those reported by Cavaco *et al.* [10] for the firmness of fresh Rocha pear, in average 3.75 kgf (36.7 ± 26.6 N). Furthermore, it is important to mention that these authors found values quite dispersed for firmness, given the high value of the standard deviation (72% of the medium value).

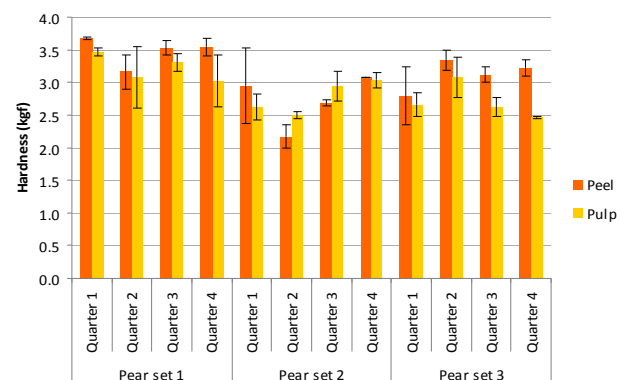


Fig. 2 Hardness of the fresh pears

Adhesiveness represents the work necessary to overcome the forces of attraction between the sample and the probe surface, and is given by the value of the area corresponding to the negative force (A_3 in Fig. 1). Fig. 3 shows the absolute values for adhesiveness in the fresh pear samples: peel and pulp, when applicable, since in most of the cases the peel samples had values of zero. The results show that, even in the case of the pulp, the adhesiveness is very low, almost negligible. Also Santos *et al.* [11] reported for Rocha pear values of adhesiveness under 0.02 kgf.s and Guiné [12] found that adhesiveness was not relevant for pears of the variety S. Bartolomeu.

Cohesiveness represents the ratio between the work done in the second compression and the work done in the first

compression, and reflects the ability of the product to stay as one. In Fig. 4 the values found for cohesiveness of the fresh pears are presented and is observed that the values are very similar among the various samples tested, varying in general between 0.4 and 0.5. The surface of the pear (peel) shows lower cohesiveness values compared to those obtained inside the pear (pulp) (with few exceptions), although these differences are small. The average cohesiveness is in the peel $0.43(\pm 0.04)$ whereas in the pulp is $0.46(\pm 0.03)$. Also Santos *et al.* [11] reported similar findings for pears of the variety Rocha produced at different locations.

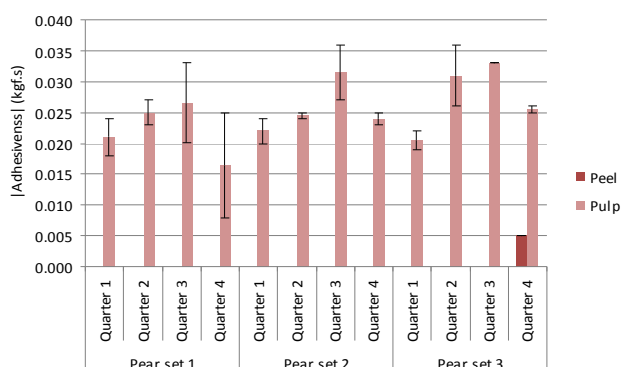


Fig. 3 Adhesiveness of the fresh pears

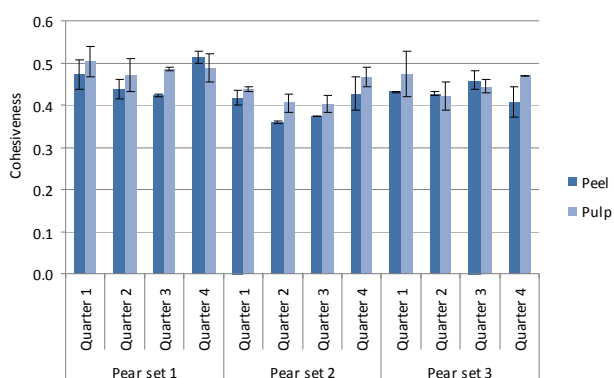


Fig. 4 Cohesiveness of the fresh pears

Fig. 5 shows the springiness found for the different samples analyzed in the fresh pears. Springiness is the ratio between the times in the two deformations, and represents the ability to regain shape when the deforming stress is removed or reduced, i.e., expresses the percent of recovery of the sample.

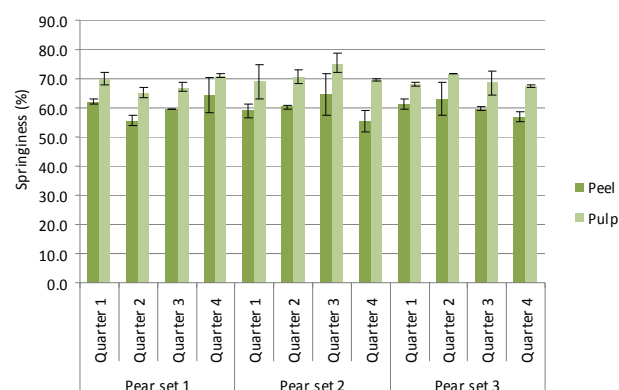


Fig. 5 Springiness of the fresh pears

The results in Fig. 5 are relatively homogeneous and obey the same trend, i.e., springiness is higher in the pulp relatively to the skin, and the results obtained vary in general between 60% and 70%. The average values are for the pulp $69.5(\pm 2.6)$ % and for the peel $60.2(\pm 3.1)$ %. Also Santos *et al.* [11] presented similar results for the springiness of fresh pears of the Rocha variety.

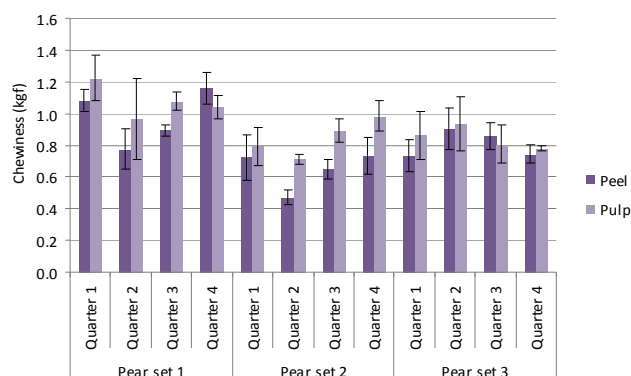


Fig. 6 Chewiness of the fresh pears

Chewiness represents the energy required to disintegrate a solid material in order to swallow it, and is presented for the fresh pears at study in Fig. 6. This textural parameter is directly related to other parameters, namely hardness, cohesiveness and springiness. The results in Fig. 6 indicate that chewiness is in general greater in the pulp than in the peel, with average values of $0.92(\pm 0.15)$ kgf and $0.81(\pm 0.19)$ kgf, respectively. A similar trend was observed by Santos *et al.* [11] for the chewiness in the pulp and in the peel of pears of the Rocha variety.

B. Influence of Processing on Texture

Dehydration has a very pronounced effect on the structure of foods, due to the loss of a considerable amount of water, either increasing very significantly the product porosity in the case of lyophilization or increasing density by shrinkage in the

case of convective drying. Therefore, the effect of processing treatments such as drying or lyophilization and re-hydration on the textural parameters of the Packhams pears were evaluated, being the results presented in Figs. 7 to 11.

Fig. 7 shows the values found for hardness in the fresh samples and in those submitted to processing. The results indicate that air drying produced a very pronounced diminishing in hardness, either in the pulp or in the peel, and this effect is particularly important if the degree of dehydration is increased, like in the samples dried to a moisture content between 20 and 30%. This trend can be explained because with drying the sample loses its integrity as a pear, becoming softer in result of the loss of water. Guiné [12] also reported a diminish in harness for pears of the S. Bartolomeu variety when submitted to solar drying treatments. Again, when the samples were lyophilized their hardness was very much reduced, being in this case due to the highly porous structure developed upon the sublimation of the frozen water, thus originating a very soft product. Re-hydration produced a product with hardness even lower, because the adsorption of water did not restore the product's lost integrity, and on the contrary produced a pasty product.

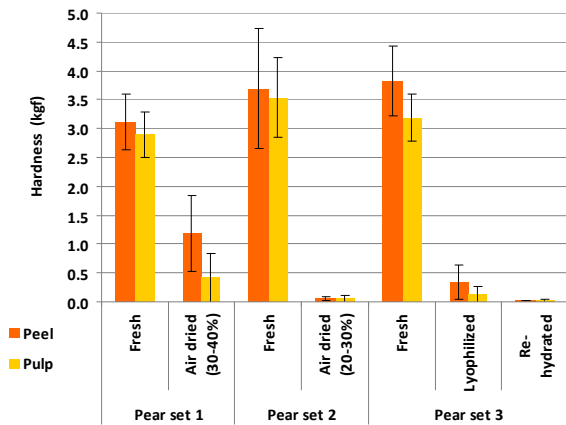


Fig. 7 Influence of processing on hardness

Regarding adhesiveness, the results in Fig. 8 indicate that this parameter diminished with all treatments tested, although the values are really very small in all cases, being this property quite meaningless in the case of the Packhams pears, with a higher value observed of 0.038(±0.001) kgf.s, for the peel of the fresh pear samples number 2.

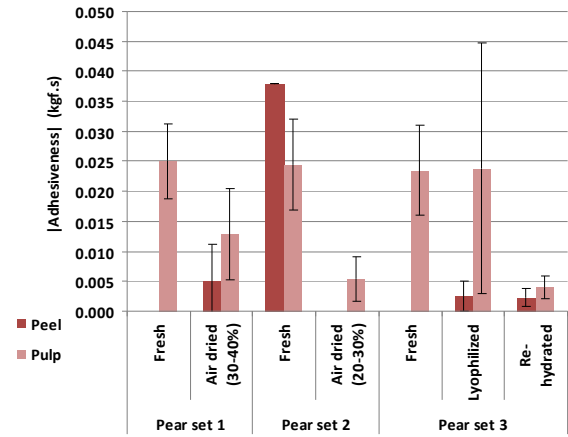


Fig. 8 Influence of processing on adhesiveness

The values found for cohesiveness are presented in Fig. 9 and they reveal that air drying increased cohesiveness, being this effect more pronounced for those samples that were dehydrated to a further extent. This observation results from the intense shrinking that the pears undergo at convective drying, thus giving place to more cohesive products. Guiné [12] reported for the solar drying of pears that when they became drier, with less water present, they became more cohesive. On the other hand, the lyophilized pears kept their cohesiveness approximately equal to the fresh state, because in this case shrinking did not occur. Finally, the re-hydration treatment caused cohesiveness to increase slightly, due to the formation of a product with a pastry consistency.

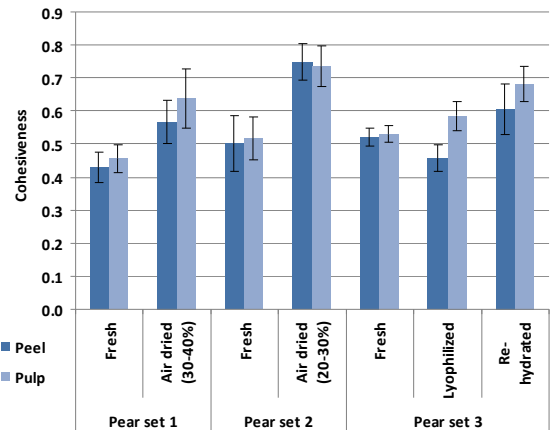


Fig. 9 Influence of processing on cohesiveness

Fig. 10 presents the results for springiness, and they reveal that air drying does not alter springiness in a visible way. However, this textural property was slightly affected by lyophilization, decreasing particularly in the case of the peel samples. Contrarily, re-hydration originated springiness to increase, either in the pulp or in the peel.

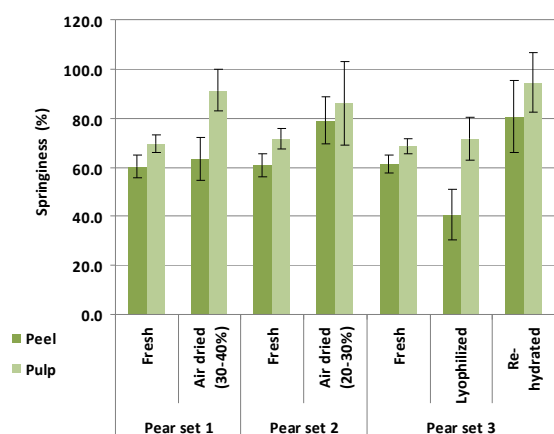


Fig. 10 Influence of processing on springiness

The results for chewiness are shown in Fig. 11 and they indicate that the effect of the different treatments on this property is quite similar to that observed in hardness, which is expected; given the influence hardness has on chewiness. Also in this case air drying caused a decrease in chewiness, and so did lyophilization and re-hydration. Guiné [12] observed for the solar drying of S. Bartolomeu pears that the drying operation had a great influence on the cell and tissue structure of the biological materials that constitute the pear, also reducing chewiness quite considerably.

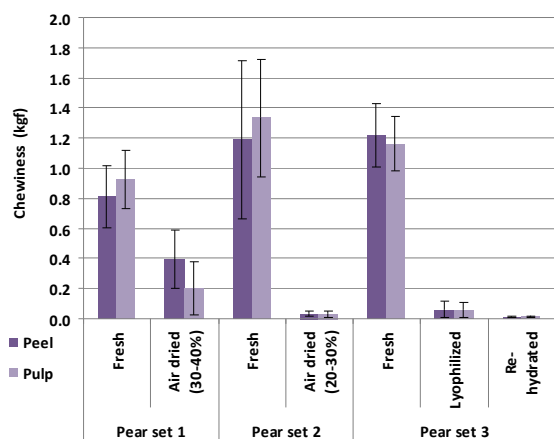


Fig. 11 Influence of processing on chewiness

IV. CONCLUSION

The results observed for the textural parameters of pears from Packams variety, before and after processing, reveal a clear change in texture that lead to a loss in hardness and chewiness. Air drying produced a significant decrease in hardness, and chewiness while originating a clear increase in cohesiveness. Lyophilization also produced a significant decrease in hardness, but cohesiveness and springiness were very slightly affected. In the case of the pears which have undergone re-hydration, it was evident that they did not regain

the same textural properties of the fresh pears.

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