

INFLUÊNCIA DAS CONDIÇÕES DE ARMAZENAMENTO E TIPO DE EMBALAGEM EM ALGUMAS PROPRIEDADES DE NOZES

INFLUENCE OF STORAGE CONDITIONS AND TYPE OF PACKAGE ON SOME PROPERTIES OF WALNUTS

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Resumo

A qualidade dos produtos desidratados é uma preocupação porque, devido ao seu baixo teor de humidade, eles tendem a hidratar com bastante facilidade, comprometendo, assim, a estabilidade química, enzimática ou microbiana, bem como as propriedades nutricionais e sensoriais. Tendo isto em mente, este estudo foi realizado para avaliar os efeitos do armazenamento sob certas condições de temperatura, humidade relativa e diferentes tipos de embalagens sobre as propriedades das nozes. As amostras de frutas utilizadas eram originárias do Chile, Portugal, Roménia e Estados Unidos. O armazenamento das nozes durou 90 dias, e as condições testadas foram: temperatura ambiente; estufa a 30 e 50 °C, sem controlo sobre a humidade relativa do ar; refrigeração e congelamento. Os dois tipos de embalagem de plástico utilizados foram o polietileno de baixa densidade (PEBD) e polietileno de baixa densidade linear (PEBDL). A atividade de água foi medida por um higrómetro; o teor de humidade por secagem em estufa até massa constante e a cor

com um colorímetro. A partir dos resultados obtidos concluiu-se que as amostras de diferentes origens são diferentes no que diz respeito ao teor de humidade, atividade de água e cor, independentemente das condições de armazenamento e tipo de embalagem. Além disso, verificou-se que, para assegurar a boa conservação das nozes, o armazenamento a 50 °C deve ser evitado, uma vez que causa uma grande desidratação do produto e uma maior mudança de cor em comparação com as amostras não armazenadas. Finalmente, em relação ao tipo de embalagem, foi observado que o uso de sacos de plástico não parece melhorar as características dos produtos em relação às amostras não embaladas.

Palavras-chave: cor, noz, conteúdo de humidade, atividade da água.

Abstract

The quality of dehydrated products is a concern because, due to their very low moisture content, they tend to rehydrate quite easily, thus compromising the chemical, enzymatic or microbial stabilities, as well as the nutritional and sensorial properties. Having this in mind, this study was undertaken to evaluate the effects of storage in walnuts, under certain conditions of temperature, relative humidity and different types of packaging. The fruit samples used were from Chile, Portugal, Romania and United States. The storage of the walnuts lasted for 90 days, and the conditions tested were: room temperature; a stove at 30 and 50 °C without control over relative humidity of the air; refrigeration and freezing. The two types of plastic package tested were low density polyethylene (LDPE) and linear low density polyethylene (LLDPE). The water activity was measured by a hygrometer; moisture content by oven drying until constant weight and colour with a colorimeter. From the results obtained it was concluded that the samples from the different origins are different with respect to moisture content, water activity and colour, regardless of the storage conditions and type of package. Furthermore, it was verified that to assure the good preservation of the walnuts the storage at 50 °C should be avoided, since it caused an extensive dehydration of the product and a high change in colour in comparison to the unstored samples. Finally, regarding the type of package, it

was observed that the use of plastic bags did not really improve the products characteristic in relation to the unpacked samples.

Keywords: colour, walnut, moisture content, water activity.

1. Introduction

The walnut (*Juglans regia* L.) is characterized by a wide differentiation and long history of cultivation throughout the temperate regions of the world, being an economically important tree species cultivated throughout the world for the timber and nutritious nuts. Walnuts are found in many region and countries around the world, like West Indies, Japan, China, Southern Asia from India to Turkey, from South Eastern Europe to the Carpathian Mountains of Poland, in the eastern and southern parts of the United States, in Mexico and Central America from Colombia to Argentina (Bayazit et al., 2007; Pop et al., 2013).

Walnuts are consumed worldwide and integrate the Mediterranean diet, being an excellent source of many fundamental nutrients. However, some care must be taken because of their allergenic potential. According to Cabanillas et al. (2014) walnut is the most frequently involved food in anaphylactic reactions after peanut.

However, in past years, nuts have gained interest for their potentialities as a natural functional food. Walnuts have many beneficial effects for human health associated to their composition, namely regarding the prevention, management and treatment of diseases such as cardiovascular diseases, diabetes, reduction of adiposity and low-grade systemic inflammation and the improvement of blood lipid profile (Tapia et al., 2013). Walnut consumption has been associated to a healthy diet, because of its benefits in reducing serum cholesterol concentrations and oxidative stress (Banel & Hu, 2009; Cabanillas et al., 2014).

Walnuts have a low glycaemic index and their health protective properties are derived from some chemical components present in walnuts. They are rich sources of polyphenols, polyunsaturated fatty acids (mainly the essential fatty acids $\Omega 6$ and $\Omega 3$, respectively linoleic and α -linolenic acids), a high $\Omega 6$ to $\Omega 3$ ratio, proteins unusually rich in essential amino acids (and thus with a high nutritive value), biogenic amines (melatonin and serotonin), minerals (magnesium, potassium, calcium, etc.), fiber, among others (Tapia et al., 2013).

According to Akbari et al. (2012) the total phenolic and flavonoid contents as well as the radical scavenging capacity of different parts of walnuts from various

genotypes is variable although a high correlation was observed between phenol content and radical scavenging activity.

Nuts in general and walnuts in particular, contain water, fat, protein and high amounts of sugar. Therefore, deteriorative reactions may occur during storage, which include lipid oxidation and browning reactions (Faruk Gamli & Hayoğlu, 2007; Maskan & Göğüş, 1997). The water activity is another important factor that influences the deteriorative reactions, and particularly in foods with water activities between 0.65 and 0.85, the lipid oxidation rate can happen quite fast, and this is also dependent on the temperature during storage (Ozçelik & Evranuz, 1998; Shahidi & John, 2013).

The aim of the present study was to evaluate the changes provoked in walnuts by storage under different conditions and with different types of package. The properties evaluated were, at the chemical level, the moisture content and water activity, that relate directly to stability and microbial safety and, at the physical level, the colour, which is associated with organoleptic acceptance. Göğüş

2. Materials and methods

Sampling: The fruits evaluated were all without the outer shell and also without the inner skin (seedcoat), and they were acquired already without the seedcoat. The walnut samples were from Chile (CH), Portugal (PT), Romania (RO) and United States (US).

Analysis of water activity and moisture content: The water activity (aw) was measured at 25 °C by a hygrometer (Rotronic Hygroskop BT-RS1) connected to a thermal bath. In all cases four determinations were made to calculate the mean value and standard deviation. Moisture content was evaluated by drying in a stove (WTB-Binder) at 105 °C until reaching constant weight. In all cases three determinations were made.

Evaluation of colour: The colour of all samples was measured using a handheld tristimulus colorimeter (Chroma Meter - CR-400, Konica Minolta). The parameters measured were the brightness L^* , which varies between 0 and 100 (from black to white, respectively), and the coordinates of opposed colour: a^* and b^* , which vary from -60 to $+60$, where the a^* assumes negative values for green and positive values for red, while b^* assumes negative values for blue and positive for yellow. The total colour difference (TCD), was the parameter considered for the overall colour difference evaluation, between a sample and the reference (Guiné & Barroca, 2012).

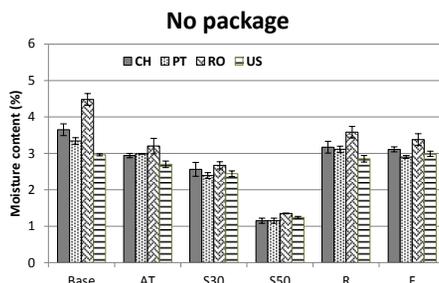
Storage conditions: The fruits were stored for 90 days at ambient conditions, in a stove at two temperatures with controlled temperature but no control over relative humidity, under refrigeration and frozen. Furthermore, the fruits were stored without any package, and with two commercial plastics: low density polyethylene (LDPE) from ALBERPLÁS with 110 μ m thickness (density = 920-940 kg/m³) and linear low density polyethylene (LLDPE) from MGP minigrip with 40 μ m thickness. Table 1 summarizes the conditions used to store all fruits.

Table 1. Summary of storage conditions for the fruits studied.

Code	Description	Temperature (°C)	Relative humidity (%)
B	Just acquired (base)	–	–
AT	Ambient temperature (not controlled)	23.4±2.5	50.5±6.7
S30	Stove (temperature controlled but RH not)	30.0±0.1	36.0±3.6
S50	Stove (temperature controlled but RH not)	50.0±0.1	13.2±1.5
R	Refrigerated	2.3±3.7	48.1±3.3
F	Frozen	-15.4±2.6	61.7±6.2

3. Results and Discussion

Figures 1 and 2 show the values of moisture and water activity for the different walnuts analysed, stored under different conditions and in different packages. Comparing the different origins, the results obtained indicate that the sample from Romania presents higher moisture content and water activity while the sample from the United States is the one with lower values. For values of water activity (aw) lower than 0.6 all microbial, enzymatic and chemical activities are inhibited, thus guaranteeing product stability and safety (Guiné, 2011). In the present case only the sample from Romania presents values over 0.6, and therefore it may constitute a problem for conservation.



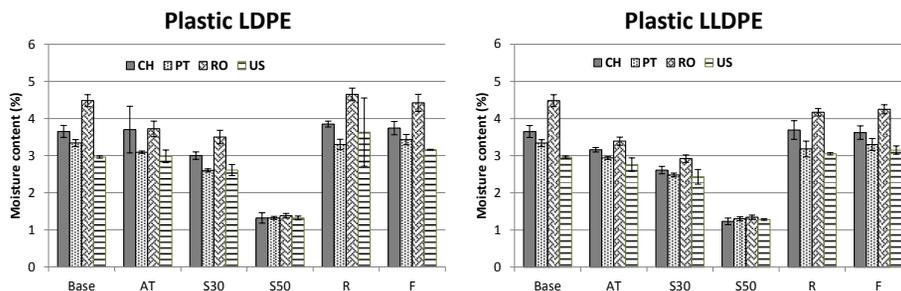


Figure 1. Moisture content of walnuts. Legend: AT – Ambient temperature; S30, S50 – storage at high temperature (30 and 50 °C); R – refrigerated; F – frozen; Almond origin: CH – Chile, PT – Portugal, RO – Romania, US – United States. The interval range represented in each bar represents the standard deviation.

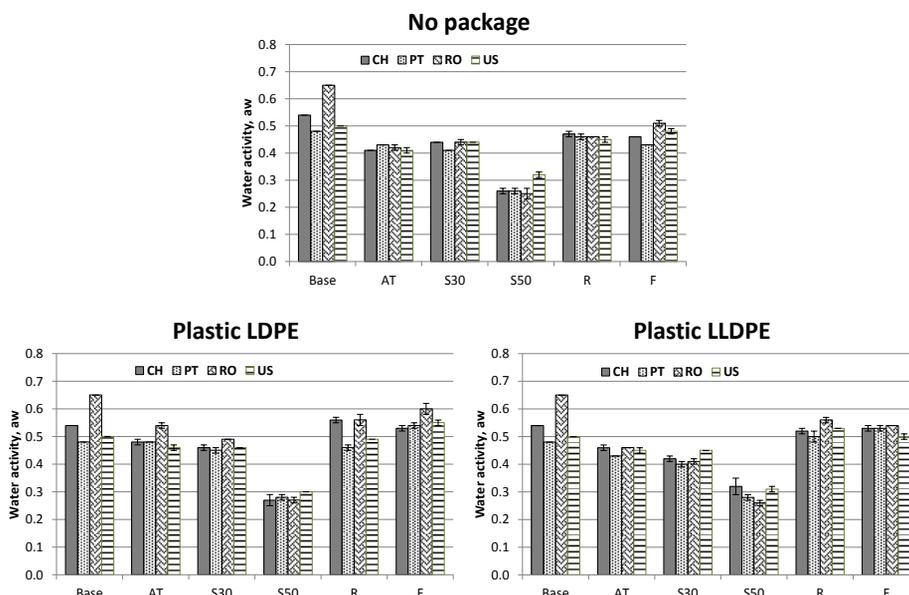


Figure 2. Water activity of walnuts. Legend: AT – Ambient temperature; S30, S50 – storage at high temperature (30 and 50 °C); R – refrigerated; F – frozen; Almond origin: CH – Chile, PT – Portugal, RO – Romania, US – United States. The interval range represented in each bar represents the standard deviation.

With respect to the storage conditions, the storage at 50 °C and 13% RH (relative humidity) originates a high degree of dehydration, and therefore is not recommended for the storage of the walnuts. All other methods are relatively similar and allow obtaining values of moisture and water activity similar to the unstored samples.

Finally, the use of the package does not produce any alterations in relation to the unpacked nuts, since the results obtained for moisture content and water activity are

very similar for the samples from all origins when stored with or without plastic package.

Table 2 shows the values of the colour parameters for the walnut samples before storage (designated by a subscript 0). The values of L* (brightness) are very similar for the walnuts from Portugal Romania and USA, but higher than that of the walnuts from Chile, thus indicating that these last are darker in comparison with all others, since the lower values of L* indicate a darker colour (L*=0 is black while L*=100 is white). The values of a* are positive in all cases, thus indicating that the samples have a more or less reddish colouration, owing to the internal skin. In the case of the sample from USA, the value is lower, indicating that the predominance of red is weaker. Regarding the values of b*, they are all strongly positive, and so the intensity of the yellow colour is high, being the sample from Romania the one with the more intense yellowish colouration.

Table 2. Colour parameters of the walnuts.

Origin	L* ₀	a* ₀	b* ₀
Chile	40.6±6.4	11.5±1.9	24.2±2.4
Portugal	48.2±6.3	9.4±2.4	28.4±3.7
Romania	49.3±6.0	10.3±1.8	31.1±2.8
USA	47.0±6.4	8.9±1.9	26.7±4.1

Figure 3 presents the total colour change among the tested walnuts, having the unstored products as reference. The results indicate that the samples from Chile show in general lower colour differences while the sample from Romania presents the higher values for colour difference, thus revealing that these last are more susceptible to colour degradation under storage. Comparing the different storage conditions tested, the results obtained for storage at ambient temperature and in a chamber at 30 °C are very similar either for the unpacked or packed samples, just with one exception, the storage of the sample from Portugal at 30 °C, which reveals values excessively high. The results also indicate that the storage at 50 °C and 13% RH originates the higher colour changes, thus producing fruits less valued by the consumers. The refrigeration is the method that for all samples and types of package produces the best results, lower colour difference, followed by refrigeration.

In relation to colour change, and comparing the storage without package with that using the two types of plastic tested, it is observed that the use of LDPE is the best choice for package, because it produces the lower values of colour change, thus allowing to preserve the original colour of the walnuts before storage.

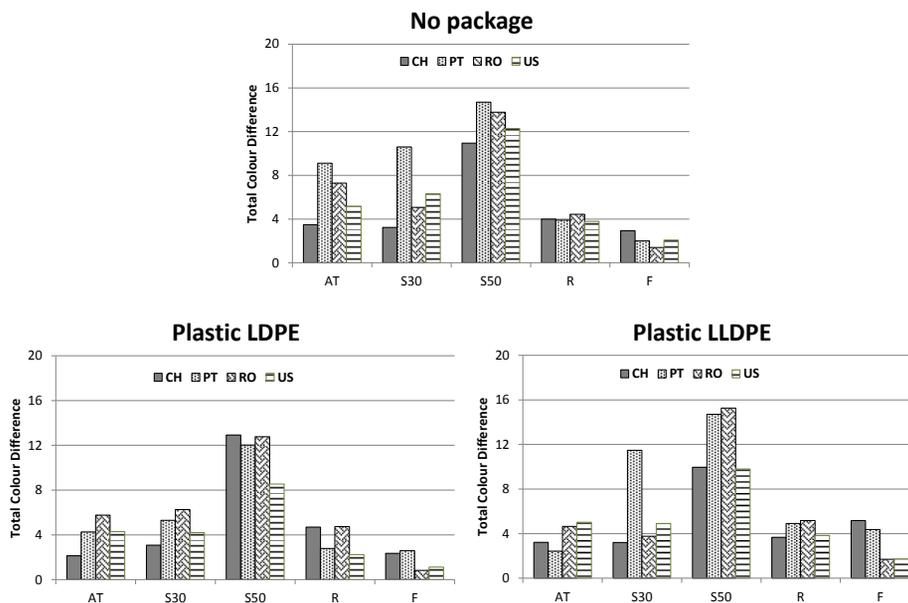


Figure 3. Total colour difference of walnuts. Legend: AT – Ambient temperature; S30, S50 – storage at high temperature (30 and 50 °C); R – refrigerated; F – frozen; Almond origin: CH – Chile, PT – Portugal, RO – Romania, US – United States. The interval range represented in each bar represents the standard deviation.

4. Conclusions

This work allowed concluding that the sample from Romania has higher moisture content and water activity than the other samples (Portugal, Chile and United States).

Furthermore, it was observed that all storage conditions are adequate, except at 50 °C, because in this case originates an important dehydration of the product and a high change in colour in comparison to the unstored samples.

Finally, regarding the type of package, it was observed that the use of plastic bags did not really improve the products characteristics in relation to the unpacked samples, except for colour where the LDPE plastic is preferred.

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Recebido: 3 de junho de 2014.

Aceite: 30 de setembro de 2014.