

Storage of canola in hermetic plastic bags

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Abstract

Due to the small size of the seed, canola (*Brassica napus* or *Brassica campestris*) offers different challenges in the harvest and the subsequent post-harvest operations. Often, in Argentina, farmers do not have enough permanent storage capacity so they overcome this deficit with the use of hermetic plastic bags (silobags). The objectives of this work were: 1) Determine the feasibility of the bagging and extraction processes of canola. 2) Monitoring the condition of canola by periodic measurement of carbon dioxide (CO₂), temperature, moisture content (m.c.) and quality of the grain. Thirty tonnes of canola with initial m.c. of 6 % were stored in a silobag in the southeast of the Buenos Aires province, Argentina. The storage period was extended from November 2008 to November 2009. The variables measured every two weeks were CO₂ concentration, m.c. and grain quality parameters, such as foreign matters, fat acidity and fat content. The temperature and relative humidity (r.h.) of the interstitial air inside the bag and of the ambient air were also recorded with a frequency of one hour. It was observed that, even the size and characteristics of the canola seeds, it was possible to perform the bagging and extraction operations of canola seeds without problems. The r.h. in the interstitial air remained below 50% along the entire storage period. The temperature of the grain inside the bag followed the monthly average ambient temperature. The CO₂ concentration ranged from 1 to 8 %, indicating low to moderate biological activity in the grain mass. The m.c., foreign matters and fat values remained unchanged throughout the storage period. The fat acidity increased during storage in 0.7 % points, reaching a final value of 1.4 %, but did not represent a commercial quality loss. It was concluded that under the conditions of temperature and m.c. evaluated in this study it is possible to store canola in hermetic plastic bags without commercial quality deterioration.

Keywords: Silobags, CO₂ concentration, Interstitial air, Moisture content, Fat acidity.

1. Introduction

Canola (*Brassica campestris* or *Brassica napus*), is an oilseed widely spread in the world, that produces excellent quality edible oil.

The increasing demand of vegetal oils as renewable energy source (biodiesel) transformed the European Unión (EU) into the main importer of soybean, canola, sunflower and palm oil in the 2006, with canola oil the most desired one for the elaboration of biodiesel.

In Argentina, the Buenos Aires province is the area of greater diffusion of canola, with 14 thousand hectares. This crop was limited in the production mainly because it competes with wheat for the land use, and the wheat production used to be more profitable than canola. The lack of selective herbicides that would allow eliminating an extensively distributed weed (*B. napus*, called "Nabo") closely related to canola, is other reason that reduced its adoption in some areas. In the Argentine wheat region, canola constitutes a diversification alternative to enrich the rotation scheme, especially in the South of the Buenos Aires and Pampa provinces. Since canola is harvested earlier than wheat, allows anticipating the soybean planting a couple of weeks (two crops per year in the same land) with greater expected yield than planting soybean after wheat (SAGPyA, 2010). Under this production system (double crop), the combination canola-soybean is more profitable than the combination wheat-soybean.

The obtained edible oil from canola is one of the most appreciated and demanded by its excellent quality, and along with the olive oil, is considered one of the best for human consumption due to its contribution to the low cholesterol formation in the blood. The genetic improvement in the last 40 years, mainly Canadian cultivars, has allowed increasing the quality of this oil (SAGPyA, 2010).

Due to the small size of the seed, canola offers different challenges in the harvest and the subsequent post-harvest operations (Bartosik, 2008). Probably, the factor that affects the quality during storage of canola is the initial condition of the seed prior to storage. Harvested canola seed can maintain high respiration rates, up to 6 weeks, before turning quiescent. This process, commonly called “sweating”, constitutes a very unstable condition for the stored canola (Thomas, 1984). During this stage a constant monitoring is required, since the high respiration rate of the seed produces conditions of heat and humidity that favor development of mold in storage. The mold growth produces more heat and humidity, and as a result the seeds of canola can be damaged. The effect of the “sweating” can be diminished by storing dry and cool grains (Thomas, 1984).

Due to the small size of the seed it is necessary to check and repair all the orifices, cracks and fissures of the storage facility, combines and grain handling equipment.

For many farmers who do not have permanent storage structures, storing grain in hermetic plastic bag (silobag) is a popular alternative solution in Argentina (Bartosik et al., 2008). Each silobag can hold approximately 200 tonnes of wheat (180 tonnes of soybean) and with the handling equipment currently available, the loading and unloading operation is fast, simple and totally mechanized. These silobags are 60 m long, 2.74 m diameter and the plastic liner is made of three layers (white outside and black inside) with 235 micrometers of thickness (Rodríguez et al., 2001 and 2002 a, b, c). A modified atmosphere is generated in the silobag, where the concentration of CO₂ increases and O₂ decreases.

Storage of canola in silobags has not been documented until this study. The objectives of this work were: 1) Determine the feasibility of the bagging and extraction processes of canola. 2) Monitoring the canola storage condition in the silobag by periodic measurement of carbon dioxide concentration, temperature, moisture content (m.c.), fat content and fat acidity.

2. Materials and methods

This study was carried out in a farm located in the South East of Buenos Aires province, Argentina, where 30 t of canola were harvested and stored in a silobag. The test started right after the harvest (25/11/2008) and lasted until the silobag was opened for selling the grain (23/11/2009).

Two sampling locations were established in the silobag. In each sampling location the gas composition was analyzed with a portable gas analyzer (PBI Dan Sensor, CheckPoint, Denmark), perforating the plastic cover with a needle at three levels at each sampling location: close to the top of the bag, at the middle and close to the bottom.

In each sampling location three samples of seeds were collected from three different levels of a 1.7 m tall bag (top = 0.10 m depth, middle = 0.75 m depth, and bottom = 1.6 m depth) using a standard torpedo probe. After probing the silobag the perforations were sealed with a special tape in order to restore the air-tightness. This sampling procedure was repeated approximately every 2 wk during the entire storage period. The samples were taken to the laboratory to determine the commercial quality. The analyzed parameters were m.c., foreign matters, fat acidity and fat content.

The temperature and relative humidity (r.h.) of the interstitial air inside the bag and of the ambient were recorded at a frequency of one hour with two data loggers (Hobo, H8, pro series, ONSET Computer Corporation). One of them was placed inside the silobag, inserted in the grain mass in the central zone, about 0.5 m from surface, for monitoring the temperature of the grain and interstitial air r.h. The other was placed on the outside of the silobag, covered with a plastic film to minimize the effect of sun radiation.

3. Results

The bagging and extraction operations of canola were carried out without problems, even though the small size of the seed and the low repose angle. The holding capacity of a 2.7 m diameter silobag (standard of the market) was of 3100 kg per linear meter of bag (similar to soybean and maize). The first sampling location (R 1) had a maximum CO₂ concentration of 4.3%, minimum of 1.2%, average of 2.6% and a standard deviation of 0.9% (Figure 1). The second sampling point (R 2) had a maximum CO₂ concentration of 8%, minimum of 0.6%, average of 3.8% and a standard deviation of 2.2% (Figure 1). Figure 2 shows that, as expected, the percentage of foreign matters did not change along the storage time.

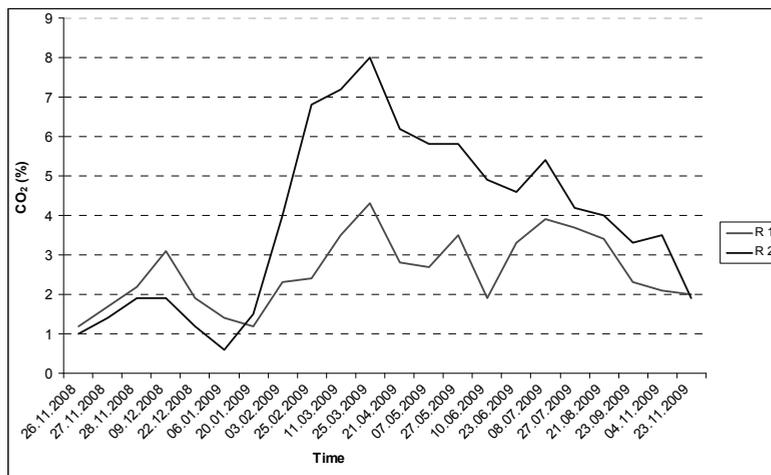


Figure 1 Changes in CO₂ concentration in two sampling locations (R1 and R2) of the canola hermetic plastic bag.

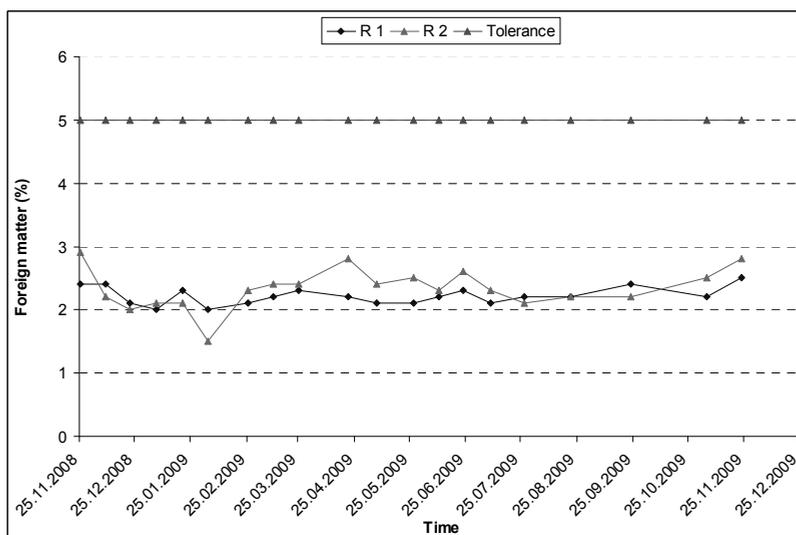


Figure 2 Percentage of foreign matters in two sampling locations (R1 and R2) and commercial standard tolerance of canola.

The percentage of fat acidity increased during storage from 0.7% to 1.4% at the end of the storage time. The increase in fat acidity started after 6 mo of storage, in May (Figure 3).

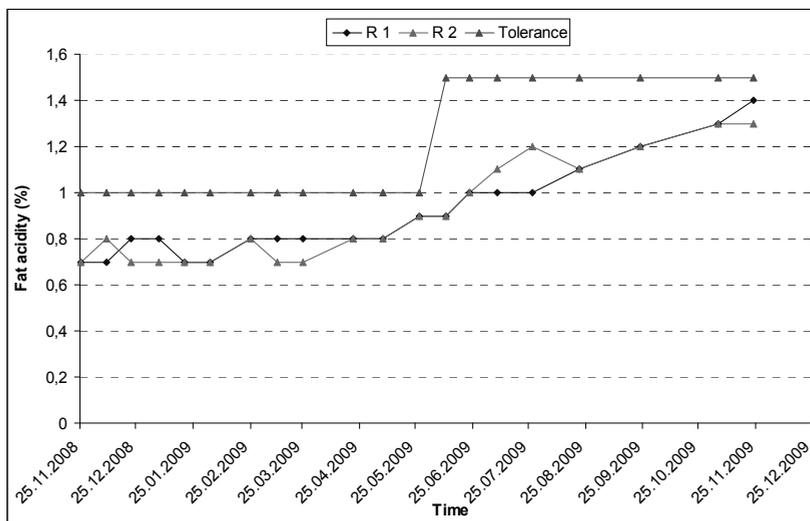


Figure 3 Fat acidity in two sampling locations (R1 and R2) and commercial standard tolerance of canola stored in bags.

Figure 4 shows that the fat content remained constant in the range between 44.5% and 45% during the entire storage period.

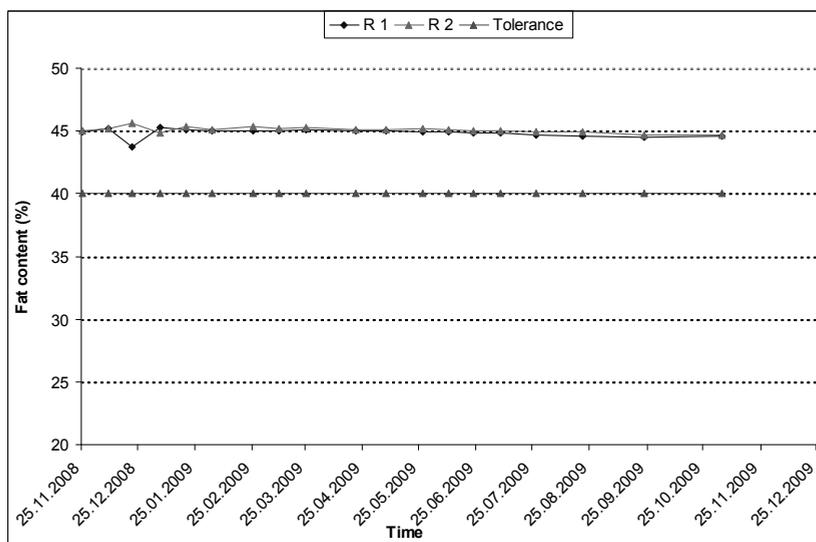


Figure 4 Fat content (%) of canola stored in bags in two sampling locations (R1 and R2) and commercial standard tolerance.

Figure 5 shows that the m.c. of canola seeds remained fairly constant during storage (between 5.3 and 6.2%).

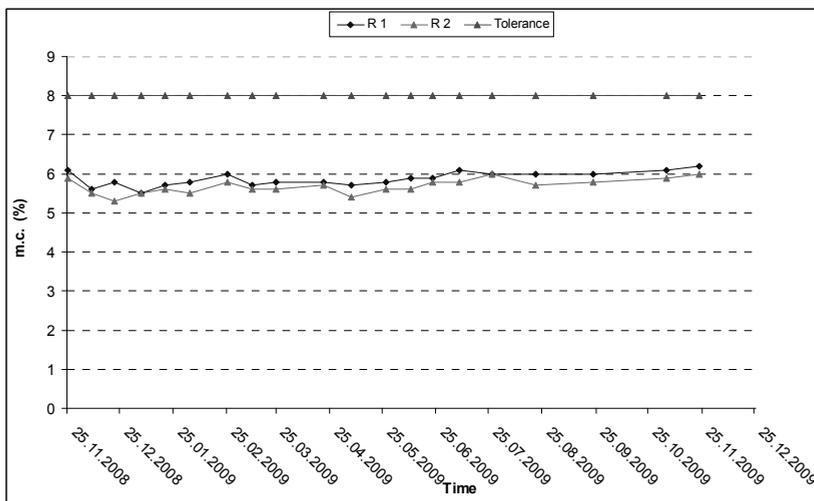


Figure 5 Changes in m.c. of canola based on the time of storage and the commercial standard tolerance.

The temperature of the canola seeds at the harvest time was of 37°C (end of November, late spring). During storage, the seed temperature quickly decreased close to the daily ambient average temperature (25°C). The seed temperature decreased during the winter time to 5°C and then increased during the spring to almost 20°C (Figure 6).

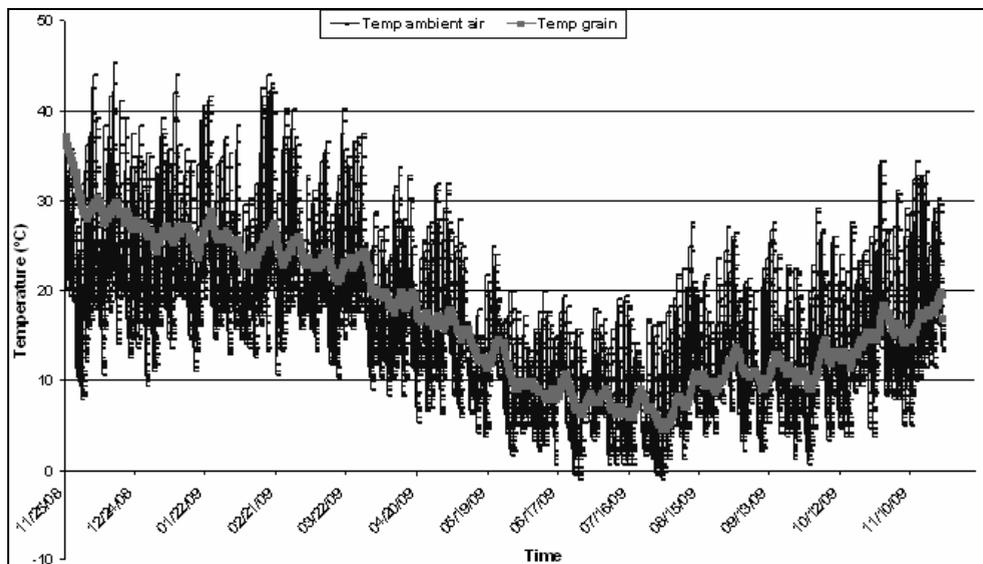


Figure 6 Temperature of the seeds and the ambient air over time of storage.

As shown in Figure 7, the r.h. of the interstitial air remained in between 40 to 50% throughout the storage period.

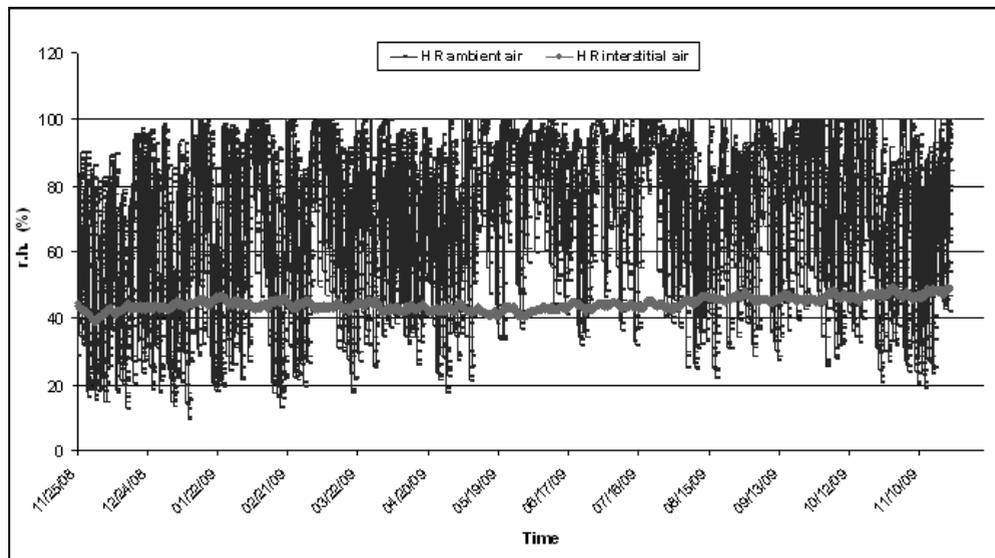


Figure 7 Relative humidity of the interstitial air and that of the ambient air over time of storage.

4. Discussion

The CO₂ concentration ranged between 1 and 8%, remaining at low levels to indicate low to moderate biological activity in the seed mass. Low biological activity was expected since the seeds had a m.c. below the safe limit of 8%. These CO₂ concentration values are in agreement with those observed by Bartosik et al. (2008) and Rodríguez et al. (2002 a, b, c) for other grains stored in silobags (wheat, soybean, sunflower and maize) in safe conditions (dry and clean). Additionally, these CO₂ concentrations agree with those reported by Darby and Caddick (2007) for canola stored at the same m.c. levels under Australian climate conditions.

In February and March, the CO₂ concentration of sampling location 2 increased from 1.5% to 8%. This increase in biological activity could be produced by the penetration of rain water through perforation that remained unsealed. However, no measurable damage was recorded in the bag. Unexpectedly, as storage time progressed the CO₂ concentration decreased down to 2%. It could be hypothesized that water penetrated the bag wetting a small proportion of grain in such a way that increased the biological activity. During the storage time, the localized moisture was slowly distributed by diffusion and air convective movements to the rest of the seed mass, eliminating the spot that could produce biological activity.

The foreign matter concentration was always below 3%, which is the tolerance of the commercial standard for canola in Argentina. It was not expected that this parameter would change during storage, but it is important to establish that to ensure that the bagging operation did not substantially increase the foreign matter, neither damaged the grain.

The fat acidity was always lower than the maximum commercial standard limit allowed in Argentina. The standard allows increase in fat acidity from harvest time until May to 1%, while the samples were below 0.8%. After May, the limit allows increase to 1.5%, while the samples had a maximum of 1.4% by November, one year after harvest.

The change in fat acidity observed in this study for canola was similar to those observed by Rodriguez et al. (2001) for sunflower seed (8.4 % m.c.) stored in silobag, which increased from 0.88% to 1.39% after 160 d of storage.

The fat content remained above the minimum limit (40%) established in the Argentina as commercial standard for canola (SAGPyA, 1994). The amount of fat remained unchanged, which is in agreement with the low biological activity observed in the bag.

These results agree with previous data (Bartosik et al., 2008; Rodríguez et al., 2002; Ochandio, 2008) that show that the average seed m.c. does not change during storage in the silobag, although some moisture stratification can be observed, particularly when seed is stored at relatively high m.c.

The temperature of the grain follows the variation of the monthly average ambient temperature, in agreement with the results found by Bartosik et al. (2008). The temperature had a minimum of 4.6°C in the winter, by the end of June, and it began to rise during spring, with the increase of the ambient air temperature. Additionally, it was also shown that the core of the grain mass did not exhibit the daily temperature oscillation that could be observed in the ambient air temperature.

The r.h. (45 %) of the interstitial air was the expected equilibrium relative humidity for canola at 6 % m.c. Since the seed m.c. did not substantially change during storage, it was also expected that the equilibrium relative humidity remained constant.

In conclusion from this study it was observed that, in spite of the small size and the special characteristics of the canola seeds, it was possible to perform the bagging and extraction operations of canola seeds without problems, and that under the conditions of temperature and m.c. evaluated in this study, it is possible to store canola seeds in silobags without quality deterioration at commercial level for a relatively long period of time of 1 year.

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