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Drying and storage conditions in white oat grains quality

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Abstract

Among quality factors of grains observed in storage physical-chemical conditions, technological properties, nutritional value, sanitary, microbiological and safety conditions are the most important. The intensity of damages caused by fungi and insects depends on the moisture content of the grain and its storage temperature. This research aimed to evaluate the effects of storage conditions in the industrial quality of oat grains. The samples were dried at three drying temperature (60, 80 and 110 °C) and stored at three ranges of grain moisture (10.5 -11.5; 12.5-13.5 and 14.5-15.5) for eight months, with and without controlled environment. The content of crude fat, acidity of crude fat, teste weight and moisture content were analyzed in the 1th, 4th and 8th month. It was concluded that: oat grains stored in non controlled environment at approximately 15% moisture showed larger reduction in the crude fat ratio and increased acidity ratio. The fatty acids composition changed during storage and increased at higher moisture content. The volumetric weight decreased along storage. The observed indexes reflected total quantitative losses, resultant of deterioration processes of grains. Oat grains when stored in environmental condition with controlled temperature are better preserved.

Key words: grains quality, storage, oat.

Introduction

Storage is an important phase to qualitative characteristics preservation of recently harvested grains during a long period and with safety, can avoid that significant deteriorations occur (Rupollo, 2003). Among quality factors we have physical-chemical conditions, technological properties, nutritional value and sanitary and safety conditions for human or animal consumption. All these factors can affect the market value of grains (Fleurat-Lessard, 2002).

Grain quality can reduce during storage due to some factors, among them harvest moisture, drying conditions, grains moisture and storage system. These factors can determine the intensity of damages caused by grains metabolism as well as insects and pests (Elias, 2006). Among these factors, in conditions of high air moisture, high grains moisture and high temperatures, deterioration occurs faster (Nora, 1992).

Quality changes that develop gradually in stored grains are result of complex interactions in an

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important ecologic system. (Multon, 1988; Tipples, 1995). According to Frisvad (1995), conditions of grains with high moisture in hygroscopic balance and maintained under environment temperature makes higher the grains metabolism, what is favorable for microorganism growing, accelerating its activity.

According Rupollo (2003), in normal aerobic conditions, the temperature and moisture are the main factors that affect the rate of CO_2 production or O_2 consumption. Other factors as storage period, fungus contamination in the storage beginning and the degree of insects infestation, can also influence (Wrigley et al., 1994).

Among oat components, lipids represent the fraction most susceptible to deterioration during storage due the reduction of its total content and/or by susceptibility to structural alterations. Scussel (2002), relate that fungus produce lipases that degrade grains fat and free fat acids, which are used as energy source in their own metabolism.

The aim of this research was to evaluate the matched effect of grain moisture and environment conditions of storage on conservation and on industrial quality of oat grains during eight months of storage.

Materials and methods

Were used oat grains of cultivar UPFA-20 Teixeirinha, harvested with about 23 % of moisture. The grains were dried in a pilot intermittent drier with three air temperatures (60, 80 and 110 °C) in three rates of moisture (10.5-11.5, 12.5-13.5 e 14.5-15.5). After stored were done physical-chemical evaluations of crude fat (AACC, 2000), crude fat acidity (AOCS, 2000), volumetric weight (using Dalle Molle balance) and moisture content (according to Agriculture Ministry). The analyses were done in the Post–harvest and Grain Industrialization Lab (Labgrãos), of Department of Science and Technology Agroindustrial (DCTA), of Faculdade de Agronomia Eliseu (FAEM), of Universidade Federal de Pelotas (UFPEL) and in the Cereals Lab of Food Research Center of Universidade de Passo Fundo (UPF). The samples were evaluated in the beginning, in the 4th and 8th months of storage.

Results and discussion

In Table 1 are represented values of crude fat of oat grains of cultivar UPFA-20 Teixeirinha, dried with three temperatures, stored with three ranges of moisture in environment conditions non-controlled during eight months.

In the storage system with non-controlled environmental condition there was reduction of crude fat value in all treatments. Rupollo (2003), studying hermetic and conventional storage systems in oats verified decrease in lipids values in both systems. In the same way, the results are in agreement with Molteberg et al. (1995), that verified decreasing in crude fat values during storage time in oat non processed and stored in relative moisture of 80 %.

In Table 2 are presented values of crude fat from oats cultivar UPFA-20 Teixeirinha, dried with three temperatures, stored with three ranges of moisture in environment conditions non controlled during eight months.

The variance analysis showed significant differences ($p < 0.05$) among treatments and time of storage related to crude fat.

In the storage with controlled environmental condition only the treatments with higher water quantity showed decreased in crude fat values during storage, showing that the storage with air temperature around 17 ºC kept the crude fat values in levels near from that found in the beginning of storage during eight months.

In the storage system with non-controlled environmental condition, there was decrease in crude fat values in all treatments. Rupollo (2003), studying hermetic and conventional storage systems in oat verified decrease in crude fat values in both systems. In the same way, the results are in agreement with Molteberg et al. (1995) that verified decrease in crude fat values during storage time of oat non processed and with relative moisture of 80 %.

This decrease in crude fat values is a result of lipids hydrolysis that occurs during storage due to grains respiration, oxidation processes and enzymatic action among other factors. Ekstrand et al. (1993)

Table 1. Crude fat in oat grains, cultivar UPFA-20 Teixeirinha, stored without controlled environment, at three ranges of grain moisture.

Drying Temperature (°C)	Moisture ranges (%)	Crude fat (%) 1	4	8
60	10.5 - 11.5	5.42 a A	5.41 a A	5.36 a A
	12.5 - 13.5	5.42 a A	5.34 a B	5.31 a B
	14.5 - 15.5	5.42 a A	5.40 a A	5.26 a B
85	10.5 - 11.5	5.42 a A	5.39 a A	5.34 a A
	12.5 - 13.5	5.42 a A	5.42 a A	5.41 a A
	14.5 - 15.5	5.42 a A	5.38 a A	5.34 a B
110	10.5 - 11.5	5.42 a A	5.42 a A	5.33 a B
	12.5 - 13.5	5.42 a A	5.40 a A	5.33 a B
	14.5 - 15.5	5.42 a A	5.27 b B	5.22 a B

[1] Simple Arithmetic means of three repetitions, accompanied by distinct small letters in the same colum with the same moisture band and big letters in the line show significant difference at 5 % by Duncan test.

Table 2. Crude fat of oat grains, cultivar UPFA-20 Teixeirinha, stored with controlled environment, at three ranges of grain moisture.

Drying Temperature (°C)	Moisture ranges (%)	Crude Fat (%) 1	4	8
60	10.5 - 11.5	5.42 a A	5.45 ab A	5.39 b A
	12.5 - 13.5	5.42 a B	5.59 a A	5.52 aAB
	14.5 - 15.5	5.42 a A	5.37 b AB	5.23 b B
85	10.5 - 11.5	5.42 a A	5.43 a A	5.42 a A
	12.5 - 13.5	5.42 a A	5.38 a A	5.40 a A
	14.5 - 15.5	5.42 a A	5.45 a A	5.38 a A
110	10.5 - 11.5	5.42 a B	5.60 a A	5.55 a AB
	12.5 - 13.5	5.42 a B	5.57 a A	5.58 a A
	14.5 - 15.5	5.42 a AB	5.50 a A	5.34 b B

[1] Simple Arithmetic means of three repetitions, accompanied by distinct small letters in the same colum with the same moisture band and big letters in the line show significant difference at 5 % by Duncan test.

verified increase in lipids hydrolysis during oat storage. Elias (2002) relates similar behavior with other grains and record that the degree of degradation is proportional to lipids contents.

Figures 1 and 2 show crude fat acidity values in oat grains of cultivar UPFA-20 Teixeirinha, stored with grain moisture between 10.5 –11.5, 12.5 – 13.5 e 14.5 – 15.5 %, in controlled and non-controlled environmental conditions during eight months.

The grain acidity of crude fat index is a good indicator of oat grains quality. In grains deteriorations the lipid hydrolysis occurs quickly than in proteins and carbohydrates. In each storage condition the increase in acidity index had a positive correlation with increase in grain moisture. The storage time also had a direct influence in the increased crude fat acidity. Although the higher increase was verified in the treatments with higher water content and stored in environmental conditions non-controlled. Using the crude fat acidity index we can verify that in the storage with controlled environmental conditions the oat grains conservation is significantly higher.

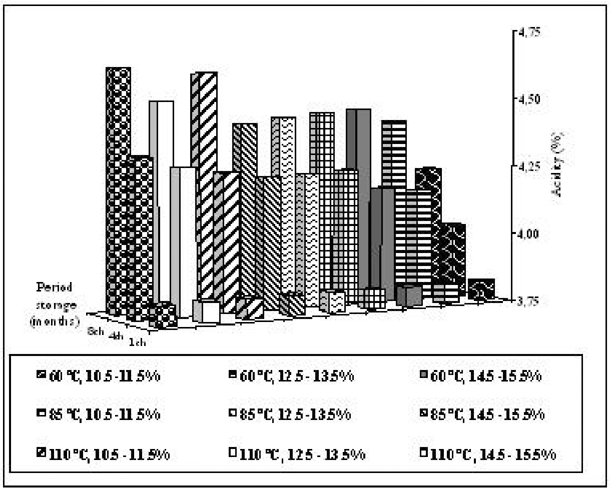

Figure 1. Acidity of crude fat in oat grains cultivar UPFA-20 Teixeirinha, submitted to intermittent drying, stored without controlled environment, at three ranges of grain moisture.

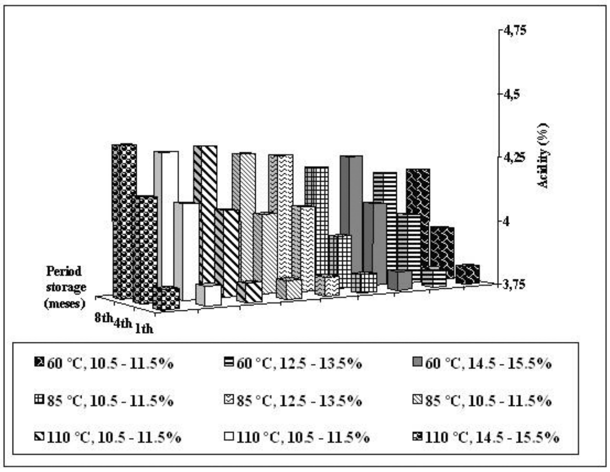

Figure 2. Acidity of crude fat in oat grains, cultivar UPFA-20 Teixeirinha, submitted to intermittent drying, stored with controlled environment, at three ranges of grain moisture.

According to Molteberg et al. (1995) oat grains, stored in a conventional system, with moisture minor then 12 %, show minimum variation in oil acidity levels. Although, moisture and temperature condition above these values, in combination with grains partial or total desagregation increases the enzymatic action, mainly the lipase activity. Gutkoski and Trombetta (1998) verified a linear acidity increase during storage of non-processed oat, while in extruded oat ther was no variation.

In Table 3 are presented the values of hectoliter weight from oat grains of cultivar UPFA-20 Teixeirinha, stored in controlled environmental for eight months, with different moisture values.

In Table 4 are presented the values of hectoliter weight from oat grains of cultivar UPFA-20 Teixeirinha, stored in non-controlled environmental for eight months, with different moisture values.

The statistic analysis showed significant differences ($p < 0.05$) in all evaluated parameters for hectoliter weight. In the treatments with higher temperature and moisture conditions it's possible to observe minor values of hectoliter weight. Despite of the use of intermittent drying, the hectoliter weight decreasing is mostly due to final moisture of storage and not by mechanic damages, as well as in other cereals (Marini, 2004).

Besides to have differences by environmental conditions and storage moisture, the hectoliter weight had significantly decreasing in all treatments during the storages period. The observed indexes reflect total quantitative lost, resulting from deterioration processes of grains due to its intrinsic metabolism, microbial activity and associated plagues. Minor variations correspond to better conservative parameters of grain mass during storage (Elias, 2002).

In Figures 3 and 4 are represented the average values of water quantity in oat grains for each treatment stored in non-controlled and controlled environmental conditions, respectively, during eight months.

The results presented in Figures 3 and 4 show variation in moisture values in grains during the storage period, tending to hygroscopic balance, which is determined based on temperature and air relative moisture. The grain mass in contact with environmental air where occurs relative moisture oscillation will absorb or give water, reaching the hygroscopic balance where air steam pressure is the

Table 3. Hectoliter weight of oat grain of cultivar UPFA-20 Teixeirinha, submitted to intermittent drying with three air temperatures, stored in conventional system in controlled environmental condition, in three ranges of moisture during eight months.

Drying Temperature (ºC)	Moisture ranges (%.b.u.)	Hectoliter weight [1] (kg/m^3) 1	4	8
60	10.5 - 11.5	44.30 a A	43.56 a B	43.33 a C
	12.5 - 13.5	43.95 b A	43.45 a B	43.23 a C
	14.5 - 15.5	44.33 a A	43.28 b B	42.92 a C
85	10.5 - 11.5	43.75 b A	43.18 b B	42.92 a C
	12.5 - 13.5	44.06 a A	43.42 a B	43.10 a C
	14.5 - 15.5	43.88 ab A	42.14 c B	41.85 b C
110	10.5 - 11.5	42.89 a A	42.36 b B	42.03 b C
	12.5 - 13.5	42.93 a A	42.74 a A	42.41 a C
	14.5 - 15.5	42.98 a A	40.69 c B	40.38 c C

[1] Simple Arithmetic means of three repetitions, accompanied by distinct small letters in the same colum with the same moisture band and big letters in the line show significant difference at 5 % by Duncan test.

Table 4. Hectoliter weight of oat grain of cultivar UPFA-20 Teixeirinha, submitted to intermittent drier with three air temperatures, stored in conventional system in non-controlled environmental condition, in three ranges of moisture during eight months.

Drying Temperature (ºC)	Moisture ranges (%.b.u.)	Hectoliter weight [1] (kg/m^3) 1	4	8
60	10.5 - 11.5	44.30 a A	44.02 a B	43.41 a C
	12.5 - 13.5	43.95 b A	43.81 b B	42.85 b C
	14.5 - 15.5	44.33 a A	43.85 ab B	43.36 a C
85	10.5 - 11.5	43.75 b A	43.22 b B	42.23 a C
	12.5 - 13.5	44.06 a A	43.45 a B	41.96 b C
	14.5 - 15.5	43.88 ab A	42.81 c B	40.71 c C
110	10.5 - 11.5	42.89 a A	42.34 a B	41.39 a C
	12.5 - 13.5	42.93 a A	42.37 a B	41.33 a C
	14.5 - 15.5	42.98 a A	42.45 a B	41.48 a C

[1] Simple Arithmetic means of three repetitions, accompanied by distinct small letters in the same colum with the same moisture band and big letters in the line show significant difference at 5% by Duncan test.

same of grain steam pressure. Chemical composition of this cultivar, genetic charge, environment, drying temperature and air relative moisture are factors that most have influence in hygroscopic balance of grains (Chen, 2000).

In the first four months, the treatments stored in controlled environmental conditions had a little drop in water values, coincided with months with minor relative moisture and by being stored with controlled air temperature favoring the hygroscopic balance with minor water content. Although, when stored in non-controlled environmental conditions, the water content found hygroscopic balance with environment in higher levels of moisture.

Although the moisture means show differences statistically significant, what has scientific importance, in technologic and commercial aspects just has importance in differences higher then 0.5 percent points in the same determination.

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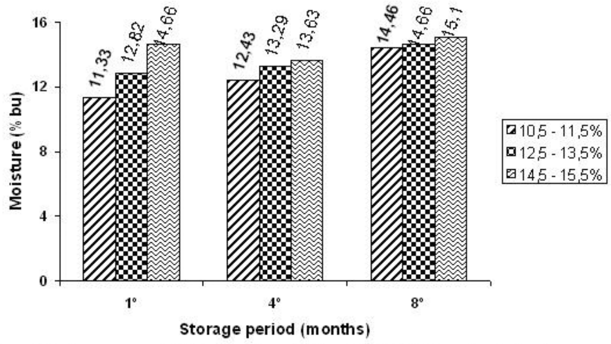

Figure 3. Moisture content (% wb) in oat grains of cultivate UPFA-20 Teixeirinha submitted to intermittent drying, stored in three moisture ranges during eight months in non-controlled environmental condition.

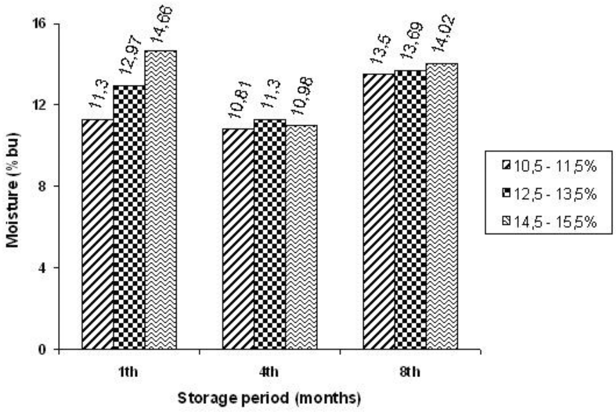

Figure 4. Moisture content (% wb) in oat grains of cultivate UPFA-20 Teixeirinha submitted to intermittent drying, stored in three moisture ranges during eight months in controlled environmental condition.

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