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Effects of drying methods and storage period in the industrial quality of wheat

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Abstract

The objective of this work is to study the influence of drying methods and storage period in the industrial quality of wheat. Samples of wheat (*Triticum aestivum*, L.) produced in a cultivated plain were harvested with moisture near to 19 % (conventional harvest) . The grains were submitted to four drying conditions: drying with natural air, not forced, stationary drying with air temperature at 45 ± 5 °C, and intermittent drying with air temperature at 65 ± 5 ° C and at 85 ± 5 °C in order to dry them to 13 % moisture. Dried grains were stored in cotton sakes, in a conventional system. At every four months the following evaluations were conducted: hectoliter weight, moisture, protein, acidity of the ethereal extract, ashes, falling number and alveographic properties. The results indicated that intermittent drying at 65 ± 5 °C showed improved ethereal extract stability, an smaller loss of hectoliter weight in storage and consequently lower ash content, although there is an equivalence among the stationary and intermittent drying since the temperature of the grains does not surpass 45 ^{o}C. The storage for a period of eight months dried under the conditions studied did not alter significantly the technological quality of the flour.

Key words: wheat, drying method and storage.

Introduction

Wheat is of great importance for the economy of Brazil, due to the high consumption of its derivatives, mainly bread, pasta and flour. However, national production of the grain has not been enough to assist the demand, worsened by the great amount of lost grains or harvested with inferior quality, insects attacked or occurrence of rain in the harvest period (Carneiro et al., 2005).

Through drying and a safe storage, it is possible to conserve agricultural products. Drying may be accomplished by methods non forced (natural method) forced (mechanical method). In the first one, the slowness and the dependence of the climatic conditions are the largest limitations, although the low cost induces many farmers to use them (Elias, 2002). Forced drying is an artificial process, destined to remove the moisture excess to the convenient limit, with the responsibility of not altering chemical, biological and you functional properties of the grains. The drying of the grains, with not very warm air, even if it is not so fast, it conserves the wheat in the better characteristics than when it is dried with higher temperature, that increases the speed of the process, but it may damage the grain. Drying with low temperature does not offer conditions the grains to loose certain volatile substances, contributing to the permanence of the original

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qualities of the product (Puzzi, 2001). Drying temperature should be adequated to the operational flow, the initial grain moisture and the application which the dried grain is destined, and the drying temperature should be around the average that are used in the mill and/or in other agroindustrial applications (Omafra, 2002).

After harvesting, drying and conditioning constitutes the main technological factors that may modify the wheat quality, especially the characteristics of the gluten proteins. Deficient or high temperature drying can provoke the proteins denaturation and therefore reducing the product technological quality (Mandarino, 1993).

Wassermann (1978) recommends a drying temperature for wheat of 36-45 °C, depending on the moisture content. In agreement with Tossi (1985), drying temperature of 58 °C does not provoke any adverse effect, but at 66 °C, there is a considerable deterioration in the quality of wheat.

Drying temperature superior to 60 °C reduce the proteic extraction. In grains harvested with high moisture content the decrease in proteic extraction is accentuated at 60 °C, while wheat harvested with low moisture the decrease in the gluten extraction is observed with drying temperature above 75 °C (Wassermann, 1978; Omafra, 2002).

Ragasits (1993), studying several drying temperatures, in two wheat varieties, observed a accentuated decrease in the amount of washed gluten. The decrease was noticed at 60 °C in both varieties, being intense with heat treatment at 80 °C, while at 100 °C the gluten could not be isolated any longer. The pharinographic value reflected a good quality in both varieties. Temperature ranging from of 20, 40 and 60 °C did not, practically, modify the quality, while heat treatment at 80 °C reduces the quality. In response to the drying treatments, the enzymatic activity also expressed by the falling number is affect, having the highest change at 100 °C. Such alteration in the falling number, as in the other quality parameters, evidences quality reduction during drying.

The aim of this work is to study the influence of drying methods and of time of storage in the technological quality of wheat.

Material and methods

The experiment was accomplished in the laboratories of the Agroindustrial Science and Technology Department, FAEM/UFPEL, Pelotas, RS and of the Industrial Quality of Wheat at the National Center of Wheat Research - EMBRAPA/CNPT Passo Fundo, RS. Wheat (*Triticum aestivum* L.) samples, produced in the South of Brazil were used. The wheat was harvested with approximately moisture of 19 %. The grains were submitted to four drying conditions: drying with natural air (no forced), stationary drying with air temperature at 45 ± 5 °C, intermittent with air temperatures at 65 ± 5 °C and at 85 ± 5 °C in order to dry them to 13 % moisture. The storage was in cotton sacks, in a conventional system, for twelve months. At 4, 8 and 12 months were measured the moisture content by the official method at 105 ± 3 °C, for 24 hours (Brasil, 1992), The hectoliter weight was measured by the Dalle Molle method, ashes by the method 13.006 A.O.A.C. (2000), ethereal extract (AACC, 2000), milling method 26-95 (AACC, 2000), falling number method 56-81B (AACC, 2000) and alveographic method 54-30 (AACC, 2000). The experiment was accomplished entirely according to a random delineation, with 3 repetitions for each treatment. The comparison of averages was made through the test of Tukey to 5 % of significance (Zonta et al., 1994).

Results and discussion

Figure 1 shows the increase of wheat moisture in all treatments during the storage. In all drying treatments with warm air the action of heat interfered in the hygroscopic equilibrium that was reached only after the fourth month of storage.

The wheat dried in natural conditions maintained its hygroscopic equilibrium having small alterations due to the variation of the room temperature of storage in different seasons. More accentuated changes were observed in grains dried under forced air conditions, as their moisture after drying was lower than the hygroscopic equilibrium. It may be affirmed that the hygroscopic equilibrium was more affected the higher the drying temperature used. Puzzi (2001) reported that the moisture content of the wheat grain decreases, approximately, 0.7 point-percent (p.p.) for each 10 °C of air temperature increase for the same time of drying and for greater temperature variations the hygroscopic equilibrium significantly affected.

The value of the moisture equilibrium is very important in the conservation of grain quality. When the vapor pressure of the grain is larger than the surrounding air, it happens the desorption, having water vapor transference from the grain to the air. The opposite happens when the vapor pressure of the grain is smaller than surrounding air, having a water sorption by the grains, humidifying them back consequently. When there is a higher moisture gradient between grain and air, a more intense change will happen. The grains chemical composition, physical integrity, sanitary state, hygrothermic gradients and post harvest operations interfere in the hygroscopic equilibrium, but drying and the storage are the most important (Elias, 2002).

Figure 2 shows the decrease of the hectoliter weight verified in all treatments along the storage, this decrease is due to a more intense consumption of organic compounds due to grains metabolism.

The smallest variation of hectoliter weight was verified, in one year of storage, in those grains

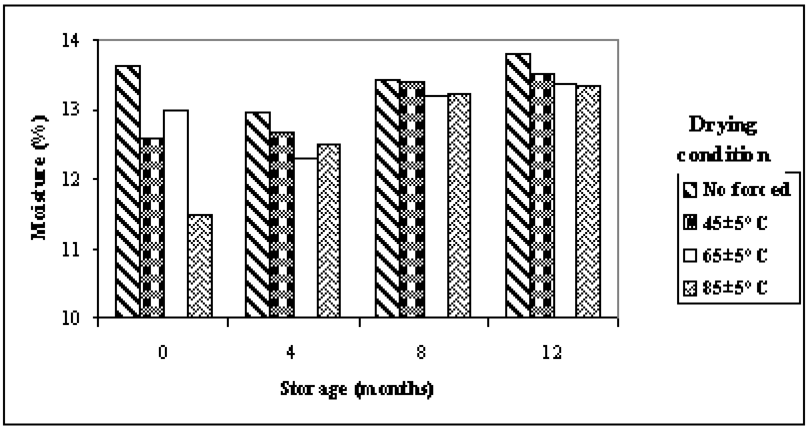

Figure 1. Moisture (%) in wheat grains submitted to four drying treatments and stored for twelve months.

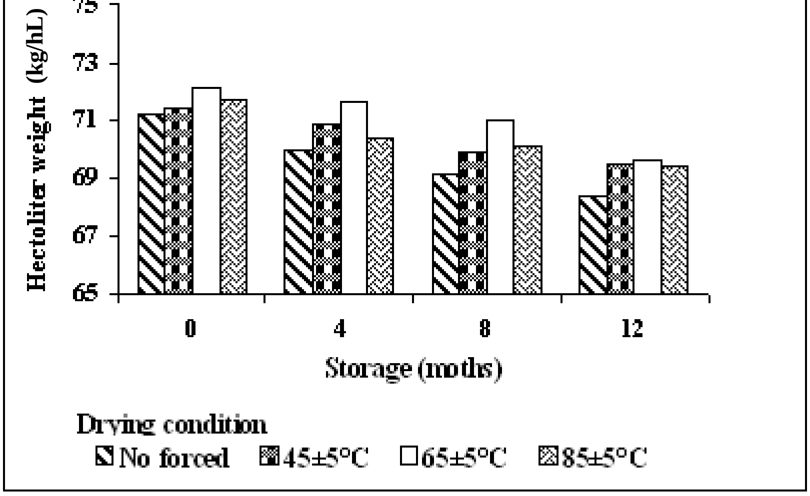

Figure 2. Hectoliter weight (kg/hL) in wheat grains, submitted to four drying treatments and stored for twelve months.

submitted to intermittent drying at 65 ± 5 ºC. The intermittent process did not show significant technical difference as in this process the time of air contact with the grains was short at the most up to 20 minutes per cycle and the temperature of the mass of grains did not surpass 45 ºC.

Figure 3 shows an increase in the acidity of ethereal extract content in all treatments during the storage. Peter (1996) has also found that the acidity of ethereal extract presented an increase in its content, in function of the degradation of these constituent and due to metabolic activity during storage.

Observing the values presented in Figure 4, it was observed that the acidity of the ethereal extract increased in all drying treatments during storage, although the percentages were not the same, the smallest increase in acidity was verified for the intermittent drying at 65 ºC.

The acidity of ethereal extract has shown to be an adequated tool to evaluate the quality of stored grains. The increase of its content denotes a direct relation to the grain's lipase activity or produced by microorganisms developing rancidity during long storage (Omafra, 2002).

Comparing to other basic constituent of the

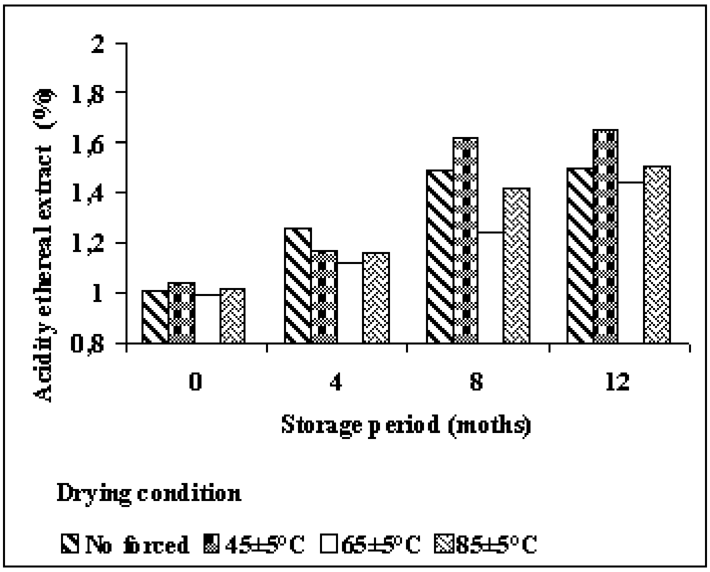

Figure 3. Acidity Ethereal extract (%) in wheat flour, submitted to four drying methods and stored for twelve months.

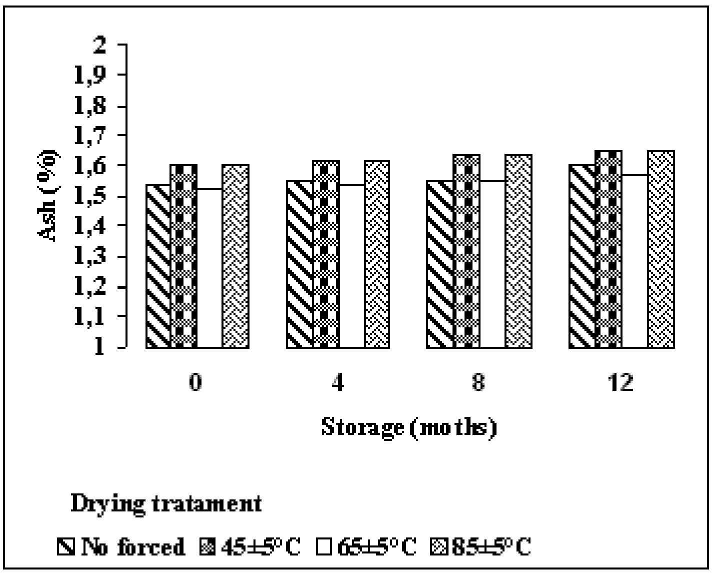

Figure 4. Ashes (%) in the wheat flour, harvest with two moisture content, submitted to two drying methods and stored for twelve months.

grains the ethereal extract presented the largest degradation. The high instability of these constituents is due to its high reactivity of the lipids and the availability of oxygen. Forlin (1991) and Elias (2002) mentioned that grain stored with high moisture and temperature favors the action of enzymes and the associated microorganism predisposing and accelerating the degradation process.

Figure 4 shows the increase in the mineral content in all the treatments during storage. It was observed a difference among the drying methods with relationship to mineral content.

The proportional increase in mineral content in all treatments is due to the consumption of organic compounds due to the grain metabolism during storage and the values observed are proportional to the increase in the acidity.

The minerals content in grain and consequently in the flour is influenced by genetic factors, edaphic and climatic conditions, agronomic, physiologic (stage of maturation of the grain in the crop) and technological (conditioning of the grain before milling grinding and degree of extraction of the flour during the milling) (Mandarino, 1993).

Drying and conditioning after the harvests are operational factors that may modify the characteristics of the gluten. Deficient drying or drying in high temperatures may provoke the denaturation of the proteins (Mandarino, 1993).

The drying methods did not interfere in the alveographic values. The storage time interfered in the alveographic values of area of the graphic ($W=10^{-4}$ J) and they increase up to 8 month, when it started a period of quality reduction (Figure 5).

The maximum rupture pressure or "P", it is considered as an index of mass stability, indicating its resistance to deformation, and it is correlated positively with the water absorption capacity of the flour (Chen and D'appolonia, 1985).

The extensibility, or "L", it is an indicative of bread volume. In general the large the L value will be biggest is the bread volume. But this characteristic is also dependent the on P value as it should exist a proportionality between the P and L content (relationship P/L) associated to the W value (work to develop the dough), end it expresses a good potential for bread making (Chen and D'appolonia, 1985). The values of P/L (not presented) related to the W showed that the technological properties of the flours of the grains stored up to 8 months after drying as the four treatments mentioned were maintained.

Figure 6 show that the enzymatic activity

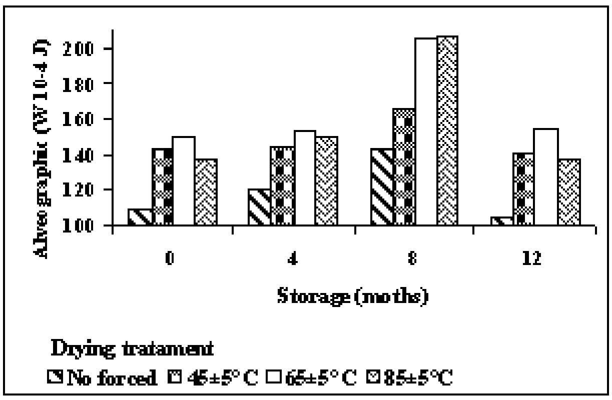

Figure 5. Alveographic (W 10^{-4} J) in wheat flour, harvest with two moisture contents, submitted to two drying methods and stored for twelve months.

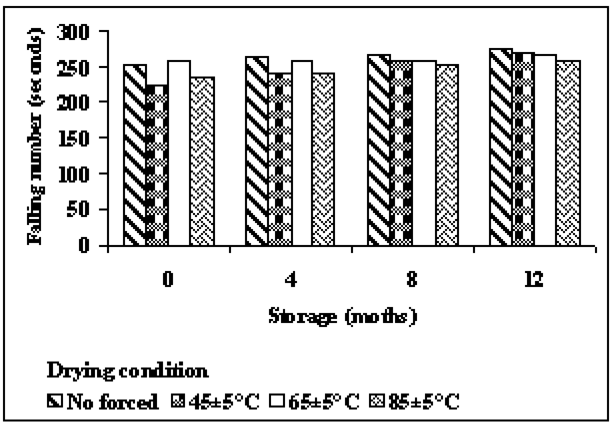

Figure 6. Falling Number (Seconds) of the wheat flour, harvest with two moisture content, submitted to two drying methods and stored for twelve months.

measured by the falling number stayed stable in all the treatments during the storage. That stability evidences that the drying and storage conditions conserved all characteristic as well as of not favoring germination.

An exxcess of á-amylase activity provokes the scarification of the starch molecules during the fermentation of dough, resulting in sticky and humid texture in the internals parts of the breads. Low activity of á-amylase enzyme affects the bread-making negatively, resulting in final product with dry and brittle intern texture (Beleia, 1982). The drying methods studied and the storage of wheat grains for up to 8 months did not alter the technological properties of its flours for bread making.

It was observed that the storage for 12 months in conventional system reduces the hectoliter weight, increases the acidity ethereal extract content, increases the ash contents, without however altering the technological quality of the flour.

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References

American Association Of Cereal Chemists, 1983. Approved methods of the AACC. St. Paul, MN, 2000.

AOAC- Association of Official Analytical Chemistr, 2000. Official methods of analysis of the Association of Official Analytical Chemistry. 16 ed. Arlington: Washington, v. I e II,

Beleia, A., 1982. Níveis de alfa-amilase de farinhas de algumas cultivares de trigos brasileiros. Embrapa, (Boletim de Pesquisa n° 5).

Brasil, 1992. Ministério da Agricultura do Abastecimento e da reforma Agrária. Regras para análise de sementes. Brasília: MAPA,. pp. 365.

Carneiro, L.M.T.A., Biagi, J.D., Freitas, J.G. De, Carneiro, M.C., Felício, J.C., 2005. Diferentes épocas de colheita, secagem e armazenamento na qualidade de grãos de trigo comum e duro. Bragantia 64, 1-5.

Chen, J., D'appolonia, B.L., 1985. Alveograph studies on hard red spring wheat flour. Cereal Foods World 30, 862-867.

Elias, M.C., 2002. Secagem e armazenamento de grãos, em média e pequena escala. 3ªed. Pelotas: Editora e Gráfica Universitária, , pp.219.

Forlin, F.J., 1991. Conservabilidade de grãos de sorgo granífero (*Sorghum bicolor* L.), armazenados com umidade de colheita e incorporação de ácidos orgânicos, nos sistemas convencional, granel e hermético: Pelotas: Universidade Federal de Pelotas,. 162p. Dissertação de Mestrado em Ciência e Tecnologia Agroindustrial.

Mandarino, J.M.G., 1993. Aspectos importantes para a qualidade do trigo. Londrina, EMBRAPA - CNPSo, pp. 32.

Peter, M.Z., 1996. Uso de microondas na conservação de farelo e grãos de arroz: Pelotas: Universidade Federal de Pelotas,. 74p. Dissert. (Mestrado) Ciência e Tecnologia Agroindustrial.

Puzzi, D., 2001. Abastecimento e Armazenamento de Grãos. Campinas, SP: Instituto Campineiro de Ensino Agrícola, pp. 666.

Ragasits, I., 1993. Effect of drying on the baking quality of wheat. Cereal Research Communications, 21, 1, pp. 87-92.

Tossi, E., 1985. Influencia de la temperatura final delgrano, tiempo de residencia e internsidad de secado en la modificacion de la celidad pana dera. Alimentaria, 164, pp.77-82.

Wassermann, L., 1978. Einfluss der trocknung auf die backeigenschaften von getreide. (In: Trocknung von getreide und mais symposion, 23. Institut für Agrartechnik, Universität Hohenheim, Sonderforschungsbereich 140, 139.

Omafra, S., 2002. Cereals: Drying and Storing Wheat. Ministry of Agriculture, Food and Rural Affairs. Canadian.

Zonta, E.P., Machado, A.A., Sanest, 1994. Sistema de Análise Estatística para Microcomputadores. Registrado na SEI - Secretaria Especial de Informática, sob o número 066.060, Categoria A Pelotas.