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Challenges and Importance of Post-Harvesting of Agricultural Products for food security in the Brazilian scenario

ENGENHARIA AGRÍCOLA UFSM

Prof. Dr. Paulo Carteri Coradi

Federal University of Santa Maria (UFSM) - Brazil

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LOCATION


Universidade Federal de Santa Maria
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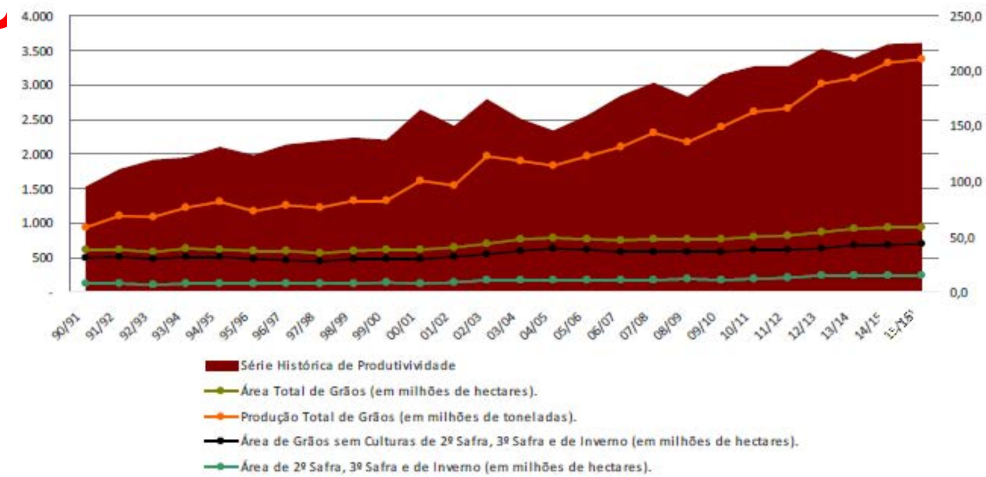
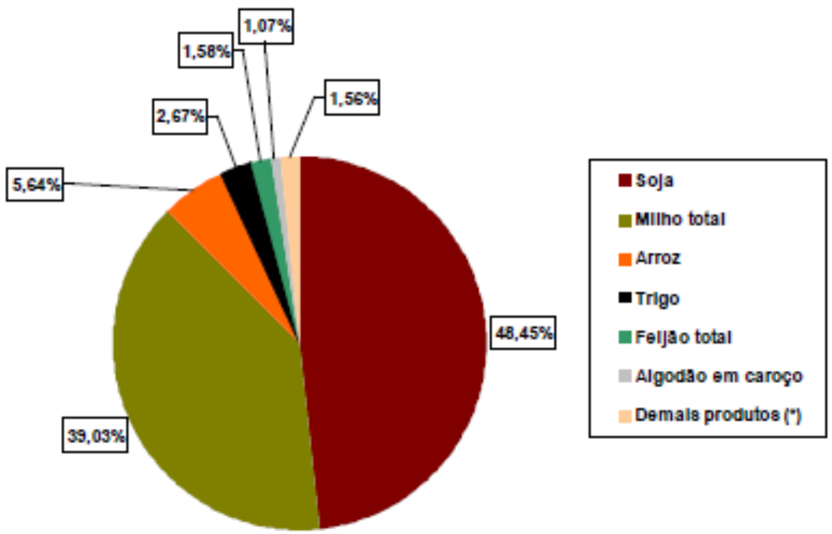
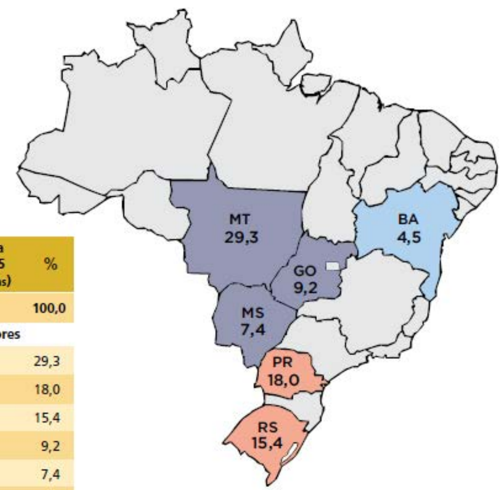
BRAZILIAN AGRICULTURAL DIVERSITY AND PRODUCTION

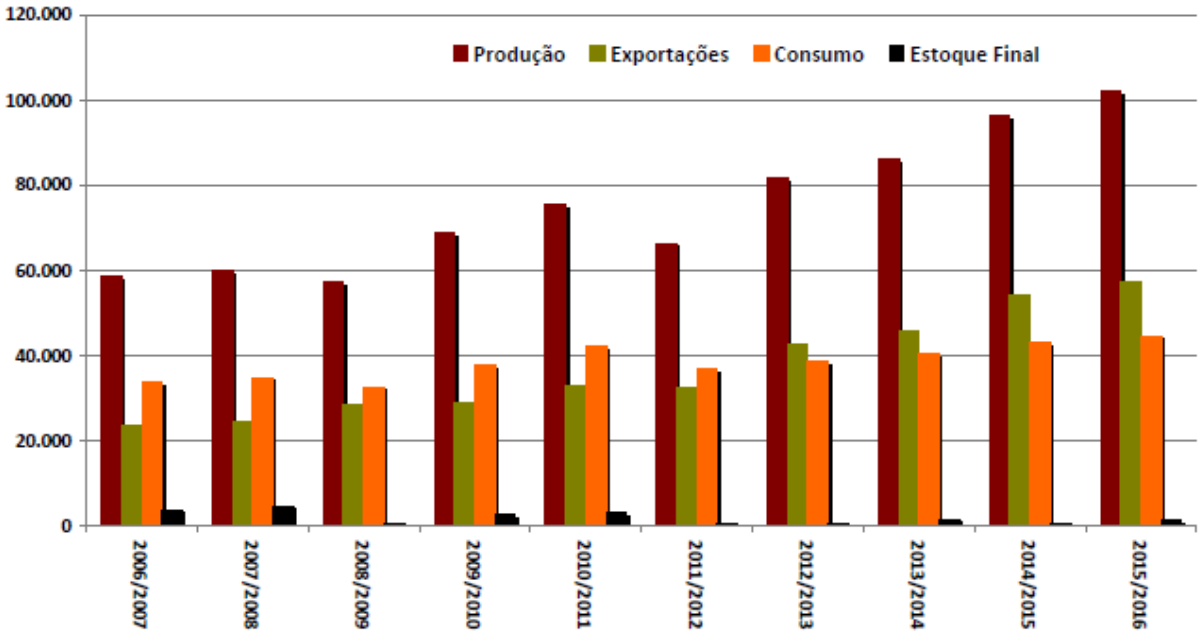




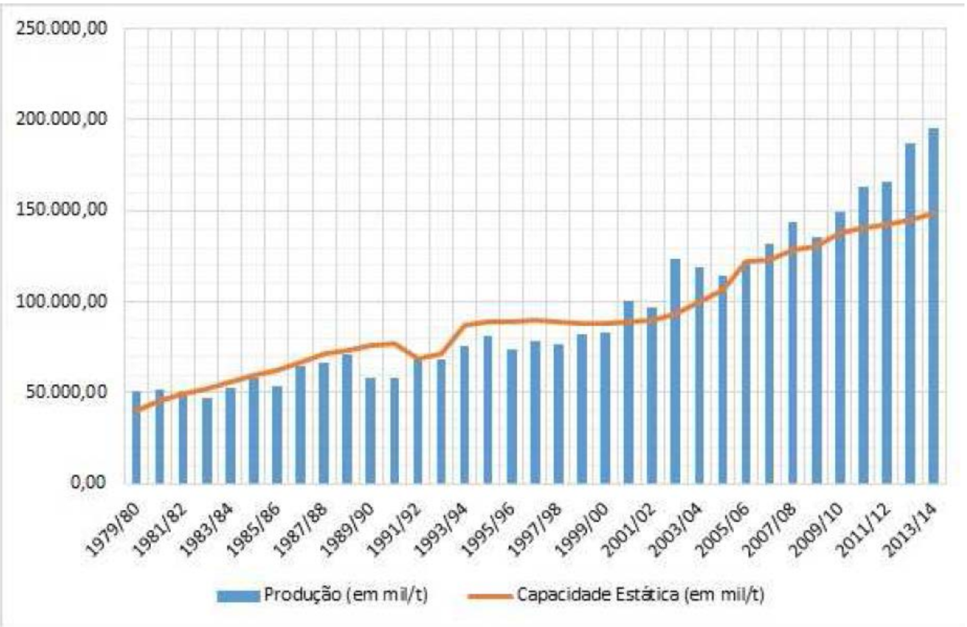
SOJA GRÃO	Ano Safra 2014/2015 (mil Toneladas)	%
Produção Nacional	95.070	100,0
Principais estados produtores		
Mato Grosso	27.869	29,3
Paraná	17.136	18,0
Rio Grande do Sul	14.688	15,4
Goiás	8.703	9,2
Mato Grosso do Sul	7.040	7,4
Bahia	4.239	4,5
Total	79.674	83,8

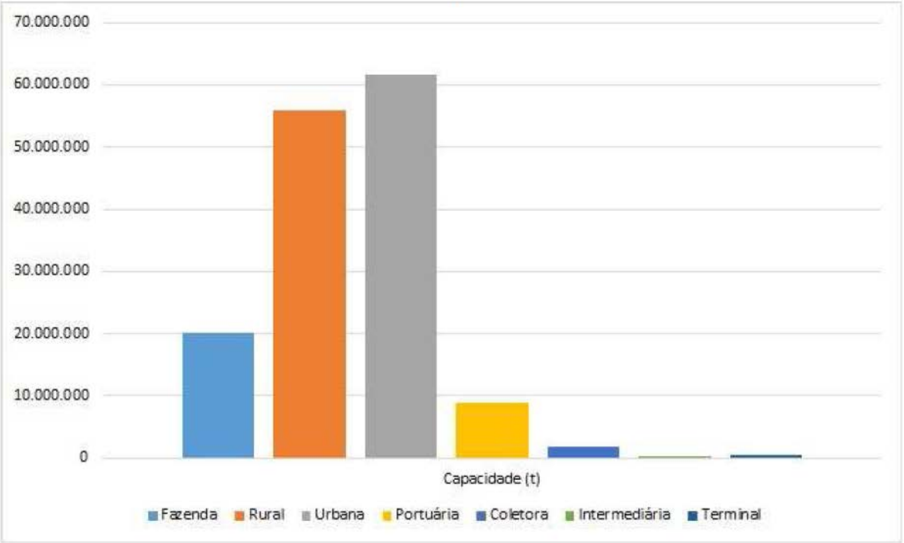
Fonte: Conab - Levantamento maio / 2015



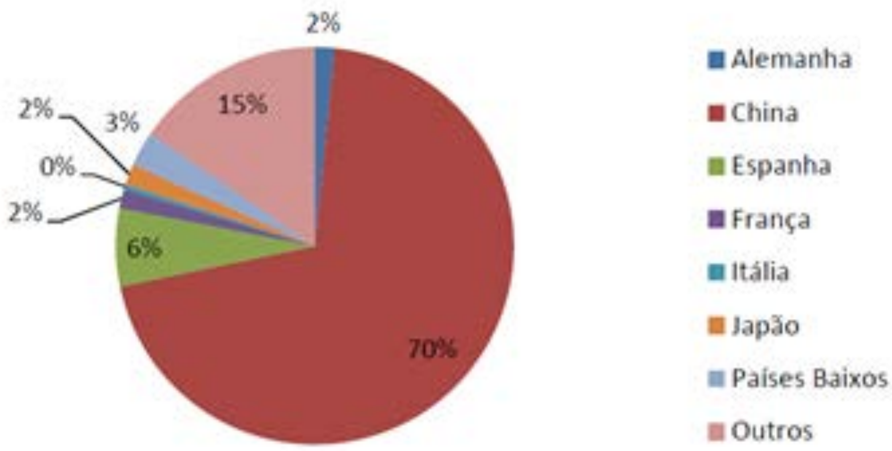


BRAZILIAN POST-HARVEST SCENARIO - STORAGE

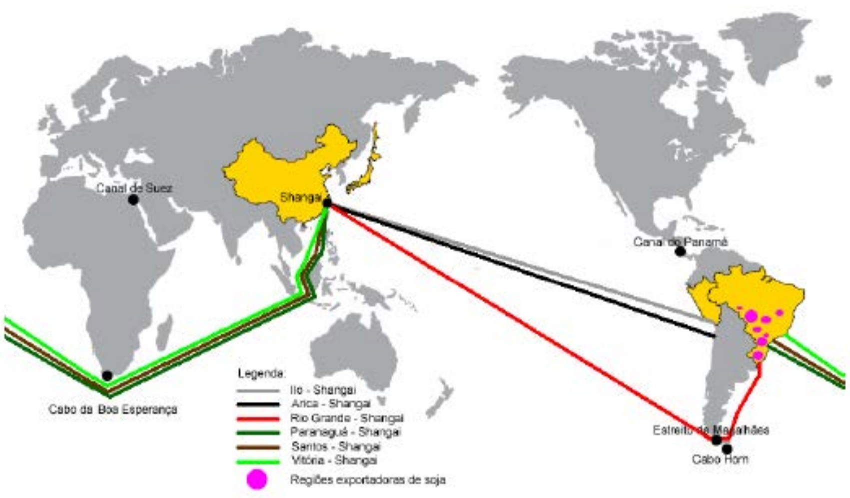




BRAZILIAN AGRICULTURAL LOGISTICS - EXPORT CORRIDORS



Soybean export route



Cost of Logistics in% of GDP in different countries

País	% do PIB
Peru	24,0
Argentina	21,0
Brasil	20,0
México	18,0
Irlanda	14,2
Singapura	13,9
Hong Kong	13,7
Alemanha	13,0
Taiwan	13,0
Dinamarca	12,8
Portugal	12,7
Canadá	12,0
Japão	11,3
Holanda	11,3
Itália	11,2
Reino Unido	10,6
Estados Unidos	10,5

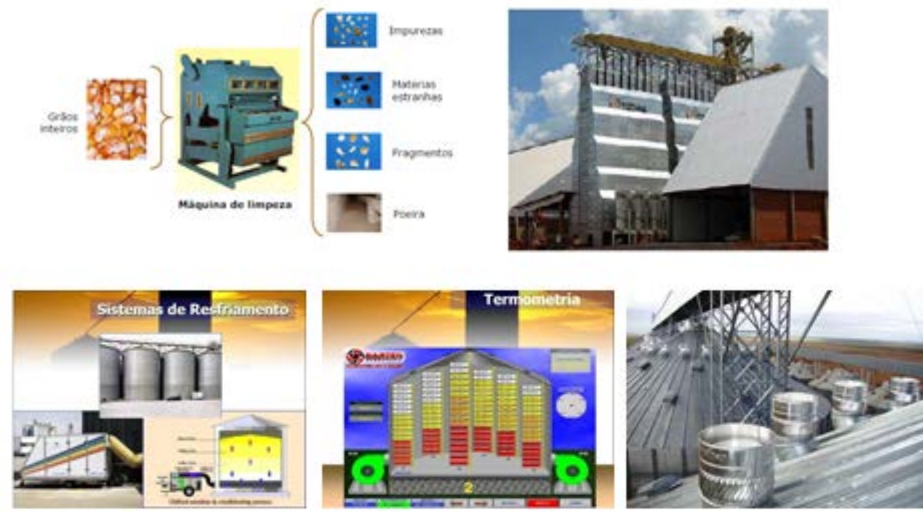
BRAZILIAN AGRICULTURAL LOGISTICS

Modal transport in different countries

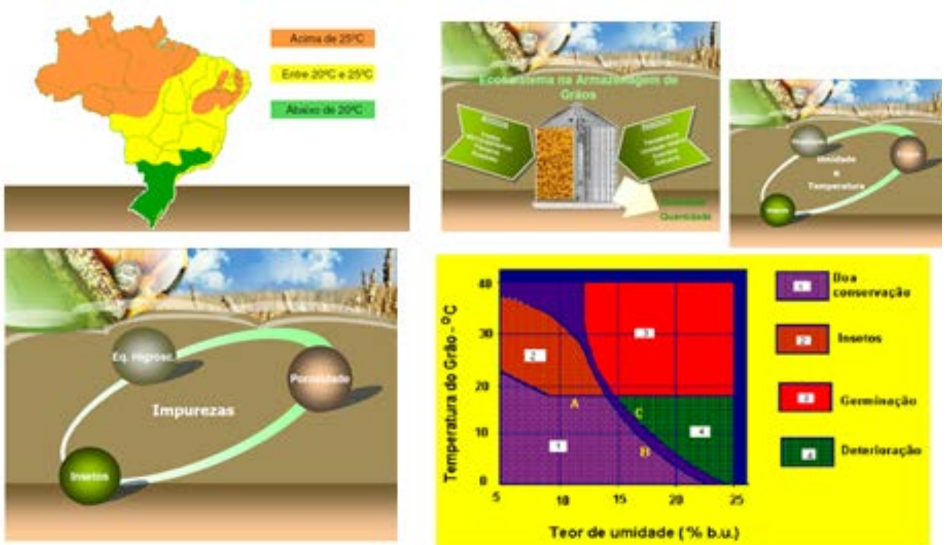
Países	Rodovia	Ferrovia	Hidrovia
Rússia	8	81	11
Estados Unidos	32	43	25
Canadá	43	46	11
Austrália	53	43	4
Alemanha	71	15	14
Brasil	58	25	17
França	81	17	2

POST-HARVEST STRUCTURES

POSTHARVEST TECHNOLOGY



CHALLENGES: REDUCING LOSSES AND INCREASING QUALITY OF AGRICULTURAL PRODUCTS



CHANGES IN QUALITY OF GRAIN DURING STORAGE

RESEARCH GROUP / PARTNERS / COLLABORATORS

RESEARCH GROUP

- **Postharvest Engineering and Agricultural Products Quality**

RESEARCH LINE

- **Postharvest Engineering**
- **Processing**
- **Drying**
- **Storage**
- **Agricultural Products Quality**

EXPERIMENTAL AREA AND LABORATORY OF POSTHARVEST, PRE-PROCESSING, DRYING AND STORAGE OF AGRICULTURAL PRODUCTS

Universidade Federal de Santa Maria

SEDES SAPIENTIAE

1960

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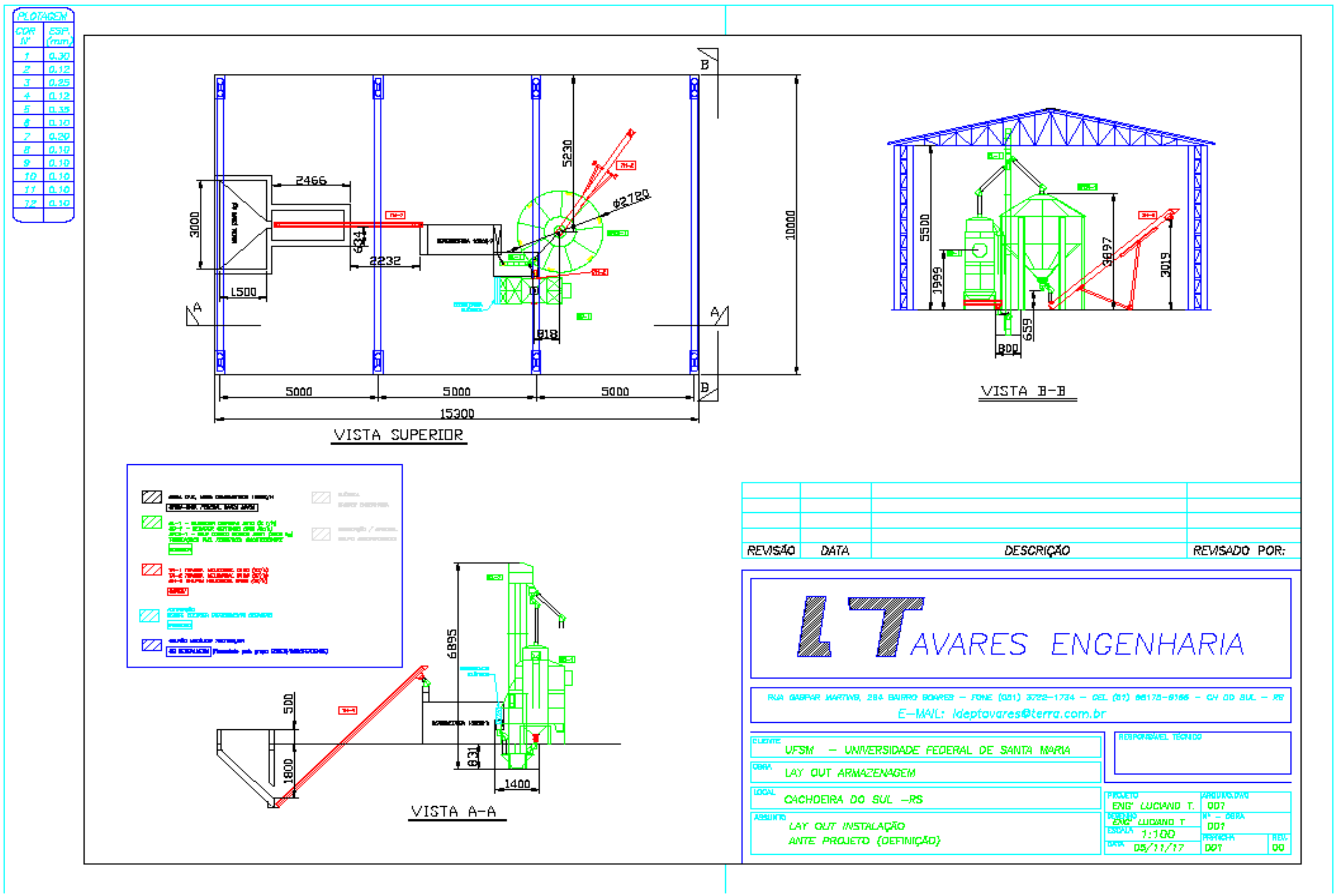
UFSM

LAPOS

EXPERIMENTAL AREA AND LABORATORY OF POSTHARVEST, PRE-PROCESSING, DRYING AND STORAGE OF AGRICULTURAL PRODUCTS



RESEARCH RESULTS

PRE-PROCESSING AND QUALITY OF CORN AND SOYBEAN

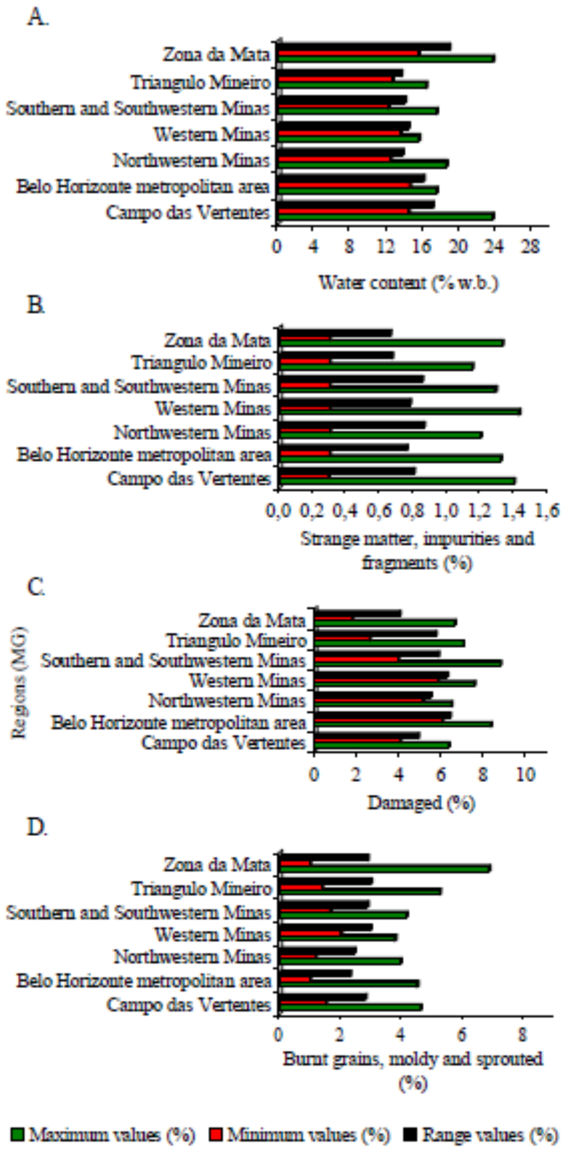
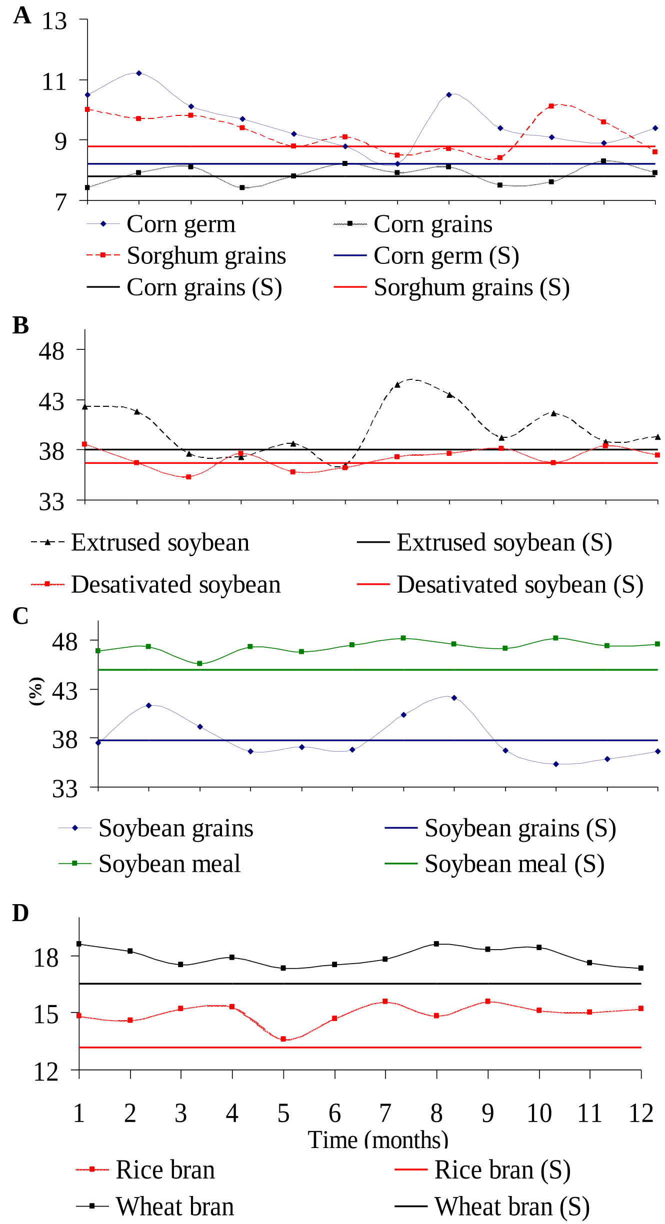


Figure 6. Water content (A), percentage of strange matter, impurities, and fragments (B), percentage of damaged grains (C), percentage of burnt, moldy, and sprouted grains (D) in corn from different regions of Minas Gerais State



CRUDE PROTEIN

DRYING CORN GRAINS X ETHANOL YIELD

1175

Original Article

DRYING AND STORAGE OF CORN GRAINS FOR ETHANOL PRODUCTION IN BRAZIL

DRYING AND STORAGE OF CORN GRAINS FOR ETHANOL PRODUCTION IN BRAZIL

Paulo Carteri CORADI[1]; Lélia Vanessa MILANE[2], Lucas Jandrey CAMILO[3]; Maria Gabriela de Oliveira ANDRADE[3]

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ABSTRACT: The aim of the present research was to evaluate the effects of drying air temperature and storage conditions used in Brazil on the quality of corn grains (*Zea mays* L.) for ethanol production. The experiment was set up in a completely randomized design in a (3x2x2) factorial arrangement (drying air temperatures of 80, 100 and 120 °C vs. ambient storage conditions of 23 °C / 60% RH and cooled to 10 °C / 40% RH vs. storage time of zero and six months). The corn grains were harvested with a water content of 18.0% (w.b.). Then, they were dried in a convection/forced-air oven at different temperatures, until water content reached 12% (w.b.). After that, the grains were stored. It was concluded that the increase in drying air temperature reduced lipid content and starch percentage, decreasing ethanol yield to 38.74 L ton^{-1} of grains. Storage under refrigeration at 10 °C was favorable for the maintenance of lipid levels (+2%), starch percentage (6%) and ethanol yield (33 L ton^{-1} of grains). Thus, considering production conditions and weather in Brazil, grains should be dried at air temperatures up to 80 °C, and storage must be performed under refrigerated air up to 10 °C for quality assurance of maize grains in the dry season and, therefore, increased ethanol production in the industry.

KEYWORDS: Biofuels. Industry. Production. *Zea mays* L.

INTRODUCTION

Maize (*Zea mays* L.) is grown worldwide. It is native to Central America and its economic importance is evidenced by the various forms of use, whether in animal or human consumption (FAO, 2012). Brazil is among the three largest producers of maize, having produced 72 million tonnes in the last harvest (ABIMILHO, 2014). Given Brazil's huge productive capacity, quality products have to be offered to the market; therefore, the practices adopted from harvest to storage have to be the most adequate and safe in order to avoid losses and preserve the products' properties (CORADI et al., 2015). Only 15% of the world production of maize is intended for human consumption while the other 85% is intended for animal feed, i.e. animal nutrition accounts for the great demand for maize, as it is a traditional energy source of formulations (FAO, 2012).

With the advent of flexible fuel engines, an innovative technology introduced in 2003, and the growth of Brazil's automobile industry, the scenario has changed: ethanol became an indispensable product in the fuel market in Brazil, despite the constant price fluctuations faced by the alcohol industry and consumers in periods of harvest and fallow, respectively (GOLDEMBERG et al., 2008).

Concomitantly, the incorporation of new areas for production of energy from agriculture has occurred without competition against food farming. There is great availability of land with degraded pastures, where the inclusion of sugar cane can also benefit cattle farmers by increasing the profitability of their farms and improving soil fertility (GOLDEMBERG et al., 2008).

Brazil and the United States are world leaders in ethanol production (HETTINGA et al., 2009). World production of ethanol is approximately 13.5 million gallons. Brazil accounted for 33.3% of this volume, producing alcohol from sugarcane, while the United States have produced 36.3% from maize (FAO, 2012; DINNEEN, 2015). In spite of instabilities and following the path of technological innovation, the sugar cane industry has introduced, into the Brazilian market, ethanol produced from industrial processing of maize. However, there are some concerns that could influence the decision to implement, in Brazil, a production unit of ethanol based on maize grains. For example, the post-harvest sector, precisely the drying and storage of grains, because maize is a crop produced in two seasons of the year and, therefore, grains would need to be stored in order to meet the demands of ethanol production.

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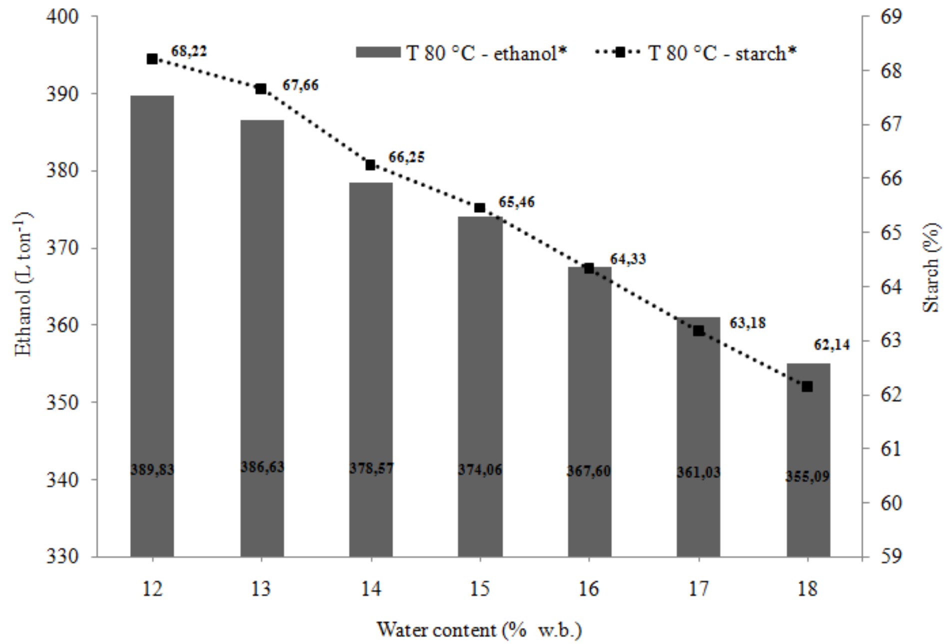
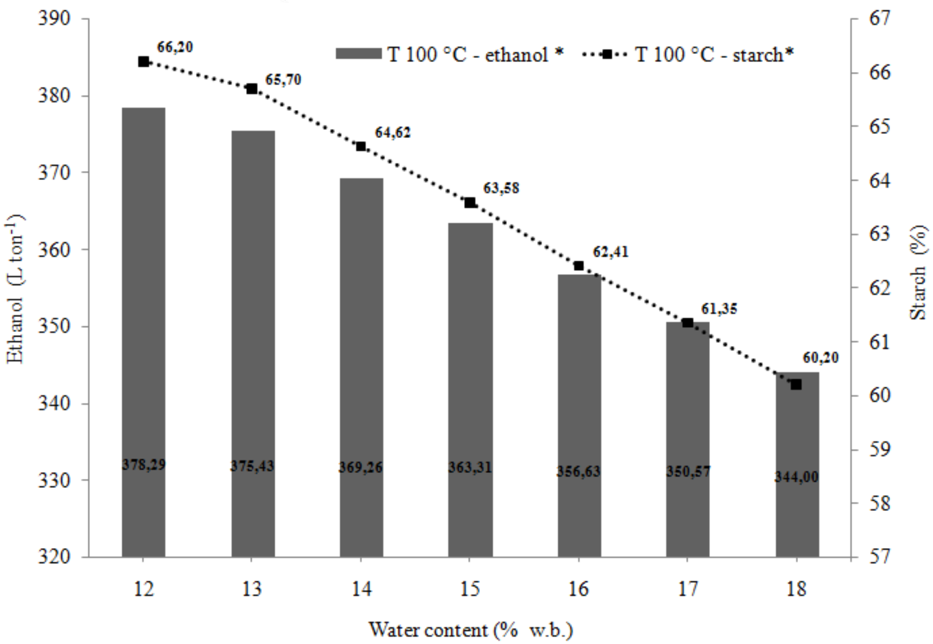
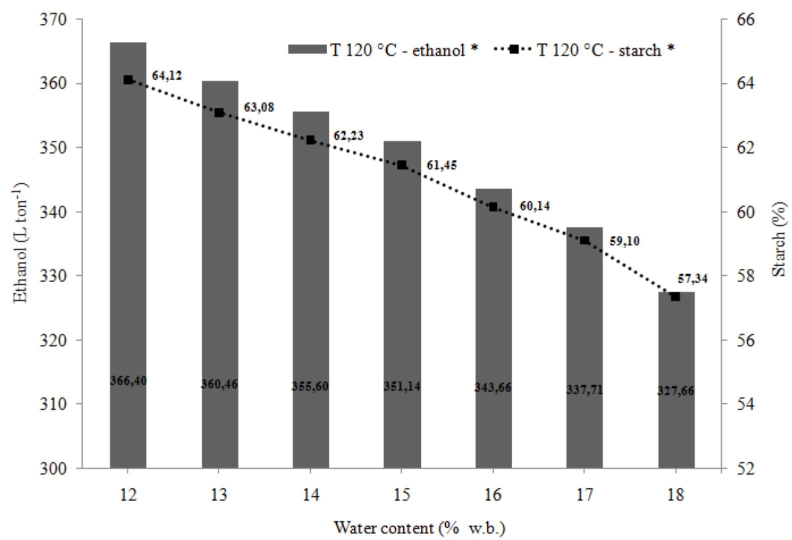
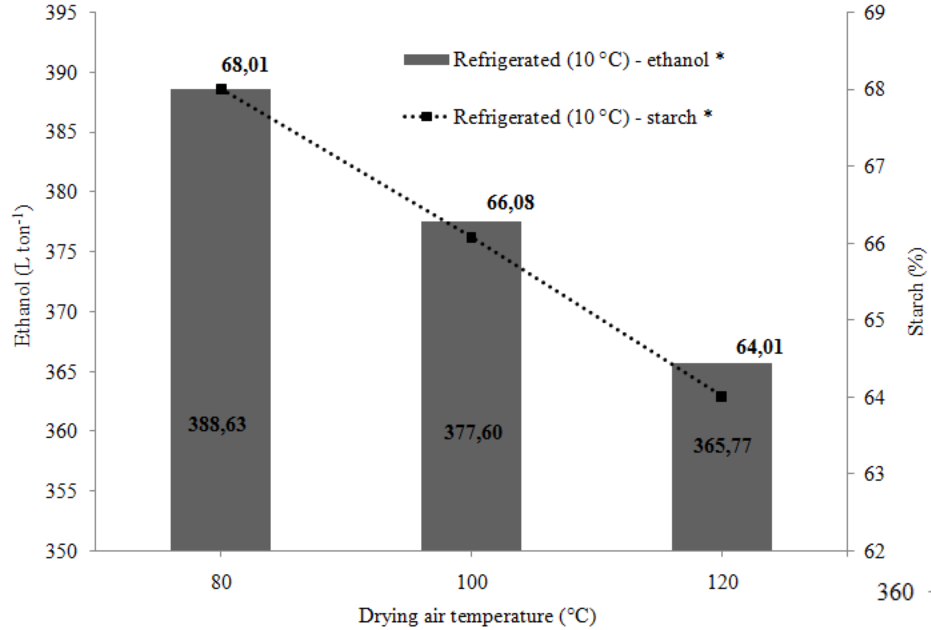
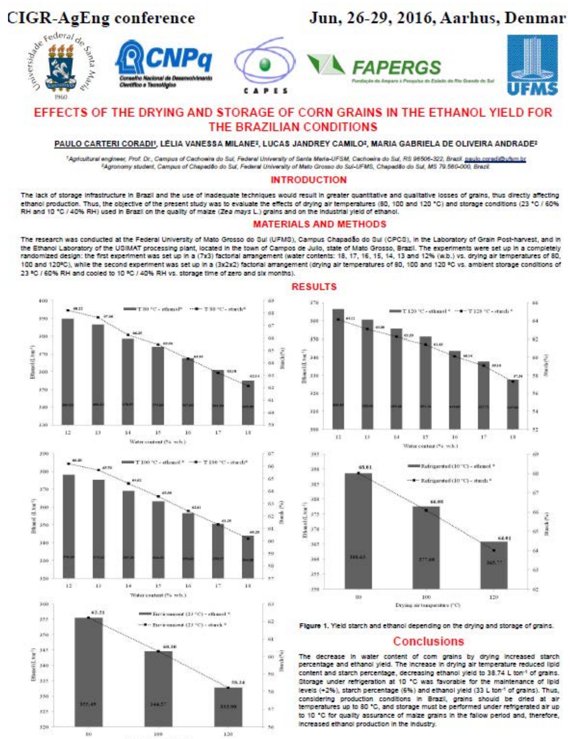






DRYING CORN GRAINS
X
ETHANOL INCOME




CIGR-AgEng conference Jun, 26-29, 2016, Aarhus, Denmar

EFFECTS OF THE DRYING AND STORAGE OF CORN GRAINS IN THE ETHANOL YIELD FOR THE BRAZILIAN CONDITIONS

PAULO CARTERI CORADI[1], LÉLIA VANESSA MILANE[2], LUCAS JANDREY CAMILO[2], MARIA GABRIELA DE OLIVEIRA ANDRADE[2]

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INTRODUCTION

The lack of storage infrastructure in Brazil and the use of inadequate techniques would result in greater quantitative and qualitative losses of grains, thus directly affecting ethanol production. Thus, the objective of the present study was to evaluate the effects of drying air temperatures (80, 100 and 120 °C) and storage conditions (23 °C / 60% RH and 10 °C / 40% RH) used in Brazil on the quality of maize (*Zea mays* L.) grains and on the industrial yield of ethanol.

MATERIALS AND METHODS

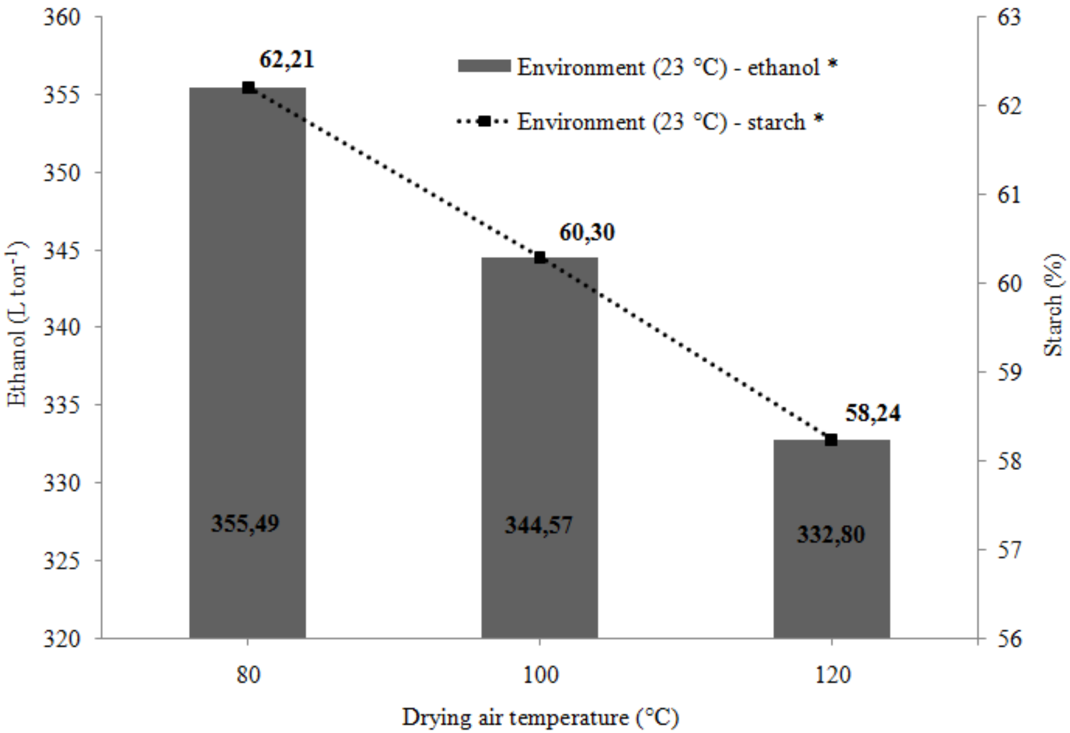
The research was conducted at the Federal University of Mato Grosso do Sul (UFMS), Campus Chapadão do Sul (CPCS), in the Laboratory of Grain Post-harvest, and in the Ethanol Laboratory of the USIMAT processing plant, located in the town of Campos de Julio, state of Mato Grosso, Brazil. The experiments were set up in a completely randomized design: the first experiment was set up in a (7x3) factorial arrangement (water contents: 18, 17, 16, 15, 14, 13 and 12% (w.b.) vs. drying air temperatures of 80, 100 and 120ºC), while the second experiment was set up in a (3x2x2) factorial arrangement (drying air temperatures of 80, 100 and 120 ºC vs. ambient storage conditions of 23 ºC / 60% RH and cooled to 10 ºC / 40% RH vs. storage time of zero and six months).

RESULTS

Figure 1. Yield starch and ethanol depending on the drying and storage of grains.

Conclusions

The decrease in water content of corn grains by drying increased starch percentage and ethanol yield. The increase in drying air temperature reduced lipid content and starch percentage, decreasing ethanol yield to 38.74 L ton^{-1} of grains. Storage under refrigeration at 10 °C was favorable for the maintenance of lipid levels (+2%), starch percentage (6%) and ethanol yield (33 L ton^{-1} of grains). Thus, considering production conditions in Brazil, grains should be dried at air temperatures up to 80 °C, and storage must be performed under refrigerated air up to 10 °C for quality assurance of maize grains in the fallow period and, therefore, increased ethanol production in the industry.



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Physical quality of grains subjected to moistening and drying processes for marketing

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Key words:
AG 1051
Herculex® 30S31H
water content
temperature

ABSTRACT
The aim was to evaluate the physical quality of conventional and transgenic corn grains, through drying and wetting processes for marketing. The experimental design was completely randomized in a factorial scheme (7 x 3 x 2), corresponding to seven drying times (0, 20, 40, 60, 80, 100 and 120 min), three temperatures of the drying air (80, 100 and 120 °C) and two hybrids of corn (conventional AG 1051 and transgenic Herculex® 30S31H). Grain drying was held in convection oven with forced air ventilation while the wetting was done in a B.O.D chamber. The water movement in the grain, the volume and the electrical conductivity were evaluated periodically. The results showed that the transgenic corn grain reduced the negative effects of drying and moistening on the physical quality. The increase in drying air temperature accelerated the physical deterioration of conventional and transgenic corn grains. The increase in water content by the moistening process caused losses in grain physical quality, similar to the drying process, for both the conventional and transgenic corn grains.

Palavras-chave:
AG 1051
Herculex® 30S31H
teor de água
temperatura

Qualidade física de grãos de milho submetidos aos processos de secagem e umedecimento para comercialização

RESUMO
O objetivo deste trabalho foi avaliar a qualidade física de grãos de milho convencional e transgênico nos processos de secagem e umedecimento para comercialização. O delineamento experimental utilizado foi inteiramente casualisado, esquema fatorial (7 x 3 x 2), sete tempos de secagem (0, 20, 40, 60, 80, 100, 120 min), três temperaturas do ar de secagem (80, 100 e 120 °C) e dois híbridos de milho (convencional AG 1051 e o transgênico Herculex® 30S31H). A secagem dos grãos foi realizada em estufa de convecção com ventilação forçada do ar enquanto o umedecimento foi feito em câmara do tipo B.O.D. Foram avaliadas periodicamente a movimentação de água nos grãos, o volume e a condutividade elétrica. Os resultados permitiram concluir que os grãos de milho transgênico reduziram os efeitos negativos da secagem e umedecimento dos grãos. O aumento da temperatura do ar de secagem acelerou a deterioração física dos grãos de milho convencional e transgênico. O aumento dos teores de água pelo processo de umedecimento proporcionou perdas na qualidade física dos grãos, semelhante ao processo de secagem, para ambos os grãos de milho convencional e transgênico.

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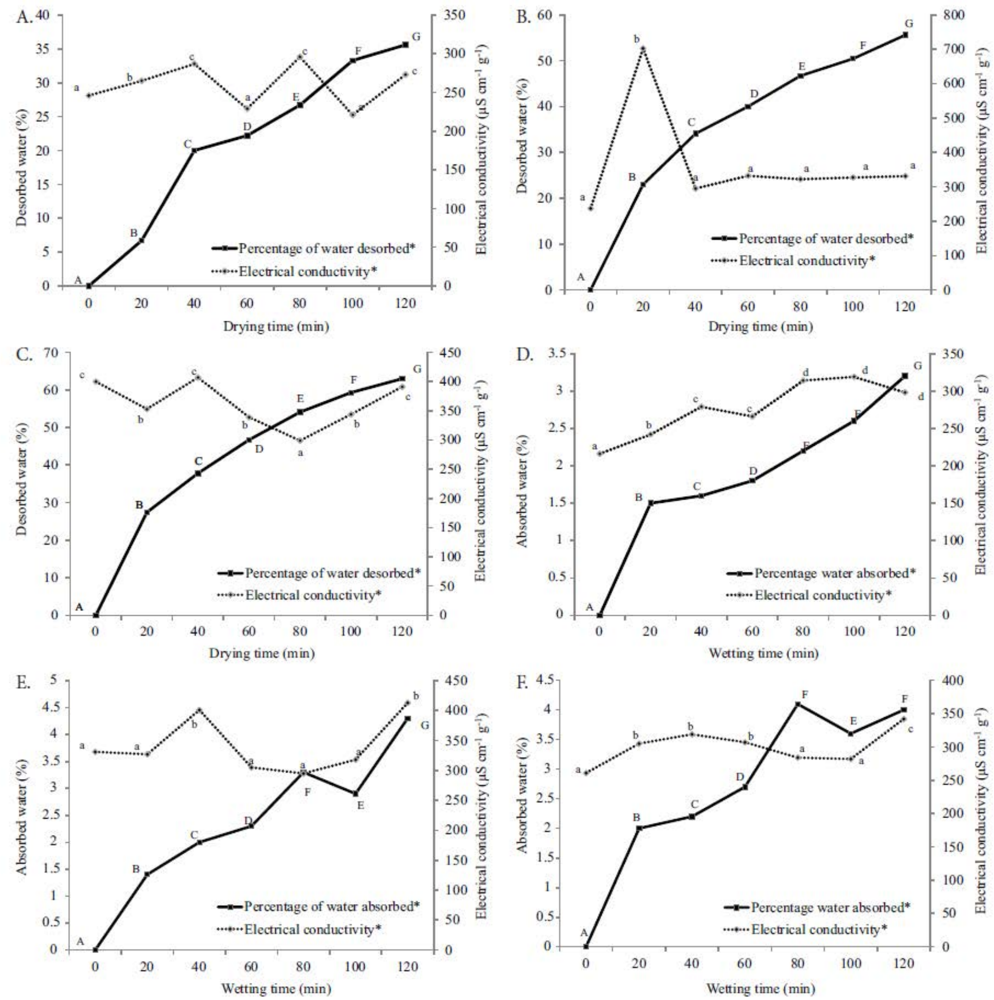
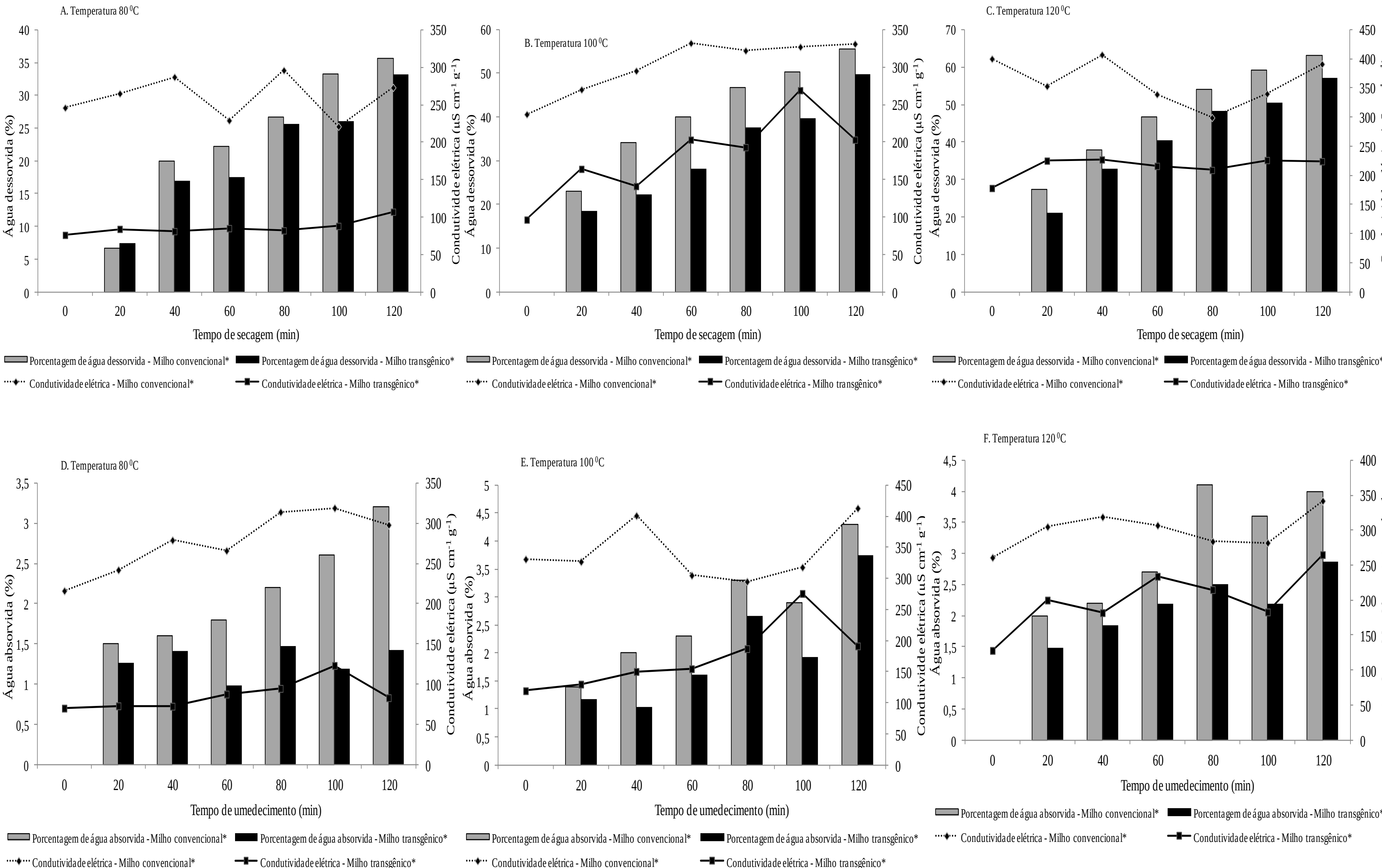


*Significant at 0.05 probability level by Tukey test

Figure 2. Variation in the percentage of desorbed and absorbed water x electrical conductivity in grains of conventional corn hybrid AG 1051, during the drying and moistening processes: (A, D) T 80 °C; (B, E) T 100 °C; (C, F) T 120 °C

DRYING AND WETTING CORN GRAIN IN STORAGE X DIFFERENT VARIETIES



Original Article

ALTERNATIVES OF STORAGE OF CORN GRAINS FOR THE CONDITIONS OF THE BRAZILIAN CERRADO

ALTERNATIVAS DE ARMAZENAGEM DE GRÃOS DE MILHO PARA AS CONDIÇÕES DO CERRADO BRASILEIRO

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2. Undergraduated Student, Universidade Federal de Mato Grosso do Sul-UFMS, Chapadão do Sul, MS, Brazil.
3. Professor, PhD., Universidade Federal do Vale do Jequitinhonha, Unaí, MG, Brazil.

ABSTRACT: The storage of grains under technical conditions in favorable environment ensures grain quality and regulates the supply of raw material for food production. For this reason, the objective of this study was to evaluate the different forms of storage (aerated silo, non-aerated silo, silo bags and airtight) of grains produced in the Brazilian cerrado, over time (zero, three and six months), for different physical qualities of maize (normal grains, whole grains and broken grains). The research was conducted at the Federal University of Mato Grosso do Sul (UFMS), Chapadão do Sul Campus (CPCS), Grain Postharvest Laboratory. To determine the physical-chemical quality and the physical properties of grains over six months, samples were taken from the stored lots. Analysis of variance and comparison of means by Tukey's test were conducted at 5% probability. The six-month storage time was the main factor contributing to the reduction of the quality of maize grains. Storage alternatives with aeration, non-aeration, bags and airtight environment did not influence the physical properties of maize grains. The broken maize grains showed the worst physical and chemical quality during storage time, while the batch of whole corn grains differ in quality during storage. It was concluded that airtight storage and storage in aerated silos were the conditions that best preserved the physical and chemical quality of maize grains over time.

KEYWORDS: Water content. Quality. Cerrado region. Ambient temperature. *Zea mays* L.

INTRODUCTION

Brazil is one of the leading maize producers worldwide, and the Midwest region is the main producer. Maize is the second most produced grain in Brazil, second only to soybeans (FAO, 2012). However, it is known that quantitative and qualitative losses of extremely variable magnitude occur both at the harvest and in all stages of post-harvest system, transport, handling, drying, storage, processing, marketing and endpoints distribution to consumers. In Brazil, losses in the stages of post-harvest of grains range between 25 and 30% of what is produced (FAO, 2012). After the corn grain harvest will be sold, or else stored for a period of time, seeking better market conditions for marketing.

During storage, it is essential to maintain the quality characteristics of maize grains and minimize quantitative and qualitative losses, as well as choose the best alternative for storage conditions, according to the region and the producer capitalization (ANTUNES et al., 2011).

Deterioration of the grains is a natural and inevitable process of physical disruption and loss of physiological capacity; however, it can be controled, and this is the essence of storage, which is one type of conservation strategy (ALENCAR et al., 2011). There are several ways to store corn; one of them is bulk storage in sacks and under controlled environmental conditions. Although the method chosen for grain storage is important, proper management of the operation should be performed strictly.

The main factors that affect grain quality during storage are temperature and water content, and they are related to the breathing of the product and the presence of microorganisms (CORADI et al., 2011). During (bulk) storage, grains are subject to changes in ambient temperature which, combined with water content of the grains, have a direct influence on the occurrence of insects and microorganisms (SANTOS et al., 2012). For better efficacy in bulk storage, it is recommended to install a thermometry and aeration system for control of grain mass temperature, thereby cooling the product and reducing the risks of growth and multiplication of microorganisms and insect pests.

Corn storage in sacks in conventional warehouses can be successfully used, provided that the storing structures meet the minimum requirements. Corn must be dry (13 to 13.5% moisture) and there must be good ventilation in the structure. The floor should be concreted and

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Table 2. Alterations in the physical mass of corn grains stored under different forms and storage times.

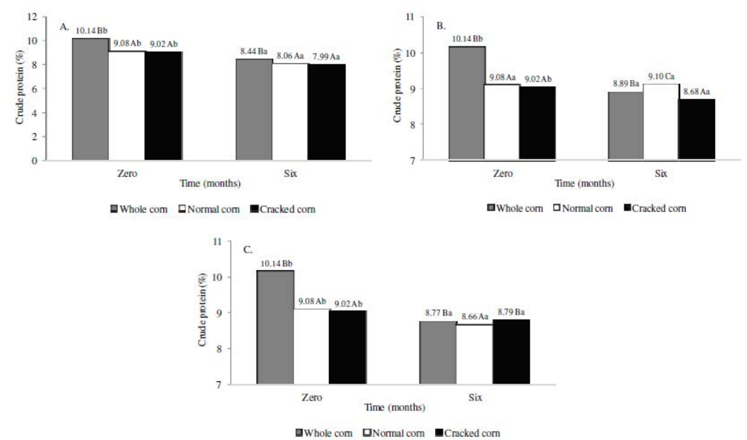
	Whole corn			Cracked corn			Normal corn		
	Time (months)			Time (months)			Time (months)		
Storage	Zero	Three	Six	Zero	Three	Six	Zero	Three	Six
Porosity (%)*									
Airtight	46.25aA	66.67bB	65.47aB	44.24aA	65.68bC	64.06bB	46.16aA	66.94bcB	66.38bB
Bag	46.25aA	65.82abB	65.87aB	44.24aA	61.55aC	58.97aB	46.16aA	67.96cC	66.49bB
Non-aerated	46.25aA	66.59bB	66.16aB	44.24aA	64.35bB	63.96bB	46.16aA	65.98abB	67.10bB
Aerated	46.25aA	64.91aB	65.15aB	44.24aA	61.55aB	60.45aB	46.16aA	65.20aB	64.03aB
Bulk density apparent (kg m^{-3})*									
Airtight	750 aA	790 bB	810 cC	740 aA	760 dB	770 dC	760 aA	770 aB	800 cC
Bag	750 aA	790 bB	810 cC	740 aC	690 aA	700 aB	760 aA	780 bB	810 dC
Non-aerated	750 aA	780 aB	790 aC	740 aA	750 cB	750 cC	760 aA	770 aB	790 bC
Aerated	750 aA	780 aB	800 bC	740 aB	730 bA	730 bA	760 aA	770 aB	770 aB
Thousand kernel weight (g)*									
Airtight	298 aB	300 cB	289 bA	220 aB	216 cA	220 bB	291 aA	295 bB	289 bA
Bag	298 aA	305 bB	298 cA	220 aC	150 bB	140 aA	291 aA	300 cB	295 bA
Non-aerated	298 aB	299 aB	294 aA	220 aB	234 dA	230 cA	291 aA	301 cB	300 cB
Aerated	298 aA	312 dB	294 aA	220 aC	125 aA	143 aB	291 aC	283 aB	272 aA

*Means followed by the capital letter in the line for each storage time and lowercase in the column for each storage form, do not differ at 5% probability.

Table 3. Physical quality of corn grains stored under different forms and storage conditions.

	Whole corn			Cracked corn			Normal corn		
	Time (months)			Time (months)			Time (months)		
Storage	Zero	Three	Six	Zero	Three	Six	Zero	Three	Six
Electrical conductivity (μS cm^{-1} g^{-1})*									
Airtight	114 aA	148 bC	138 aB	678 aC	511 aB	428 aA	169 aB	161 aB	150 aA
Bag	114 aA	133 aB	145 bC	678 aB	658 bA	781 bC	169 aB	156 aA	167 bB
Non-aerated	114 aA	157 cB	209 cC	678 aC	351 aA	466 cB	169 aA	170 cA	168 bA
Aerated	114 aA	335 dB	329 dB	678 aA	955 cB	961 dB	169 aA	317 dB	429 cC
Germination (%)*									
Airtight	97.50 aA	98.50 bA	98.50 bA	40.50 aA	54.00 dC	39.50 cB	87.50 aA	97.50 bC	95.00 bB
Bag	97.50 aA	97.50 bA	96.50 bA	40.50 aB	47.50 cB	25.50 bA	87.50 aA	94.50 aB	94.50 bB
Non-aerated	97.50 aB	96.00 bB	94.00 aA	40.50 aB	37.50 bA	44.50 dB	87.50 aA	95.00 aB	95.00 bB
Aerated	97.50 aB	92.00 aA	93.50 aA	40.50 aC	08.00 aB	05.50 aA	87.50 aC	44.50 aB	21.00 aA

*Means followed by the capital letter in the line for each storage time and lowercase in the column for each storage form, do not differ at 5% probability.



*Means followed by the capital letter in the line for each storage time and lowercase in the column for each corn type, do not differ at 5% probability

Figure 2. Determination of crude protein (%) in maize stored: aerated (A), non-aerated (B); conventional in bags (C), airtight storage (D).

DRYING AND STORING SOYBEAN AND SUNFLOWERS GRAINS X OIL AND QUALITY YIELD

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Yield and acidity indices of sunflower and soybean oils in function of grain drying and storage

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ABSTRACT. The aim of this study was to identify the best conditions for drying and storing soybeans and sunflower grains to maintain their quality. In the first experiment, the soybeans were found to have initial moisture contents of 25 and 19% (w.b.) at different drying air temperatures (75, 90, 105, and 120°C). In the second step, the soybeans were evaluated after they were stored in paper bags and plastic polyethylene at temperatures of 3, 10 and 23°C for six months. In the third experiment, sunflower grains were tested after exposure to drying air temperatures of 45, 55, 65, and 75°C, and under storage conditions of 25°C and 50%, 20°C and 60%, 30°C and 40% RH over six months in paper bags and raffia. Drying the sunflower seeds at 45°C and storing them at 30°C and 40% RH led to higher oil yields and lower acid numbers. The oil that was extracted from the acid number was higher for soybean grains that were dried down from initial concentrations of 25% water at a drying air temperature of 120°C. The air temperature in storage at 3°C favored for yield and reduction of the soybean oil acidity.

Keywords: postharvest, processing and quality.

Table 4. Average results for oil yield (%) in soybean after drying (12% w.b.) at different temperatures

Temperature air drying (°C)[NS]	Initial moisture content (19% w.b.)[NS]	Initial moisture content (25% w.b.)[NS]
75	15.37	15.73
90	15.59	15.41
105	15.20	15.25
120	15.69	15.37

Coefficient variation (%) = 14.67, NS = not significative.

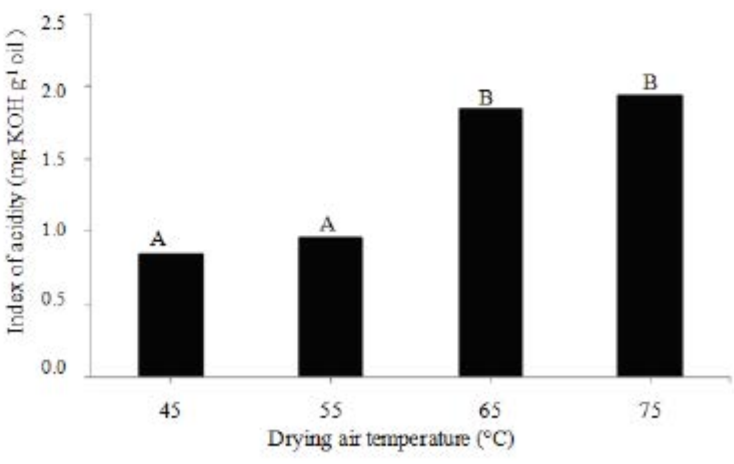

Figure 2. Evaluation of oil extracted from the acid value of sunflower grains after drying with different air temperatures.

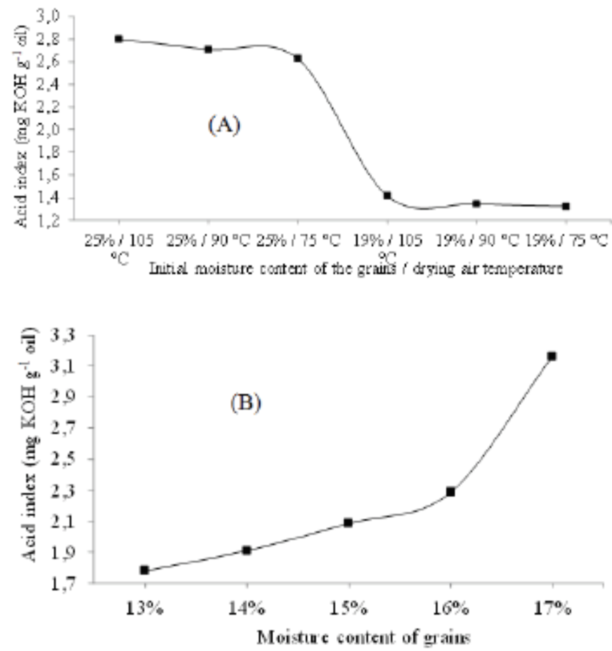

Figure 4. Extracted oil acid value of soybeans after the drying process in different initial moisture content of the grains and drying air temperature (A). Extracted oil acid value of soybeans, along the process for drying air temperature of 120°C (B).

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EFFECTS OF DRYING AIR TEMPERATURE AND GRAIN INITIAL MOISTURE CONTENT ON SOYBEAN QUALITY (*GLYCINE MAX* (L.) MERRILL)

Doi:http://dx.doi.org/10.1590/1809-4430-Eng.Agric.v36n5p866-876/2016

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ABSTRACT: This study aimed to evaluate the effect of air-drying temperature and initial moisture content on volume shrinkage, physical quality and oil extraction yield of soybean grains. The grains used in this experiment were harvested at two distinct moisture levels of 19 and 25%. Then, these grains were taken to dryness at three different air temperatures of 75 °C, 90 °C and 105 °C, in a forced circulation convection oven of the air. The results showed a drying time reduction with increasing air temperatures. Regarding volume shrinkage, moisture content reductions influenced grain volume and the Rahman's model was the one that best fit the data. Moreover, the higher the air temperature, the greater the effects on soybean grain shrinkage and physical quality. By grain volume reduction effected on oil yield, major impacts were observed when assessing grain initial moisture content were higher. Furthermore, the temperature of 105°C and an initial moisture content of 25% were the factors that most affected soybean grain quality, however not affecting oil extraction yield.

KEY WORDS: extraction, performance, processing.

INTRODUCTION

Brazilian agriculture has a high yield potential that increases each year. In 2012/ 2013, there was a record of 53.27 million hectares being grown. One of the crops that has most contributed to such growing trend is soybean (*Glycine max* (L.) Merrill). The average yield of this crop have increased due to technology breakthroughs and increased acreage. Some areas of the Brazilian Cerrado which have been used for cattle rearing are being converted into soybean fields (CONAB, 2013). Furthermore, soybean yields in 2013/ 2014 season reached 3,056 kg ha^{-1}, being 356 kg ha^{-1} higher than the previous season (2,700 kg ha^{-1}) (CONAB, 2013).

Mostly, soybean grains are harvested at high moisture levels, from 16% to 25%, which becomes inappropriate for storage since such levels make grains most susceptible to infections by fungi or other microorganisms, thereby reducing their quality. For storing and selling, moisture content of soybeans must not exceed 14%, or even 12%, because it would improve storage quality. Therefore, drying process is extremely important; however, it may damage grains for changing their physical properties or even causing direct damage thereto (RESENDE et al., 2010; NIAMNUY et al., 2011; SOUSA et al., 2011; CORADI et al. 2014a). Even though the mechanical drying of soybeans can anticipate harvest, the high air temperatures involved in such process may cause biochemical changes in the product, affecting its quality.

The drying process accelerates the loss of water in grains but may be damaging to the cell structure thereof, leading to a change in shape and decrease in size of the tissue (CORRÊA et al., 2010; GONELI et al., 2011; NIAMNUY et al., 2012; CORADI et al., 2014b). For GONELI et al. (2011), grain volume shrinkage derives from a decrease in tension within the cells as water is removed whilst the drying process continues. On the other side, size reductions of plant products by drying process are not only related to loss of water, the process conditions also have great influence on product size and format (CORRÊA et al., 2010; ULLMANN, et al., 2010; GONELI et al., 2011;

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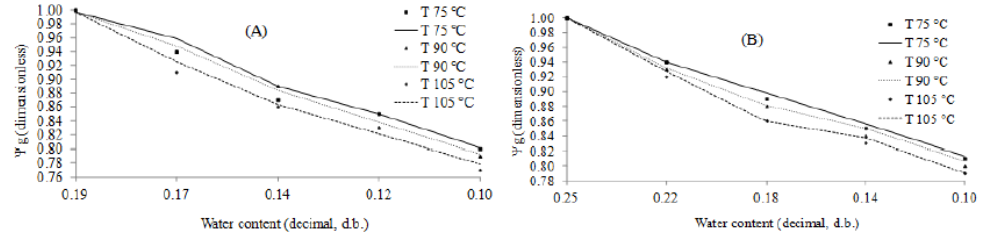

FIGURE 2. Volumetric shrinkage of soybeans during drying at different air temperatures and initial moisture content of 19% (w.b.) (A) and 25% (w.b.) (B) with the model of Rahman.

TABLE 4. Electrical conductivity test (µS cm^{-1}g^{-1}) in soybeans grains with different drying temperatures and initial water content.

Temperature of air drying (°C)	Initial water content (19% w.b.)	Initial water content (25% w.b.)
75	396.17 a A	409.3 b B
90	412.94 a A	423.30 a A
105	471.79 b A	457.96 a b A

Means followed by the lower case letter in the column, for each temperature of the drying air, upper lines for each water content was not significantly different at 1% probability.

TABLE 6. Oil yield (%) in soybeans grains after drying at different temperatures.

Temperature of air drying (°C)	Average
75	15.37 a
90	15.59 a
105	17.20 a

Means followed by the lower case letter in the column, for each temperature of the drying air was not significantly different at 1% probability.

TABLE 7. Oil yield (%) in soybeans grains with different initial water contents after drying.

Initial water content (% w.b.)	Average
19	15.73 a
25	16.37 a

Means followed by the lower case letter in the column, for each temperature of the drying air was not significantly different at 1% probability.

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Effects of drying and storage conditions in the quality of sunflower seeds

Efeitos das condições de secagem e armazenamento na qualidade de sementes de girassol

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ABSTRACT: The viability of seeds passing through the appropriate conditions of harvest and post -harvest storage and the step. The objective of this study was to evaluate the physiological potential of sunflower seeds under different storage conditions (25 °C and 50%, 20 °C and 60%, 30 °C and 40% RH air) using different packages (permeable and impermeable). Physiological assessments were carried seeds in zero, three and six months of storage times and analyzed by the average test were compared by Tukey test at 5% probability. Under the conditions of 20 °C and 60% RH, and 25 °C and 50% RH in air and impermeable packaging obtained the best quality results. The physiological potential of sunflower seeds was affected by drying temperatures and storage conditions. The drying air temperature above 45 °C negatively affected the quality of sunflower seeds. Permeable and waterproof packaging not guaranteed the quality of sunflower seeds during storage. The quality of sunflower seeds stored up time of three months was negatively affected. The conditions of 20 °C and 60% RH air were more favorable for the preservation of physiological quality of sunflower seed during the storage time.

KEYWORDS: Conservation, *Helianthus annus* L., quality.

RESUMO: *A viabilidade das sementes passa pelas condições adequadas de colheita e pós-colheita, como a etapa de armazenamento. O objetivo deste trabalho foi avaliar o potencial fisiológico das sementes de girassol sob diferentes condições de armazenamento (25 °C e 50%, 20 °C e 60%, 30 °C e 40% de UR do ar) utilizando diferentes embalagens (permeáveis e impermeáveis). As avaliações fisiológicas das sementes foram realizadas nos tempos zero, três e seis meses de armazenamento e analisadas pelo teste de média, comparadas pelo teste Tukey a 5% de probabilidade. Nas condições de 20 °C e 60% UR e de 25 °C e 50% de UR do ar, para as embalagens impermeáveis obtiveram-se os melhores resultados de qualidade. O potencial fisiológico das sementes de girassol foi afetado pela temperatura do ar de secagem e condições de armazenamento. A temperatura do ar de secagem acima de 45 °C afetou negativamente a qualidade das sementes de girassol. As embalagens permeáveis e impermeáveis não garantiram a qualidade das sementes de girassol ao longo do armazenamento. A qualidade das sementes de girassol armazenadas acima do tempo de três meses foi afetada negativamente. As condições de 20 °C e 60% de UR do ar foram as mais favoráveis para a conservação da qualidade fisiológico das sementes de girassol, ao longo do tempo de armazenamento.*

PALAVRAS-CHAVE: *Conservação, Helianthus annus L., qualidade.*

Table 1. Sunflower seed germination (%) according to the drying air temperature and storage conditions for each type of packaging and storage time.

Storage time (months)	Packing	Storage conditions	Temperature of the drying air			
			45 °C	55 °C	65 °C	75 °C
0	-	-	100 a	94 b	78 d	84 c
3	Impermeable	20 °C / 60%	96 Aa	82 Bb	82 Cb	86 Bb
		25 °C / 50%	94 Ab	100 Aa	88 Bc	10 Ca
		30 °C / 40%	96 Ab	100 Aa	96 Ab	92 Ac
	Permeable	20 °C / 60%	94 Ab	100 Aa	96 Ab	96 Ab
		25 °C / 50%	96 Aa	96 Ba	96 Aa	96 Aa
		30 °C / 40%	0 Ba	0 Ca	0 Ba	0 Ba
6	Impermeable	20 °C / 60%	19 Bc	20 Ac	41 Aa	31 Bc
		25 °C / 50%	22 Ab	17 Bc	30 Ca	28 Ca
		30 °C / 40%	14 Cc	0 Cd	37 Bb	45 Aa
	Permeable	20 °C / 60%	12 Bb	8 Bc	19 Ba	21 Aa
		25 °C / 50%	32 Aa	32 Aa	26 Ab	0 Ba
		30 °C / 40%	0 Ca	0 Ca	0 Ca	0 Ba

Means followed by the capital letter in the column for each storage condition and lower lines for each temperature of the drying air, do not differ at 5% probability. Coefficient of variation (CV) = 5.23%.

Table 8. Determination of electrical conductivity in sunflower seeds (μS cm^{-1} g^{-1}) as a function of drying air temperature and storage time for each type of packaging and storage condition

Storage time (months)	Packing	Storage conditions	Temperature of the drying air			
			45 °C	55 °C	65 °C	75 °C
0	Impermeable	-	111.5 Bc	130.6 Aa	123.0 Ab	111.7 Ac
3		20 °C / 60%	102.8 Cc	109.6 Bb	109.3 Cb	113.4 Aa
6		20 °C / 60%	134.1 Aa	109.9 Bd	116.6 bc	115.2 Ab
0	Permeable	-	111.5 Bc	130.6 Aa	123.0 Ab	111.7 Cc
3		20 °C / 60%	119.2 Ab	120.5 Bb	110.6 Bc	199.9 Aa
6		20 °C / 60%	99.9 Cc	107.6 Cb	104.8 Cc	117.5 Ba
0	Impermeable	-	111.5 Ac	130.6 Aa	123.0 Ab	111.7 Bc
3		25 °C / 50%	113.6 Aa	100.7 Cc	105.6 Cc	108.6 Ba
6		25 °C / 50%	107.8 Cc	124.2 Bb	142.8 Aa	123.4 Ab
0	Permeable	-	111.5 Bc	130.6 Aa	123.0 Ab	111.7 Bc
3		25 °C / 50%	108.3 Cb	99.6 Cc	110.3 Cb	124.6 Aa
6		25 °C / 50%	122.6 Aa	109.8 Bc	116.6 Bb	0.0 Cd
0	Impermeable	-	111.5 Bc	130.6 Ca	123.0 Bb	111.7 Cc
3		30 °C / 40%	106.6 Cc	155.4 Ba	137.5 Ab	144.0 Ab
6		30 °C / 40%	135.7 Ab	226.3 Aa	102.3 Cc	141.0 Ab
0	Permeable	-	111.5 Cc	130.6 Ca	123.0 Cb	111.7 Cc
3		30 °C / 40%	200.0 Ba	200.0 Ba	200.0 Ba	200.0 Ba
6		30 °C / 40%	346.3 Ac	376.0 Ab	432.0 Aa	349.7 Ac

Means followed by the capital letter in the column for each storage time and lower lines for each temperature of the drying air; do not differ at 5% probability. Coefficient of variation (CV) = 4.35%.

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BIOENG

SECAGEM DE GRÃOS DE MILHO DO CERRADO EM UM SECADOR COMERCIAL DE FLUXOS MISTOS

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RESUMO

Objetivou-se avaliar os efeitos da temperatura do ar de secagem (80, 100 e 120 °C) e a redução dos teores de água na qualidade física e físico-química de grãos de milho (*Zea mays* L.) em um secador de fluxo mistos operando de forma contínua. O delineamento experimental foi inteiramente casualizado, em esquema fatorial (7x3) (teores de água x temperaturas de secagem). A redução dos teores de água associados ao aumento da temperatura do ar de secagem reduziu o comprimento, a largura, a espessura, o volume, a esfericidade e a circularidade dos grãos de milho. Os índices de acidez e a porcentagem de cinzas aumentaram com a redução dos teores de água, não havendo diferenças entre as temperaturas do ar de secagem. A diminuição dos teores de água com o aumento da temperatura do ar de secagem aumentou a condutividade elétrica e reduziu a germinação dos grãos, não havendo diferença entre as temperaturas de 100 e 120 °C. Concluiu-se que, o processo de secagem contínua em secadores de fluxo misto de ar e produto na temperatura do ar de até 80 °C, não afetou negativamente a qualidade física e físico-química dos grãos de milho.

Palavras-chave: Armazenamento, qualidade, *Zea mays* L.

DRYING CLOSED CORN GRAIN DRYER FLOW IN A COMMERCIAL MIXED

ABSTRACT

The objective was to evaluate the effects of drying air temperature (80, 100 and 120 °C) and falling water levels in physical and physicochemical quality of grains of maize (*Zea mays* L.) in a dryer flow mixed operating of continuous form. The experimental design was completely randomized in a factorial scheme (7x3) (water content x drying temperatures). The reduction of the water content associated with the increased temperature of the drying air reduced length, width, thickness, volume, sphericity and roundness of corn grains. The acid values and the percentage of ash increased with the reduction of water levels, with no differences between the drying air temperatures. The decrease of the water content by increasing the drying air temperature increased electrical conductivity and reduced the germination of grains, with no difference between the temperatures of 100 and 120 °C. It was concluded that the drying process is continuously mixed flow of air and product dryers in the air temperatures at 80 °C in not affected the physical and physical-chemical quality of the corn grains.

Keywords: Storage, quality, *Zea mays* L.

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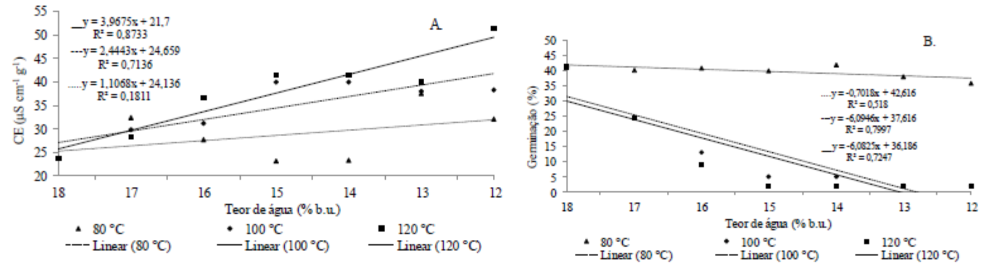


Figura 4. Avaliação da condutividade elétrica (A) e germinação (B) dos grãos de milho submetidos a diferentes temperaturas do ar e teores de água de secagem, (b.u.) – base úmida.

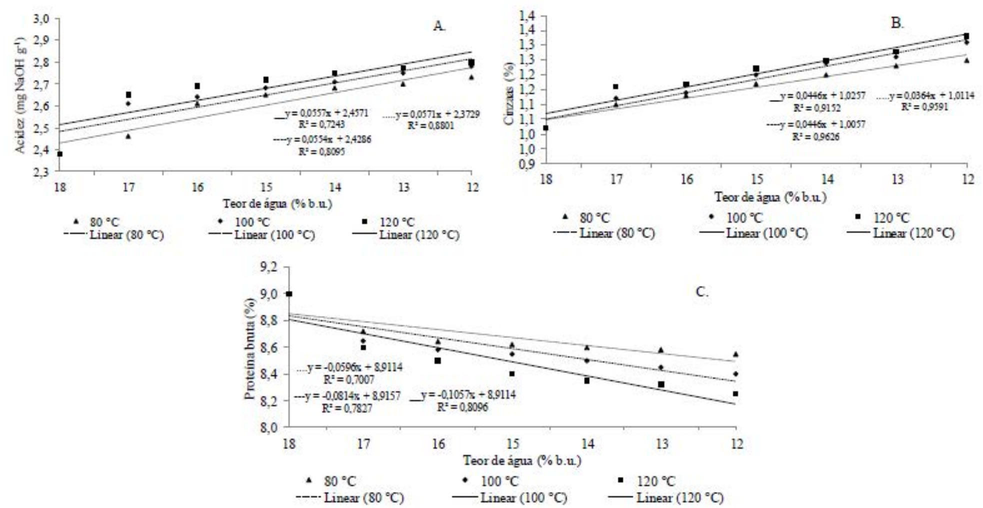
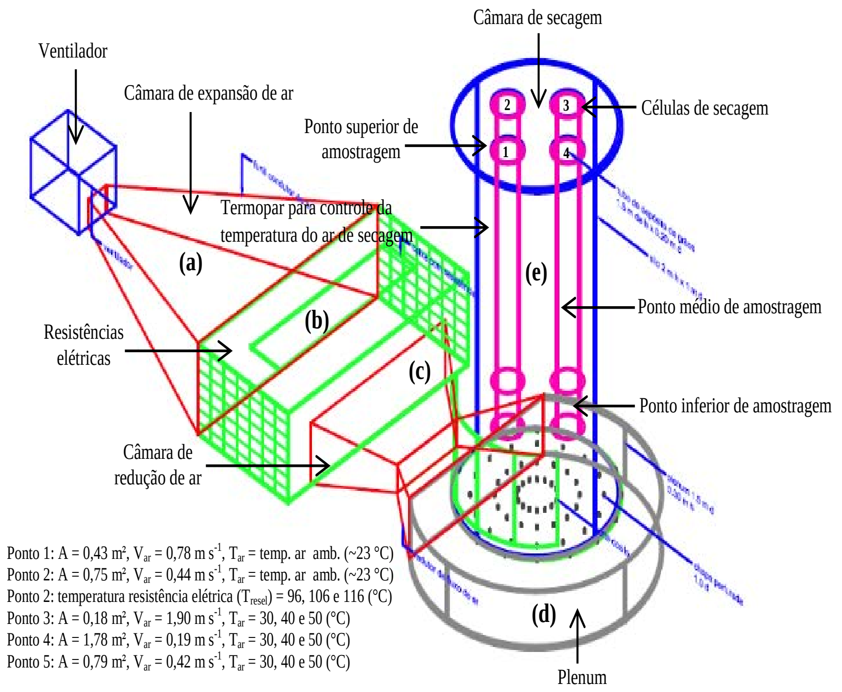
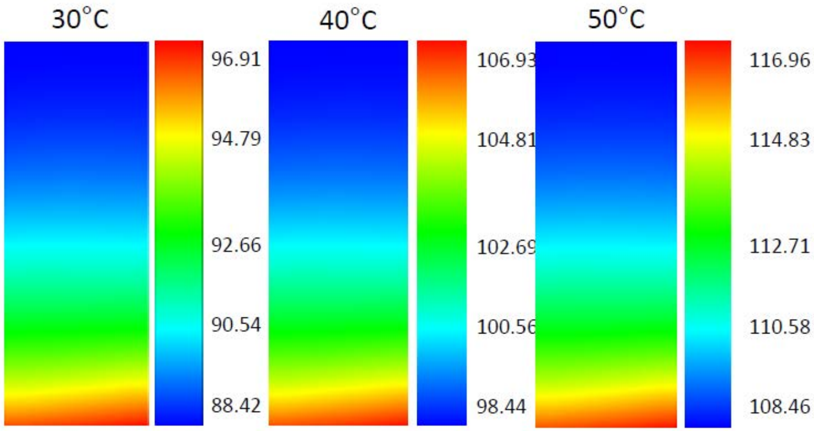


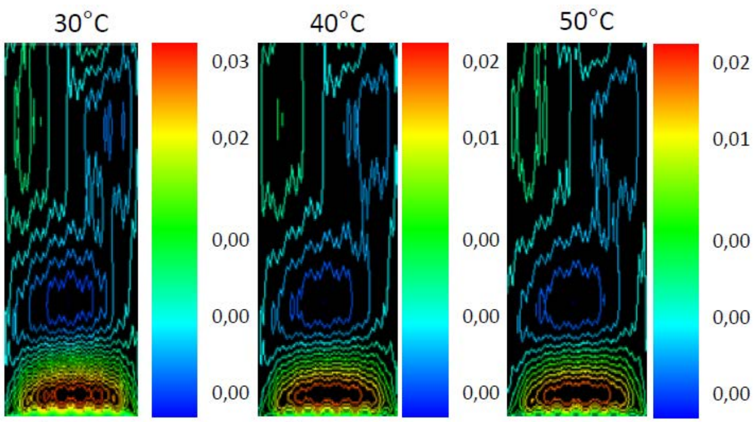
Figura 5. Avaliação do índice de acidez (A), cinzas (B) e proteína bruta (C) dos grãos de milho submetidos a diferentes temperaturas do ar e teores de água de secagem, (b.u.) – base úmida.



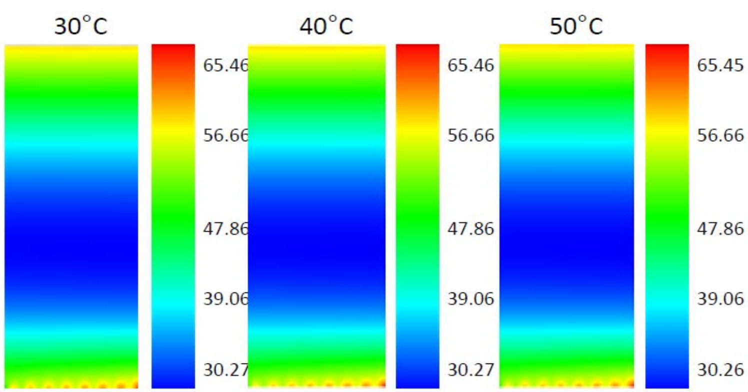
Development of drying system



1a) Temperature 2a) Temperature 3a) Temperature



1e) Linha de corrente 2e) Linha de corrente 3e) Linha de corrente



1c) Pressure 2c) Pressure 3c) Pressure

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Adjustment of mathematical models and quality of soybean grains in the drying with high temperatures

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Key words:
dimensioning
optimization
post-harvest

ABSTRACT

The aim of this study was to evaluate the influence of the initial moisture content of soybeans and the drying air temperatures on drying kinetics and grain quality, and find the best mathematical model that fit the experimental data of drying, effective diffusivity and isosteric heat of desorption. The experimental design was completely randomized (CRD), with a factorial scheme (4 x 2), four drying temperatures (75, 90, 105 and 120 °C) and two initial moisture contents (25 and 19% d.b.), with three replicates. The initial moisture content of the product interferes with the drying time. The model of Wang and Singh proved to be more suitable to describe the drying of soybeans to temperature ranges of the drying air of 75, 90, 105 and 120 °C and initial moisture contents of 19 and 25% (d.b.). The effective diffusivity obtained from the drying of soybeans was higher (2.5×10^{-11} $m^2 s^{-1}$) for a temperature of 120 °C and water content of 25% (d.b.). Drying of soybeans at higher temperatures (above 105 °C) and higher initial water content (25% d.b.) also increases the amount of energy (3894.57 kJ kg^{-1}), i.e., the isosteric heat of desorption necessary to perform the process. Drying air temperature and different initial moisture contents affected the quality of soybean along the drying time (electrical conductivity of 540.35 µS $cm^{-1} g^{-1}$); however, not affect the final yield of the oil extracted from soybean grains (15.69%).

Palavras-chave:
dimensionamento
otimização
pós-colheita

Ajustes de modelos matemáticos e qualidade de grãos de soja na secagem com altas temperaturas

RESUMO

O objetivo deste estudo foi avaliar a influência do teor de água inicial da soja e as temperaturas do ar de secagem sobre a cinética de secagem, qualidade do grão e encontrar o melhor modelo matemático que se ajustar aos dados de secagem experimental, a difusividade efetiva e o calor isostérico de dessorção. Foi adotado o delineamento experimental inteiramente casualisado (DIC) com esquema fatorial (4 x 2), quatro temperaturas de secagem (75, 90, 105 e 120 °C) e dois teores de água inicial (25 e 19% b.s.) com três repetições. O teor de água inicial do produto interferiu no tempo de secagem. O modelo de Wang e Singh mostrou-se mais adequado para descrever o processo de secagem dos grãos de soja para as faixas de temperaturas do ar de secagem de 75, 90, 105 e 120 °C e teores de água iniciais de 19 e 25% (b.u.). A difusividade efetiva obtida da secagem dos grãos de soja foi maior ($2,5 \times 10^{-11}$ $m^2 s^{-1}$) para a temperatura de 120 °C e teores de água de 25% (b.s.). A secagem dos grãos de soja com temperaturas mais elevadas (acima de 105 °C) e com maior teor de água inicial (25% b.u.) aumentou também a quantidade de energia (3894,57 kJ kg^{-1}), ou seja, o calor isostérico de dessorção necessário para realizar o processo. A temperatura do ar de secagem e dos diferentes teores de água inicial afetou a qualidade dos grãos de soja ao longo do tempo de secagem (condutividade elétrica de 540,35 µS $cm^{-1} g^{-1}$), no entanto, não interferiu no rendimento de óleo final extraído dos grãos de soja (15,69%).

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Modelos matemáticos	80 °C	100 °C	120 °C
		R² (%)	
$RU = \exp(-k \cdot t)$	99,33	99,67	98,70
$RU = \exp(-k \cdot t^n)$	99,81	99,92	99,42
$RU = \exp(-(k \cdot t)^n)$	99,81	99,92	99,42
$RU = a \cdot \exp(-k \cdot t)$	99,48	98,24	98,00
$RU = a\exp(-kt)+c$	99,94	99,70	99,42
$RU = a \cdot \exp(-k_0 \cdot t)+b \cdot \exp(-k_1 \cdot t)$	99,48	98,24	98,10
$RU = a \cdot \exp(-k \cdot t)+(1-a)\exp(-k \cdot a \cdot t)$	99,80	99,83	98,56
$RU = 1+a\,t+b\,t^2$	99,79	99,65	99,87
$RU = a \cdot \exp(-k \cdot t)+b \cdot \exp(-k_0 \cdot t)+c \cdot \exp(-k_1 \cdot t)$	99,49	98,24	98,10
$RU = a \cdot \exp(-k \cdot t^n)+b \cdot t$	99,96	99,94	99,99
$RU = a \cdot \exp(-k \cdot t)+(1-a) \cdot \exp(-k \cdot b \cdot t)$	99,33	99,88	98,70
		SE (decimal)	
$RU = \exp(-k \cdot t)$	0,0366	0,0722	0,1535
$RU = \exp(-k \cdot t^n)$	0,0199	0,0137	0,0580
$RU = \exp(-(k \cdot t)^n)$	0,0199	0,0137	0,0580
$RU = a \cdot \exp(-k \cdot t)$	0,0304	0,0602	0,1768
$RU = a\exp(-kt)+c$	0,0831	0,0244	0,3817
$RU = a \cdot \exp(-k_0 \cdot t)+b \cdot \exp(-k_1 \cdot t)$	0,0330	0,0737	0,2500
$RU = a \cdot \exp(-k \cdot t)+(1-a)\exp(-k \cdot a \cdot t)$	0,0209	0,0206	0,0909
$RU = 1+a\,t+b\,t^2$	0,0215	0,0301	0,0259
$RU = a \cdot \exp(-k \cdot t)+b \cdot \exp(-k_0 \cdot t)+c \cdot \exp(-k_1 \cdot t)$	0,0365	0,1042	0,2500
$RU = a \cdot \exp(-k \cdot t^n)+b \cdot t$	0,0116	0,0151	0,0078
$RU = a \cdot \exp(-k \cdot t)+(1-a) \cdot \exp(-k \cdot b \cdot t)$	0,0396	0,0196	0,2659

Energy performance of grain dryer

Energy and mass balance in the drying process (start)

Grains							Air							
P_t (kg)	U_i (%)	P_{al} (kg water)	P_{ms} (kg)	U_f (%)	P_{a2} (kg water)	Q_{water} (kg water)	T_i (^{0}C)	T_f (^{0}C)	UR_i (%)	UR_f (%)	RM_2 (kg kg^{-1})	RM_1 (kg kg^{-1})	Δ RM	$M_{dry\ air}$ (kg dry air)
150.72	22	33.1584	117.56	12	14.107	19.051	106.93	98.44	50	70	1.22	1.093	0.126	151.2
150.72	12	18.0864	132.63	12	15.916	2.1704	106.93	98.44	50	70	1.22	1.093	0.126	17.225

Energy and mass balance in the drying process (final)

Air							Dryer						
T_a (^{0}C)	UR_a (%)	E_2 (kJ kg^{-1} dry air)	E_1 (kJ kg^{-1} dry air)	ΔE	E_t (kJ dry air)	C_{es} (kJ kg^{-1})	t (min)	$Q_{dry\ air}$ (kg dry air min^{-1})	V_{e3} (m^3 kg^{-1} dry air)	Q_v (m^3 h^{-1})	C_{ee} (kJ kg^{-1})	M_a (kg water)	*n* *(%)*
30	80	3,050.972	85,3536	2,965.619	448,397.1	2,975.03	23.556	6.4184852	0.845	325	23.53	17.12727	72.7685
30	80	3,050.972	85,3536	2,965.619	51,083.2	338.92	2.683	6.4184852	0.845	325	23.53	0.000000	0.0000

P_t: total weight, U_i: initial moisture, P_{al}: water weight in the initial condition, P_{ms}: weight of total dry matter, U_f: Final water content, P_{a2}: water weight for the final condition of the drying process, $Q_{água}$: total amount of water to be evaporated, Δ_{rm}: variation of the mixing ratio, R_{M2}: ratio of exhaust mixture R_{M1}: air mixture ratio in the initial condition, dry M_{ar}: air mass total dry, T_i: initial temperature drying air, T_f: final temperature of the drying air, UR_i: initial relative humidity drying, UR_F: RH end of the drying air.

Grains quality in the drying

Oil Yield (%) after drying

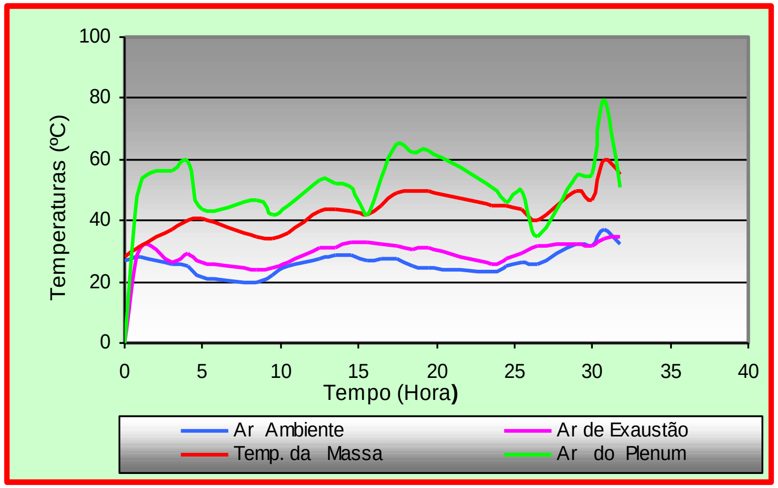
Chambers	30 °C	40 °C	50 °C	Initial
1	9.1806	7.6145	11.9091	15.5191
	8.9136	7.7904	12.4291	15.3609
2	10.2325	10.8582	12.6211	15.5191
	9.5503	10.9763	12.0572	15.3609
3	9.0180	14.0316	14.1795	15.5191
	9.4142	14.7073	14.7600	15.3609
4	9.7186	13.2295	14.1413	15.5191
	8.8342	12.6083	14.9981	15.3609

Germination of the grains (%) after drying

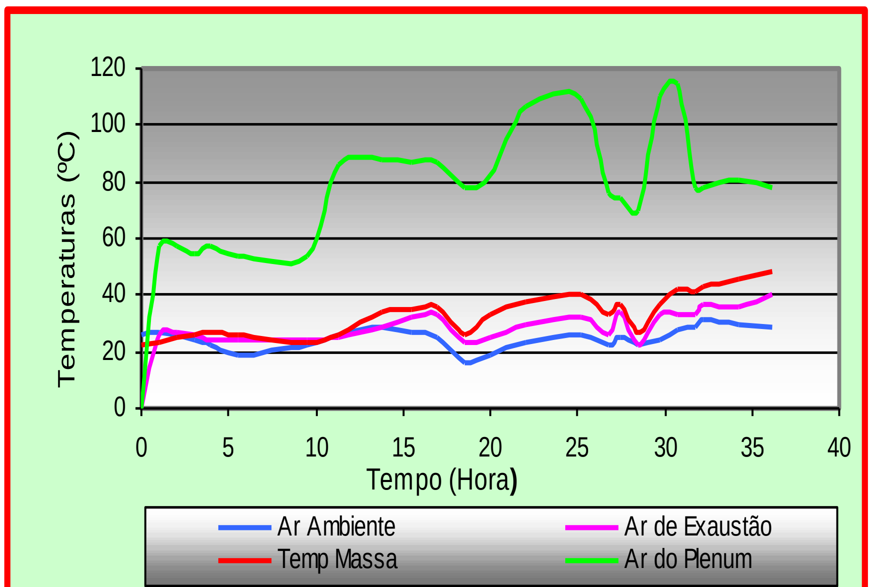
Chambers	30 °C	40 °C	50 °C	Inicial
1	86%	80%	70%	94%
	80%	82%	72%	92%
2	80%	80%	78%	94%
	82%	88%	72%	92%
3	86%	86%	72%	92%
	86%	86%	72%	92%
4	86%	80%	78%	94%
	86%	86%	76%	92%

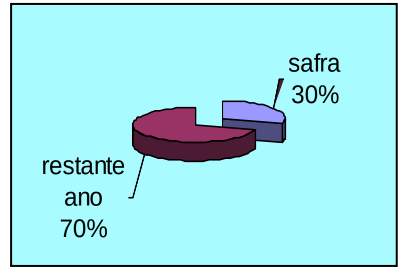
REAPROVEITATION OF RICE CASKS

BIOMASS

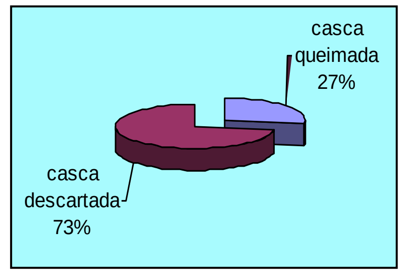


GAS

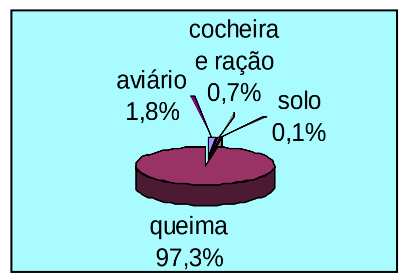




(a) Percentual de casca queimada na safra e no restante do ano nos engenhos consultados

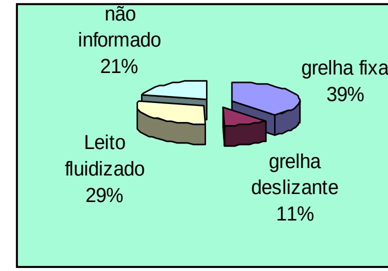


(b) Destino da casca produzida nos engenhos – queimada no próprio engenho ou descartada

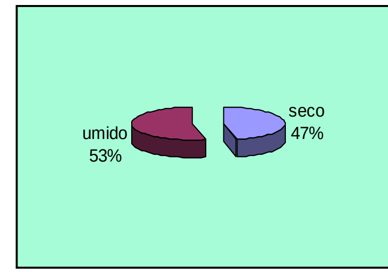


(c) Destino da casca descartada dos engenhos

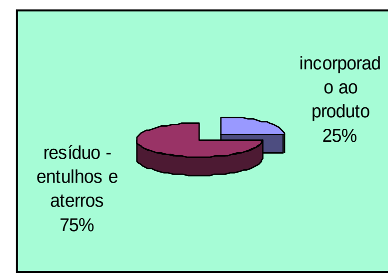
Figura 4 – Dados sobre a casca de arroz levantados junto aos engenhos



(a) Percentuais de ocorrência de cada sistemas de queima



(b) Percentuais de ocorrência de cada sistema de escoamento das cinzas



(c) Percentuais de ocorrência de cada destino dado à cinza

Figura 5 - Características dos sistemas de queima da casca de arroz

International Conference of Agricultural Engineering

XXXVII Congresso Brasileiro de Engenharia Agrícola

ASABE ILES VIII

Iguassu Falls City – Brazil – August 31 to September 04, 2008

Application of Computational Fluid Dynamics (CFD) to a gas heater used for the drying of agricultural products

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ABSTRACT

The objective of this study was to evaluate a gas heater used for the drying of agricultural products. The effects of fuel, primary air and secondary air flows on the distribution on temperature and velocity in a heater were evaluated with the objective of rationalizing combustion fuel. LPG was used as the energy source to provide heated air for drying. The Navier-Stokes equations were used to resolve the problem of air and fuel flow, respecting the energy conservation, equations in the heater. From the results generated, it was confirmed that greater temperature were obtained with the convection coefficient was minimal (h = 0.01). Velocity presented a parabolic, fully developed profile. The greatest velocity was encountered in the central region of the flow, obtained when the Reynolds number was at its greatest. CFD software proved to be applicable in order to resolve heat and mass transfer problems in heaters.

INTRODUCTION

By definition, a gas heater is a device which must guarantee the spraying and mixing of fuel with air. The construction of a gas heater is dependent on various factors with the main factors being the consumption of gas and air, the available pressures for combustion and of the air entering the heater, temperature of the air and the fuel and the flame length. In order to decrease the flame length, it is necessary to increase the turbulence of the mixture, pre-heat the air and fuel, increase the flame temperature, decrease the fuel/air ratio and use fuel with greater values of specific heat capacities (VLASSOV, 2001). Initial turbulence can be created by the heater and by setting the combustion chamber walls nearer to each other. Not only does turbulence mix the fuel and air, but also draws the hot gases and intermediates from the flame to return to the ignition zone, consequently reducing ignition time. The secondary air introduction mechanism also influences the form, intensity and stability of the flame (BIZZO, 2003). Commercial gas heaters used for the drying of agricultural products are large consumers of fuel. The principal problem facing this equipment resides in the adaptation of the combustion mechanism, considering that in many cases the dryer-heater system doesn't present satisfactory performance. Based on these considerations, the objective of this study was the evaluation of gas heaters used for agricultural product drying and specifically the investigation of the effects of primary and secondary air flow, temperature and velocity, in an attempt to optimize gas combustion.

METHODOLOGY

Figure 1 and 2 exhibit the design of the gas heater and the computational geometry and symmetry of the problem, respectively.

Figure 1. Design: gas heater, tri-dimensional (a) and longitudinal view (b).

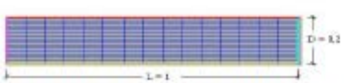

Figure 2. Computational geometry and symmetry of the gas heater.

RESULTS AND DISCUSSION

Table 1. Reynolds number, convection coefficient, entrance velocity and selected ΔT's.

Reynolds number (Re)	Convection coefficient (h)	Velocity (u)	Time difference (ΔT)
100	0.1	10	0.001
	0.01		0.001
500	0.1	50	0.001
	0.01		0.001
1500	0.1	150	0.0001
	0.01		0.0001

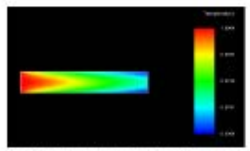

Figure 3. Temperature distribution in the gas heater as a function of the Reynolds number (Re = 100), velocity (u = 10) and convection heat transfer coefficient (h = 0.1).

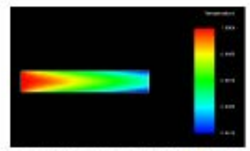

Figure 4. Temperature distribution in the gas heater as a function of the Reynolds number (Re = 100), velocity (u = 10) and convection heat transfer coefficient (h = 0.01).

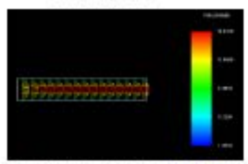

Figure 5. Velocity distribution in the gas heater as a function of the Reynolds number (Re = 100), velocity (u = 10) and convection heat transfer coefficient (h = 0.1).

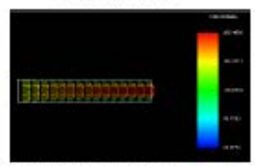

Figure 6. Velocity distribution in the gas heater as a function of the Reynolds number (Re = 1500), velocity (u = 150) and convection heat transfer coefficient (h = 0.1).

CONCLUSION

As the value of the convection coefficient increase, proportionally lower temperatures were found exiting the heater. The velocity profile remained fully developed. The obtained results confirm that CFD software can be employed to resolve heat and mass transfer problems in heaters.

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COMPUTATIONAL FLUID DYNAMICS (CFD) SIMULATING HEATED AIR FROM WOOD BURNING INSIDE A POULTRIES BARN

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ABSTRACT: Animal welfare is essential for livestock yield gains, which has been ethically justifiable and socially acceptable. Thus, our research aimed to test computational fluid dynamics model (CFD) to simulate heated air within a poultry barn. Data were simulated in CFD software based on Navier-Stokes equations (geometry of 3 m x 6 m, considering a symmetric mesh). As boundary conditions, a temperature of 38°C was considered for walls where heating pipe outlets are, to the west side, besides a heat flow of zero, in symmetry to the same side. As for the sides east, south and north, walls were taken as isolated, i.e. heat flow equals to zero. The aviary heating system did not achieve a homogeneous temperature distribution, heat flow, heated air pressure and speed. Heated-air convection cells were spotted in the upper part of the building, being little used for thermal comfort by the birds.

KEY WORDS: environment, animals, thermal comfort, airflow.

INTRODUCTION

Brazilian poultry houses are often built without proper thermal insulation. In addition, heating equipment, traditionally used in initial rearing, such as pancake type heaters and furnaces, are inefficient in terms of energy output, and may not provide an environment full of comfort as needed for birds (VIGODERIS, 2006; ABREU & ABREU, 2011). Heated air distribution into the interior of aviaries usually occurs by thermal convection. OSÓRIO et al. (2012) stated that while selecting a heating system, besides cost, other factors should be considered as thermal power generation ability and produced-air quality, which is set by temperature level and concentration of gases (CO and CO_2).

Several heaters have been used in poultry houses, including turbo gas, infrared, high-pressure, low-pressure, firewood furnaces with preheated air, coal and firewood ones without air renewal

Heated-air distribution is influenced by heating system, barn building conditions, air temperature and humidity, facility insulation, ventilation system and stocking density (VIGODERIS, 2006; CARVALHO et al., 2012; OSÓRIO et al., 2012).

In commercial poultry farms, traditional heating systems are regularly composed of pancake heaters and gas furnaces, which have been proved to be flawed for proper brooder heating, mainly in southern Brazil, resulting in temperatures below the comfort range for birds (VIGODERIS, 2006). The temperature bands claimed as comfort zone for broilers vary with animal age, among which a range from 32 to 34°C is ideal for the first rearing week. In contrast, during the second week, this range drops to 28 and 32°C (VIGODERIS, 2006; MOURA et al., 2010; JENTZSCH et al., 2013).

The computational fluid dynamics (CFD) consists of a computer software that allows the study of flow dynamics of fluids (liquid or gas), as experimental prototypes. This technology is widely applied to simulate diverse processes, especially in certain field areas as chemical industry,

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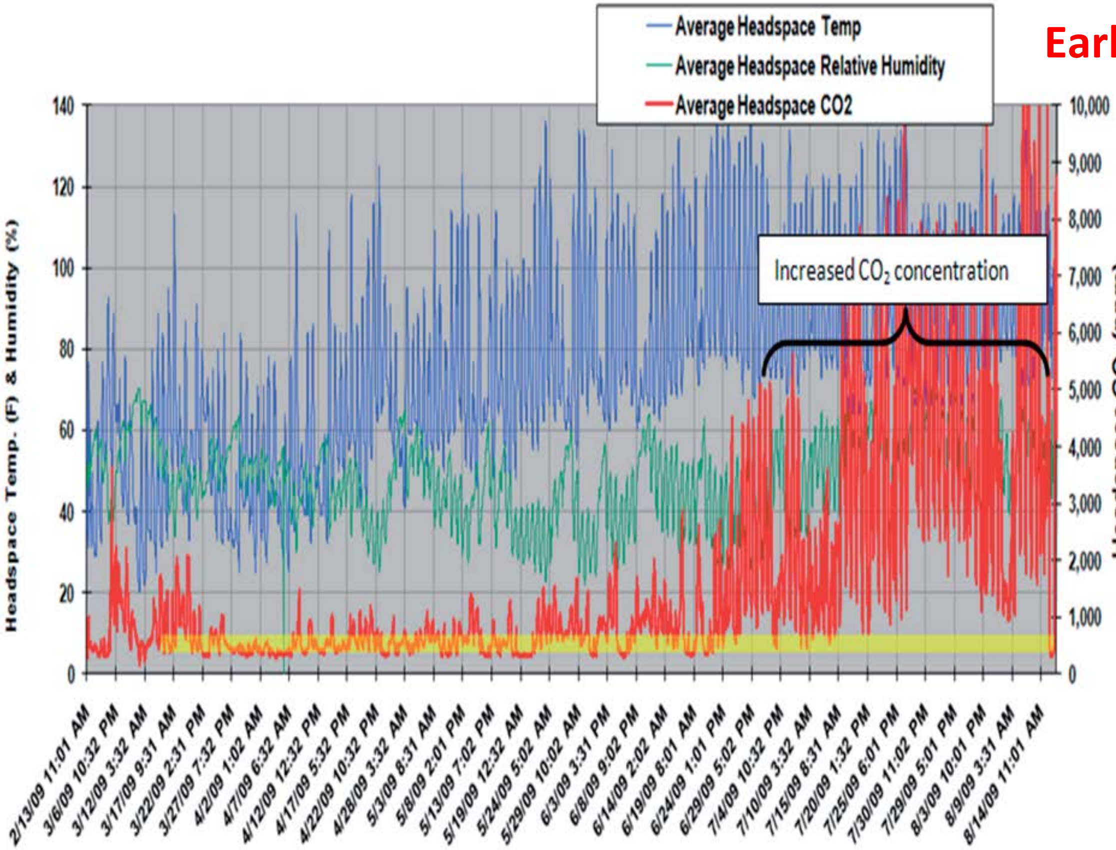


Early detection of spoilage in stored grain

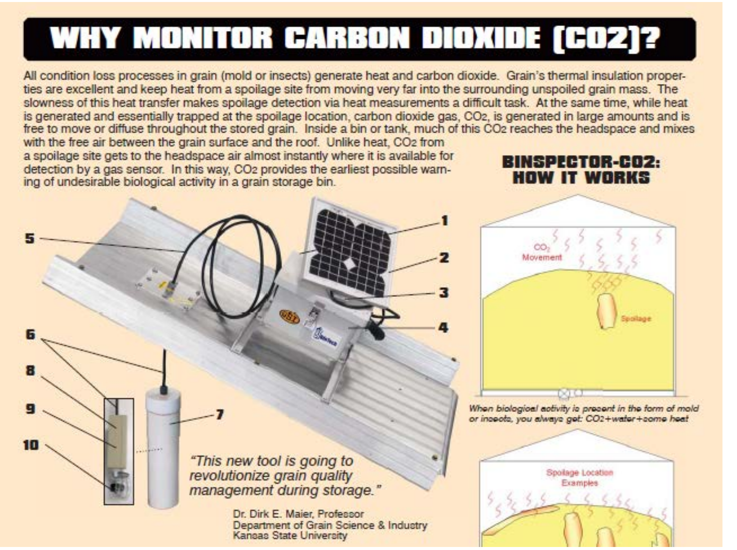
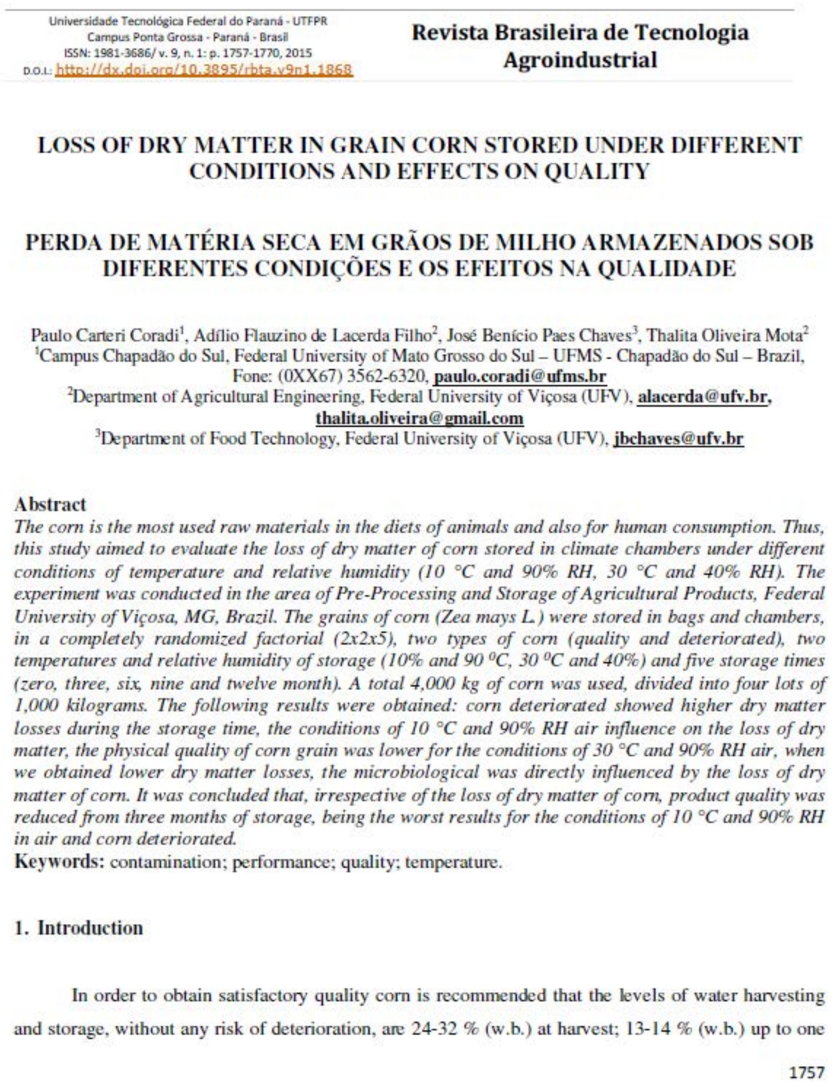


Table 1 Grain quality parameters and incidences of stored-product insects, molds and mycotoxins in maize during storage

Time (2009)	Grain Moisture (%)	Air Temperature (°C)	Relative Humidity (%)	Stored-product Insects (No. insects/kg)	Percent Infections (%)	Kernel cfu/g	Molds Total aflatoxins (ppb)	Mycotoxins Fumo-nisins (ppm)	Deoxy-nivalenol (ppm)
February	14.5	16	60	0	30	$2.0 \pm 0.2 \times 10^2$	0	0	0
March	NA	26	60	1	70	$5.0 \pm 0.1 \times 10^6$	0	2	0
April	NA	26	50	2	NA	$2.2 \pm 0.0 \times 10^2$	0	0	0
May	NA	33	50	4	NA	$2.5 \pm 0.2 \times 10^3$	0	0	0
June	NA	43	52	10	NA	NA	0	0	0
July	13.5	50	59	18	80	$4.2 \pm 0.3 \times 10^6$	1	0	0
August	13.7	49	62	27	90	$6.5 \pm 0.3 \times 10^7$	2	0	1

NA: Data not available

Dry matter losses and quality of corn grains stored under different temperature and relative humidity conditions



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Revista Brasileira de Tecnologia Agroindustrial

LOSS OF DRY MATTER IN GRAIN CORN STORED UNDER DIFFERENT CONDITIONS AND EFFECTS ON QUALITY

PERDA DE MATÉRIA SECA EM GRÃOS DE MILHO ARMAZENADOS SOB DIFERENTES CONDIÇÕES E OS EFEITOS NA QUALIDADE

Paulo Carteri Coradi[1], Adílio Flauzino de Lacerda Filho[2], José Benício Paes Chaves[3], Thalita Oliveira Mota[2]
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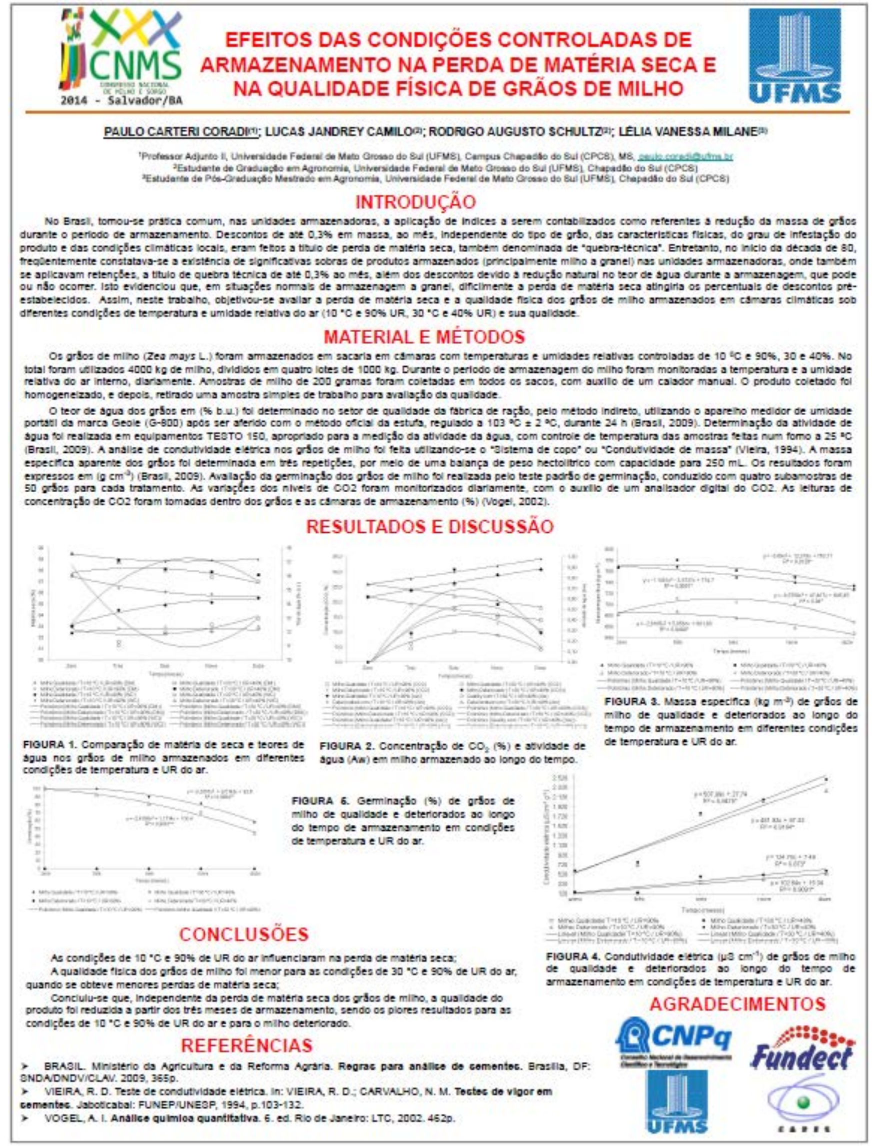
Abstract
The corn is the most used raw materials in the diets of animals and also for human consumption. Thus, this study aimed to evaluate the loss of dry matter of corn stored in climate chambers under different conditions of temperature and relative humidity (10 °C and 90% RH, 30 °C and 40% RH). The experiment was conducted in the area of Pre-Processing and Storage of Agricultural Products, Federal University of Viçosa, MG, Brazil. The grains of corn (Zea mays L.) were stored in bags and chambers, in a completely randomized factorial (2x2x5), two types of corn (quality and deteriorated), two temperatures and relative humidity of storage (10% and 90 ºC, 30 ºC and 40%) and five storage times (zero, three, six, nine and twelve month). A total 4,000 kg of corn was used, divided into four lots of 1,000 kilograms. The following results were obtained: corn deteriorated showed higher dry matter losses during the storage time, the conditions of 10 °C and 90% RH air influence on the loss of dry matter, the physical quality of corn grain was lower for the conditions of 30 °C and 90% RH air, when we obtained lower dry matter losses, the microbiological was directly influenced by the loss of dry matter of corn. It was concluded that, irrespective of the loss of dry matter of corn, product quality was reduced from three months of storage, being the worst results for the conditions of 10 °C and 90% RH in air and corn deteriorated.
Keywords: contamination; performance; quality; temperature.

1. Introduction

In order to obtain satisfactory quality corn is recommended that the levels of water harvesting and storage, without any risk of deterioration, are 24-32 % (w.b.) at harvest; 13-14 % (w.b.) up to one



XXX CNMS Congresso Nacional de Milho e Sorgo 2014 - Salvador/BA

EFEITOS DAS CONDIÇÕES CONTROLADAS DE ARMAZENAMENTO NA PERDA DE MATÉRIA SECA E NA QUALIDADE FÍSICA DE GRÃOS DE MILHO

UFMS

PAULO CARTERI CORADI[1]; LUCAS JANDREY CAMILO[2]; RODRIGO AUGUSTO SCHULTZ[2]; LÉLIA VANESSA MILANE[3]

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INTRODUÇÃO

No Brasil, tomou-se prática comum, nas unidades armazenadoras, a aplicação de índices a serem contabilizados como referentes à redução da massa de grãos durante o período de armazenamento. Descontos de até 0,3% em massa, ao mês, independente do tipo de grão, das características físicas, do grau de infestação do produto e das condições climáticas locais, eram feitos a título de perda de matéria seca, também denominada de "quebra-técnica". Entretanto, no início da década de 80, freqüentemente constatava-se a existência de significativas sobras de produtos armazenados (principalmente milho a granel) nas unidades armazenadoras, onde também se aplicavam retenções, a título de quebra técnica de até 0,3% ao mês, além dos descontos devido à redução natural no teor de água durante a armazenagem, que pode ou não ocorrer. Isto evidenciou que, em situações normais de armazenagem a granel, dificilmente a perda de matéria seca atingiria os percentuais de descontos pré-estabelecidos. Assim, neste trabalho, objetivou-se avaliar a perda de matéria seca e a qualidade física dos grãos de milho armazenados em câmaras climáticas sob diferentes condições de temperatura e umidade relativa do ar (10 °C e 90% UR, 30 °C e 40% UR) e sua qualidade.

MATERIAL E MÉTODOS

Os grãos de milho (*Zea mays* L.) foram armazenados em sacaria em câmaras com temperaturas e umidades relativas controladas de 10 ºC e 90%, 30 e 40%. No total foram utilizados 4000 kg de milho, divididos em quatro lotes de 1000 kg. Durante o período de armazenagem do milho foram monitoradas a temperatura e a umidade relativa do ar interno, diariamente. Amostras de milho de 200 gramas foram coletadas em todos os sacos, com auxilio de um calador manual. O produto coletado foi homogeneizado, e depois, retirado uma amostra simples de trabalho para avaliação da qualidade.

O teor de água dos grãos em (% b.u.) foi determinado no setor de qualidade da fábrica de ração, pelo método indireto, utilizando o aparelho medidor de umidade portátil da marca Geole (G-800) após ser aferido com o método oficial da estufa, regulado a 103 ºC ± 2 ºC, durante 24 h (Brasil, 2009). Determinação da atividade de água foi realizada em equipamentos TESTO 150, apropriado para a medição da atividade da água, com controle de temperatura das amostras feitas num forno a 25 ºC (Brasil, 2009). A análise de condutividade elétrica nos grãos de milho foi feita utilizando-se o "Sistema de copo" ou "Condutividade de massa" (Vieira, 1994). A massa especifica aparente dos grãos foi determinada em três repetições, por meio de uma balança de peso hectolítrico com capacidade para 250 mL. Os resultados foram expressos em (g cm^{-3}) (Brasil, 2009). Avaliação da germinação dos grãos de milho foi realizada pelo teste padrão de germinação, conduzido com quatro subamostras de 50 grãos para cada tratamento. As variações dos níveis de CO2 foram monitorizados diariamente, com o auxilio de um analisador digital do CO2. As leituras de concentração de CO2 foram tomadas dentro dos grãos e as câmaras de armazenamento (%) (Vogel, 2002).

RESULTADOS E DISCUSSÃO

FIGURA 1. Comparação de matéria de seca e teores de água nos grãos de milho armazenados em diferentes condições de temperatura e UR do ar.

FIGURA 2. Concentração de CO_2 (%) e atividade de água (Aw) em milho armazenado ao longo do tempo.

FIGURA 3. Massa especifica (kg m^{-3}) de grãos de milho de qualidade e deteriorados ao longo do tempo de armazenamento em diferentes condições de temperatura e UR do ar.

FIGURA 6. Germinação (%) de grãos de milho de qualidade e deteriorados ao longo do tempo de armazenamento em condições de temperatura e UR do ar.

FIGURA 4. Condutividade elétrica (µS cm^{-1}) de grãos de milho de qualidade e deteriorados ao longo do tempo de armazenamento em condições de temperatura e UR do ar.

CONCLUSÕES

As condições de 10 °C e 90% de UR do ar influenciaram na perda de matéria seca;

A qualidade física dos grãos de milho foi menor para as condições de 30 °C e 90% de UR do ar, quando se obteve menores perdas de matéria seca;

Concluiu-se que, independente da perda de matéria seca dos grãos de milho, a qualidade do produto foi reduzida a partir dos três meses de armazenamento, sendo os piores resultados para as condições de 10 °C e 90% de UR do ar e para o milho deteriorado.

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AGRADECIMENTOS

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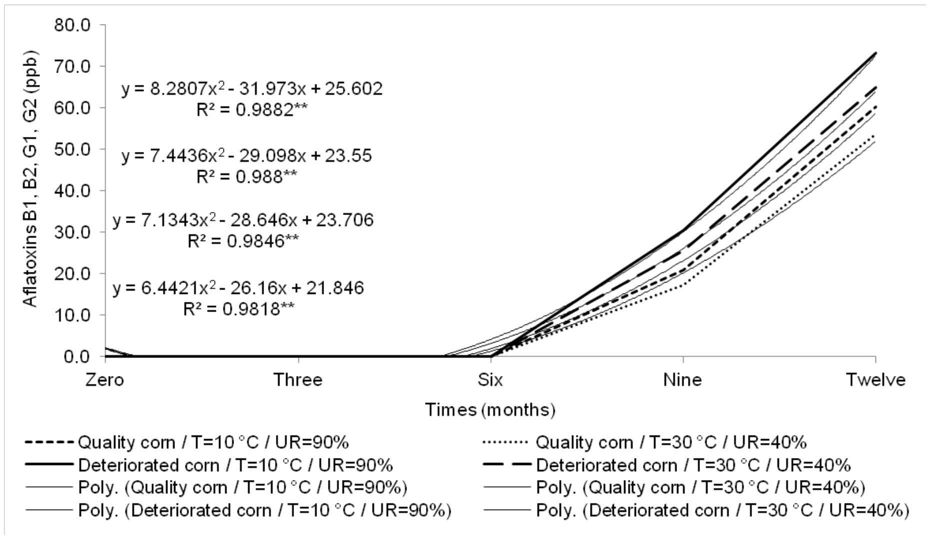
Evaluation of mycotoxins in corn grains stored under different conditions of relative air temperatures and humidity



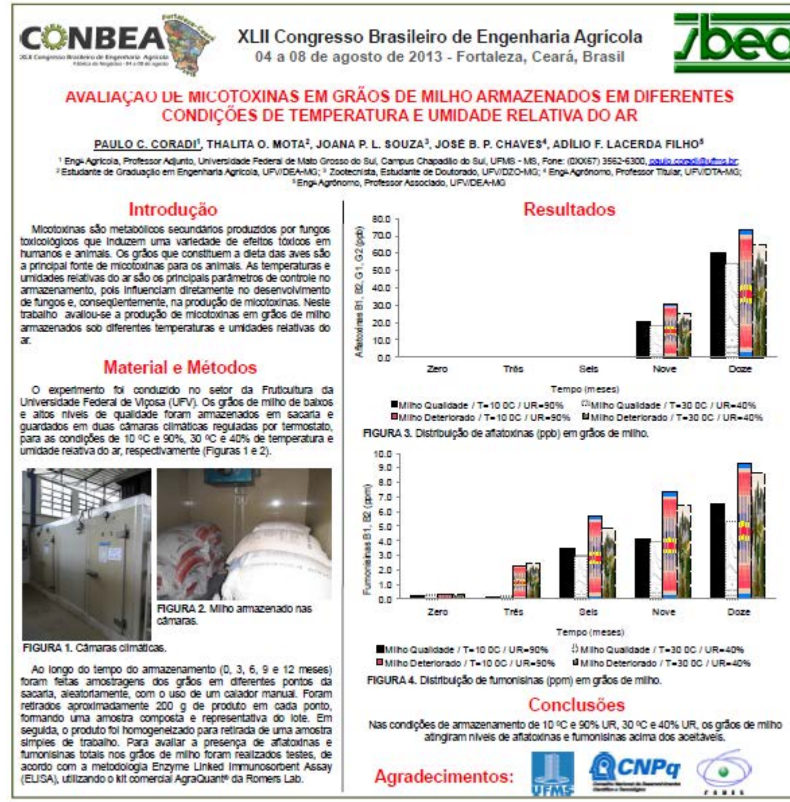
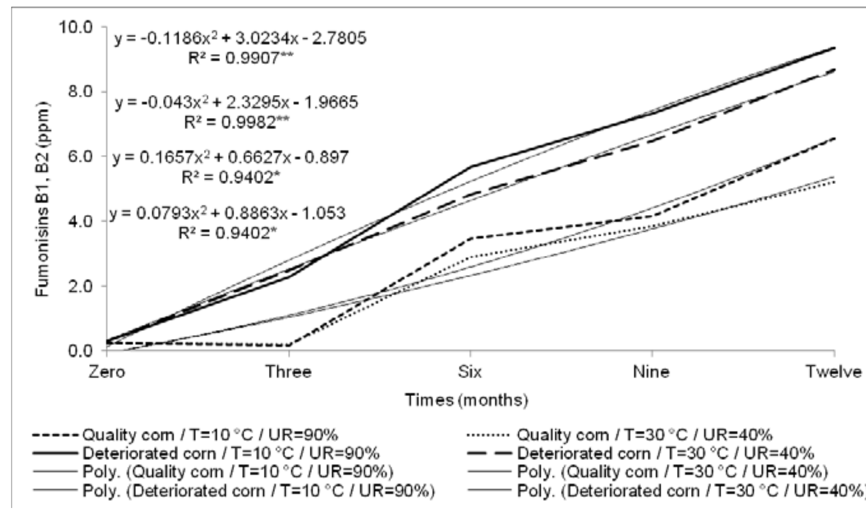


Table 6 - Evaluation of fungus (CFU.g^{-1}) for different types of corn, the conditions and time of storage

Evaluation	Times (days)	Quality corn / T=10 ºC / UR=90%	Quality corn / T=30 ºC / UR=40%	Deteriorated corn / T=10 ºC / UR=90%	Deteriorated corn / T=30 ºC / UR=40%
Aspergillus sp.	0	0.2×10^{1}	2.2×10^{2}	0.2×10^{1}	2.2×10^{2}
	90	4.2×10^{4}	6.6×10^{3}	5.6×10^{5}	7.4×10^{6}
	180	6.1×10^{5}	9.5×10^{5}	5.9×10^{6}	8.5×10^{5}
	270	5.2×10^{6}	8.4×10^{6}	6.7×10^{7}	6.3×10^{3}
	360	8.0×10^{7}	7.4×10^{7}	7.6×10^{8}	7.9×10^{7}
Aspergillus flavus	0	0.1×10^{1}	1.5×10^{2}	0.1×10^{1}	1.5×10^{2}
	90	2.0×10^{3}	5.7×10^{3}	2.2×10^{4}	4.7×10^{4}
	180	1.8×10^{4}	3.8×10^{4}	1.2×10^{6}	4.8×10^{5}
	270	2.6×10^{5}	4.7×10^{5}	4.2×10^{7}	5.6×10^{6}
	360	8.9×10^{5}	7.3×10^{5}	5.7×10^{8}	6.6×10^{7}



PHYSICAL QUALITY OF GRAINS CORN STORED ON DIFFERENT CONDITIONS OF TEMPERATURE AND RELATIVE HUMIDITY OF AIR

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INTRODUCTION

Several studies on stored grains indicated that the temperature and relative humidity of the grain are the main controlling factors for safe storage. Due to the geographical position of Brazil and its large land area has great climatic variations. To ensure the quality of stored products must meet the conditions of the air in the storage site. The objective of this study was to evaluate the physical quality of corn stored with controlled temperatures and relative humidities of 10% and 90 °C, 30 °C and 40%, respectively, simulating two regions of different climates.

RESULTS AND DISCUSSION

In the results were observed that the corn deteriorated not germinated in any of the storage conditions (Table 1). Under the conditions of 30 °C and 40% RH, 10 °C and 90% RH, the rate of germination of the grains started to decrease (90%) from the third and sixth months of storage, respectively. A high electric conductivity (C.E.) (511 $\mu S.cm^{-1}.g^{-1}$) in grains stored for high temperatures and low relative humidity air were verified. The time of storage had a negative impact on the grains quality, increasing the C. E. of 580 $\mu S.cm^{-1}.g^{-1}$ to 1908 $\mu S.cm^{-1}.g^{-1}$ in the grains deteriorated, and 137 $\mu S.cm^{-1}.g^{-1}$ to 511 $\mu S.cm^{-1}.g^{-1}$ in the corn healthy.

MATERIALS AND METHODS

The experiment was conducted in the Department of Food Technology of the Federal University of Vicosa (UFV), Minas Gerais State, Brazil. In the total 2,000 kg of corn healthy and 2,000 kg of corn deteriorated were stored in two chambers (Figure 1 and 2). Samplings of corn (Figures 3) were done in 0, 3 and 6 months of storage. To according BRAZIL (2009) the quality physical of the corn was measured by the water content (w.b. %), electric conductivity ($\mu Scm^{-1}g^{-1}$), germination test (%), mass specific ($g.cm^{-3}$), weight of 1,000 grains (g).

FIGURA 1. Câmaras climáticas.

FIGURA 2. Milho nas câmaras

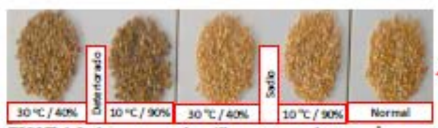

FIGURA 3. Amostagem de milho armazenados nas câmaras.

Table 1. Physical quality of the grains of corn stored on different conditions of temperature and relative humidity of the air

	Zero month		Third month of storage				Sixth month of storage			
			Corn healthy		Corn deteriorated		Corn healthy		Corn deteriorated	
Physical analysis	Corn healthy	Corn deteriorated	10 °C / 90%	30 °C / 40%	10 °C / 90%	30 °C / 40%	10 °C / 90%	30 °C / 40%	10 °C / 90%	30 °C / 40%
Water content (%)	12.43 aA	17.61 bB	13.56 aA	11.32 aA	17.16 bB	11.09 aA	13.93 aA	12.01 aA	17.04 bB	11.89 aA
Electric conductivity ($\mu Scm^{-1}g^{-1}$)	162 aA	606 bA	139 aA	153 aA	725 aB	776 aB	370 aB	481 aB	1783 aC	1798 aC
Germination (%)	100 bB	0 aA	100 aC	90 aB	0 aA	0 aA	90 aB	80 aA	0 aA	0 aA
Weight of 1,000 grains (g)	230 bA	359 aA	279 bA	269 aA	389 bB	356 aA	291 bA	279 aA	392 bB	362 aA
Mass specific ($g.cm^{-3}$)	779 bA	679 aA	768 aA	780 bA	688 aA	711 bB	749 aA	762 bA	676 aA	704 bB

Similar lower case letters have the same meanings in the lines for each treatment of corn healthy and corn deteriorated. Similar capital letters have the same meanings for corn healthy and corn deteriorated in the lines for the time of storage.

CONCLUSION

- The grains of corn stored on the conditions of low temperature and high relative humidity presented better quality;
- The increase of the time of storage reduced the quality of the grains of corn.

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DIGESTIBILIDADE DE FRANGOS DE CORTE EM FUNÇÃO DE DIETAS COM MILHO ARMAZENADOS EM DIFERENTES CONDIÇÕES

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Introdução

A qualidade da ração fornecida aos animais é de extrema importância para assegurar seu desempenho. Para que a ração tenha qualidade e garanta o bom desempenho animal, esta deve ser preparada com ingredientes de qualidade. Para manter a qualidade das matérias-primas é necessário adotar medidas de controle de temperatura e umidade relativa do ar, evitando deteriorações. Assim, o objetivo deste estudo foi avaliar a digestibilidade de frangos de corte em função de dietas com milhos armazenados (deteriorado e normal) em diferentes condições de temperatura e umidade relativa (10 °C e 90%, 30 °C e 40%) do ar e 1 milho armazenado em condição ambiente.

Material e Métodos

O experimento foi realizado no Departamento de Zootecnia da Universidade Federal de Viçosa (UFV). Os grãos de milho de baixos e altos níveis de qualidade foram armazenados em sacaria e guardados em duas câmaras climáticas reguladas por termostato, para as condições de 10 °C e 90%, 30 °C e 40% de temperatura e umidade relativa do ar, respectivamente. Foram realizados testes nos animais, com milho armazenado nos tempos zero, seis e doze meses. As aves foram alojados em gaiolas metálicas (Figuras 1) de (0,5 m x 0,5 m), localizadas dentro de um galpão de alvenaria telado e coberto com telhas de amianto. O programa de luz adotado foi de 24 horas, natural e artificial. O aquecimento artificial dos pintos foi realizado com uma lâmpada de infravermelho de 250 watts e altura regulável, ajustada para o maior conforto possível às aves. A temperatura e a umidade relativa do ar no interior do galpão foram monitoradas diariamente por dois termômetros digitais de máxima e mínima e um termo-higrômetro digital que foram distribuídos pelo galpão, posicionados à altura das aves.

FIGURA 1. Gaiolas para aves.

Resultados e Discussão

TABELA 1. Rendimento de excretas de frangos de corte em função dos tratamentos, com diferentes tipos de milho armazenados

Tratamento milho	Peso Inicial (kg)	Peso Final (kg)	Peso total excreta (kg)	Matéria umida (%)	Matéria seca (%)
Testemunha	6,75	3,35	3,560	74,24	25,76
*S 10 °C/90%	5,65	1,80	3,890	74,86	25,14
*S 30 °C/40%	6,40	2,80	3,730	74,71	25,29
*C 10 °C/90%	5,90	2,60	4,270	74,18	25,82
*C 30 °C/40%	5,80	2,05	4,030	73,99	26,01
[1]S 10 °C/90%	5,70	2,50	3,130	73,66	26,34
[1]S 30 °C/40%	6,65	3,20	3,285	72,60	27,40
[1]C 10 °C/90%	5,70	2,20	3,665	73,12	26,88
[1]C 30 °C/40%	5,10	1,40	3,620	74,29	25,71

*Rações formuladas, [1]Milho, S – Sadio, C – Contaminado.

TABELA 2. Porcentagem de energia bruta e proteína bruta nas rações formuladas com diferentes tipos de milho armazenados

Tratamentos	Energia bruta (%)	Proteína bruta (%)
Testemunha	35,51	33,51
*S 10 °C/90%	35,07	27,85
*S 30 °C/40%	36,32	29,68
*C 10 °C/90%	35,97	28,38
*C 30 °C/40%	34,84	28,75
[1]S 10 °C/90%	37,81	28,25
[1]S 30 °C/40%	37,15	25,12
[1]C 10 °C/90%	37,16	29,33
[1]C 30 °C/40%	37,60	25,41

*Rações formuladas, [1]Milho, S – Sadio, C – Contaminado.

Conclusões

As condições de armazenamento de 30 °C e 40% atendem melhor a qualidade nutricional do milho e conseqüentemente reduziram a quantidade de excretas dos frangos de corte, aumentando o rendimento dos animais.

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QUALIDADE DE GRÃOS DE MILHO APÓS SECAGEM E ARMAZENAMENTO EM AMBIENTE NATURAL E RESFRIAMENTO ARTIFICIAL

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RESUMO - As condições de pós-colheita, secagem e armazenamento são fundamentais para manutenção da qualidade dos grãos de milho. Assim, objetivou-se avaliar as propriedades físicas e a qualidade físico-química dos grãos de milho após secagem com diferentes temperaturas e armazenamento em ambiente natural e resfriamento artificial ao longo de seis meses. O experimento foi conduzido no Laboratório de Pós-Colheita de Grãos (CPCS/UFMS) em um delineamento experimental inteiramente casualizado, em esquema fatorial (3x2x2x3), três temperaturas de secagem (80, 100 e 120 °C utilizadas nos secadores de grãos na região do Cerrado), duas condições de armazenamento (refrigerada a 10 °C e em ambiente natural a 23 °C) e dois tempos de armazenamento (zero e seis meses) com três repetições. Os grãos de milho foram colhidos com teores de água de 18% (b.u.) e secos em estufa de convecção com ventilação forçada do ar para, em seguida, serem armazenados. O aumento da temperatura do ar de secagem de 80 para 120 °C, associado às condições e ao tempo de armazenamento, foram prejudiciais à qualidade físico-química dos grãos de milho. Concluiu-se que a secagem com temperatura do ar de 80 °C e o armazenamento com resfriamento artificial de 10 °C mantiveram as propriedades físicas e a qualidade físico-química dos grãos de milho.

Palavras-chave - pós-colheita, temperatura, umidade relativa do ar, *Zea mays* L.

QUALITY OF CORN GRAIN AFTER DRYING AND STORAGE IN NATURAL ENVIRONMENT AND ARTIFICIAL COOLING

ABSTRACT - The conditions of post-harvest, drying and storage are critical to maintaining the quality of corn grain. Thus, this study aimed to evaluate the physical properties and physicochemical quality of corn grain after drying at different temperatures and storage in natural environment and artificial cooling, over six months. The experiment was conducted at the Grain Postharvest Laboratory (CPCS/UFMS) in a completely randomized experimental design in a factorial scheme (3x2x2x3), three drying temperatures (80, 100 and 120 °C used in grain dryers in the "cerrado" region), two storage conditions (cooled to 10 °C and in natural environment at 23 °C), and two storage times (zero and six months), with three replications. The corn kernels were harvested at moisture contents of 18% (w.b.) and dried in a convection oven with forced air ventilation and then stored. The increase in drying air temperature from 80 to 120 °C associated with time and conditions of storage were detrimental to the physical-chemical quality of corn grains. The results showed that the drying air temperatures of 80 °C and storage with artificial cooling at 10 °C maintained the physical properties and physicochemical quality of corn grains.

Keywords - post-harvest, temperature, relative humidity, *Zea mays* L.

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TABELA 5. Resultados médios da condutividade elétrica (μS $cm^{-1}g^{-1}$), germinação (%) dos grãos de milho em função da temperatura do ar de secagem (80, 100, 120 °C), condição de temperatura (ambiente a 23 °C e resfriamento a 10 °C), tempo de armazenamento (zero e seis meses).

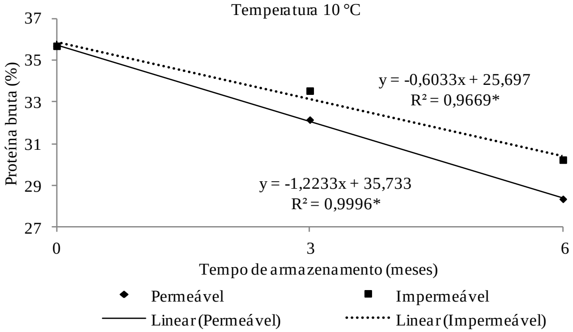
Avaliação[1]	Temp. secagem (°C)	Tempo zero		Tempo seis	
		Ambiente (23 °C)	Resfriamento (10 °C)	Ambiente (23 °C)	Resfriamento (10 °C)
Condutividade elétrica	80	32,09 Ab	32,09 Ab	47,49 Aa	19,63 Bb
	100	38,24 Ab	38,24 Ab	52,67 Aa	26,17 Ba
	120	51,37 Aa	51,37 Aa	49,62 Aa	28,86 Ba
	Temp. secagem (°C)	Ambiente (23 °C)		Resfriamento (10 °C)	
		Tempo zero	Tempo seis	Tempo Zero	Tempo seis
	80	32,08 Bb	47,49 Ba	32,09 Ab	19,63 Bb
	100	38,24 Bb	52,67 Aa	38,24 Ab	26,17 Ba
	120	51,37 Aa	49,62 Aa	51,37 Aa	28,86 Ba
	Temp. secagem (°C)	Tempo zero		Tempo seis	
		Ambiente (23 °C)	Resfriamento (10 °C)	Ambiente (23 °C)	Resfriamento (10 °C)
Germinação	80	36,00 Aa	36,00 Aa	12,66 Ba	27,00 Aa
	100	0,330 Ab	0,330 Ab	0,000 Ab	0,330 Ab
	120	0,330 Ab	0,330 Ab	0,000 Ab	0,000 Ab
	Temp. secagem (°C)	Ambiente (23 °C)		Resfriamento (10 °C)	
		Tempo zero	Tempo seis	Tempo zero	Tempo seis
	80	36,00 Aa	12,66 Ba	36,00 Aa	27,00 Ba
	100	0,330 Ab	0,000 Ab	0,330 Ab	0,330 Ab
	120	0,333 Ab	0,000 Ab	0,330 Ab	0,000 Ab

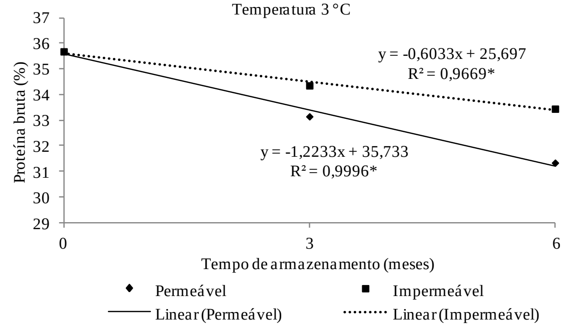
[1]Médias seguidas pelas letras maiúscula na linha para cada tempo de armazenamento e minúsculas nas colunas para cada temperatura do ar de secagem não diferem entre si a 5% de probabilidade.

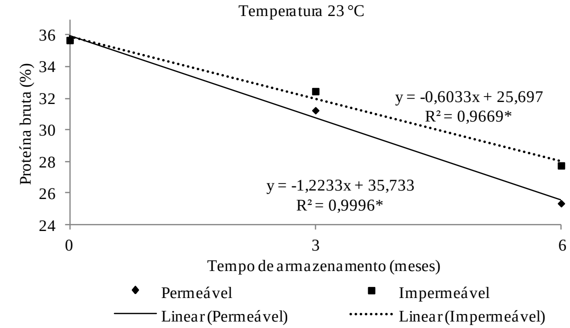
Tabela 5. Avaliações químicas em grãos de milho durante armazenamento em condições de ambiente natural e refrigerado

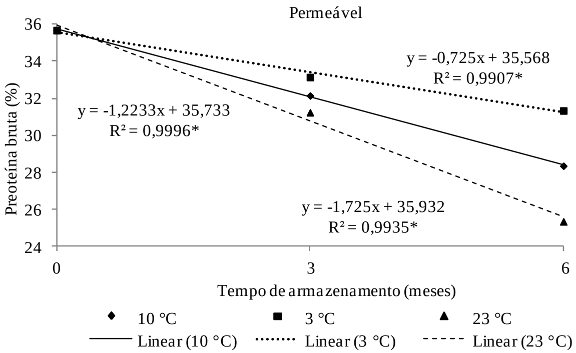
Avaliações químicas	Condições de armazenamento	Temperatura do ar de secagem (°C)					
		80		100		120	
		Tempo (meses)					
		Zero	Seis	Zero	Seis	Zero	Seis
Acidez (ml NaOH 0,1N)	Natural 23°C	2,46 aA	2,05 bA	2,33 aA	1,86 bA	1,94 aA	1,98 aA
	Refrigerado 10 °C	2,46 aA	1,47 bB	2,33 aA	1,42 bB	1,94 aA	1,31 bB
Proteína Bruta (%)	Natural 23°C	4,36 bA	7,82 aA	4,50 bA	8,06 aA	3,99 bA	7,82 aA
	Refrigerado 10 °C	4,36 bA	8,09 aA	4,50 bA	7,29 aB	3,99 bA	7,67 aA
Cinzas (%)	Natural 23°C	1,31 aA	1,28 aB	1,06 bA	1,55 aA	1,13 bA	1,51 aA
	Refrigerado 10 °C	1,31 bA	1,69 aA	1,06 bA	1,65 aA	1,13 bA	1,53 aA

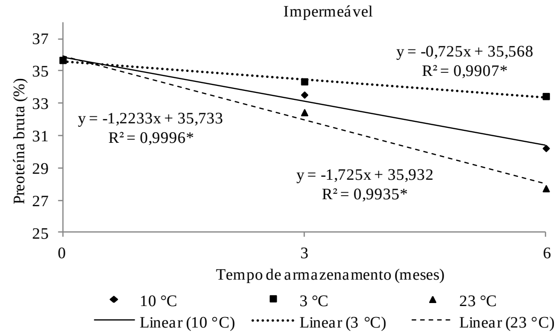
Médias seguidas pela letra maiúscula na coluna para a condição de armazenamento, e letra minúscula na linha para os tempos de armazenamento, não diferem a 5% de probabilidade.

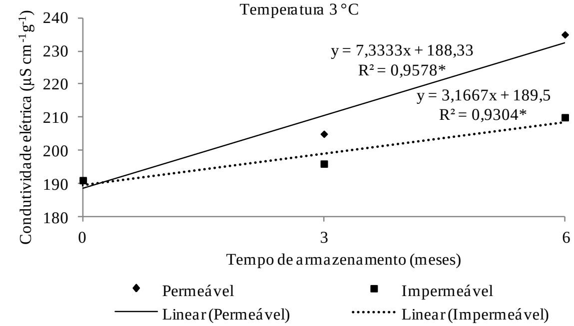


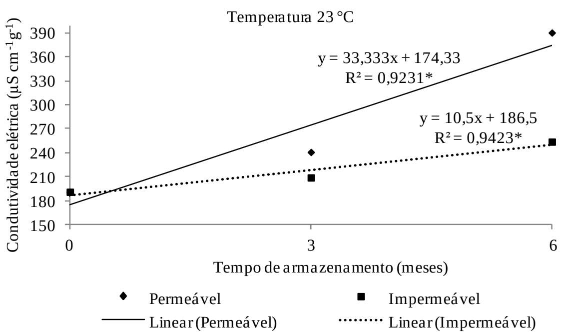


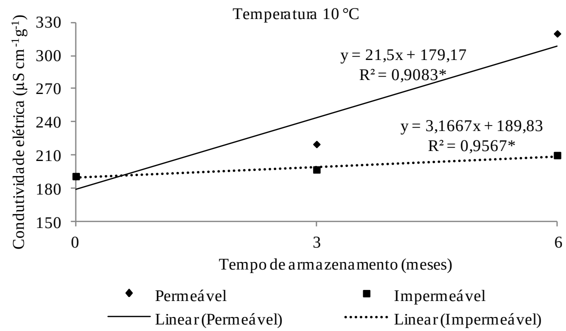


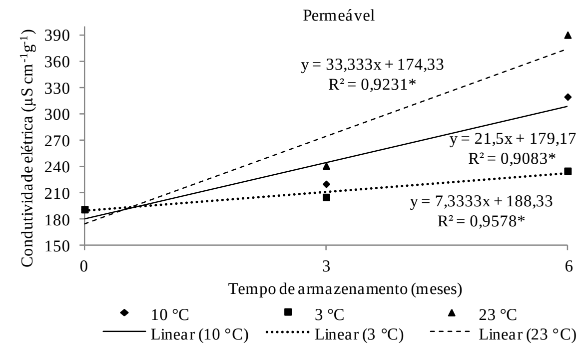


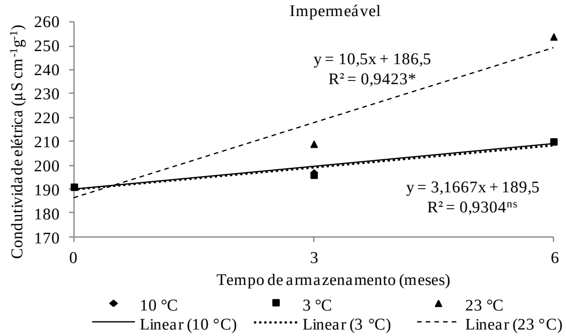




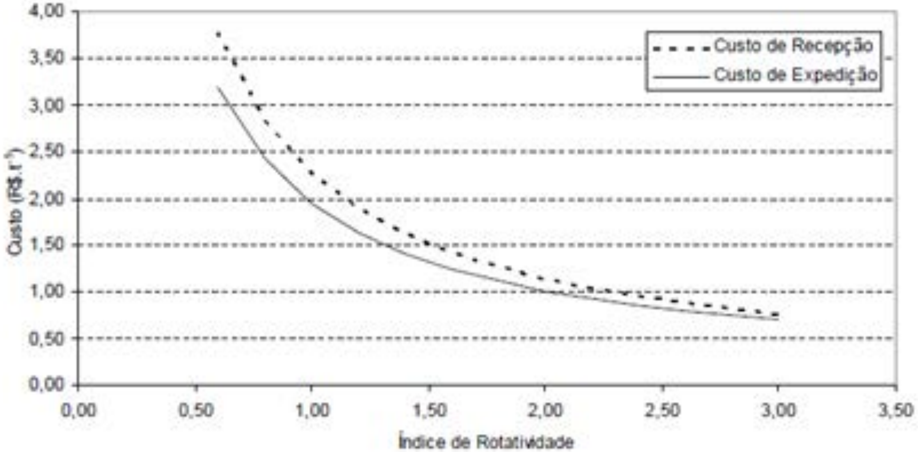




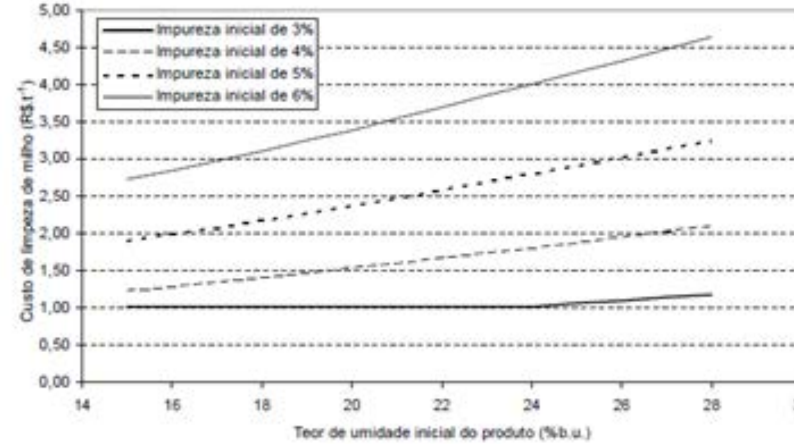




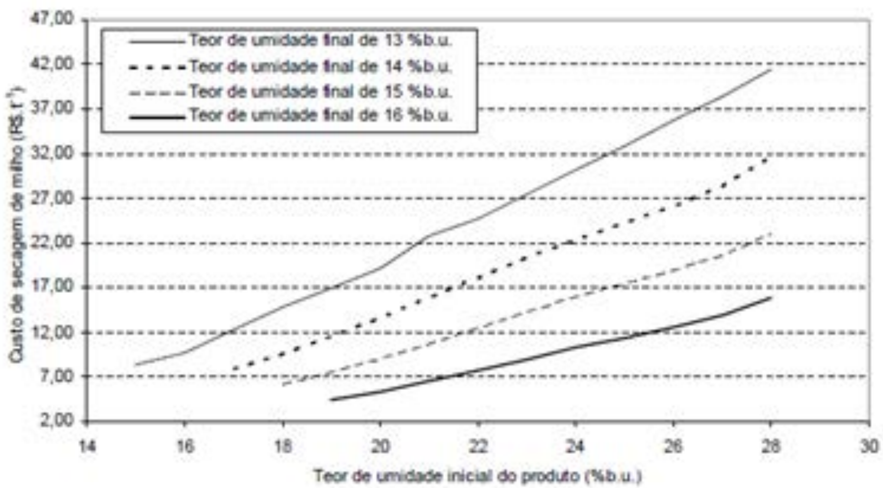
Stored soybean cooling



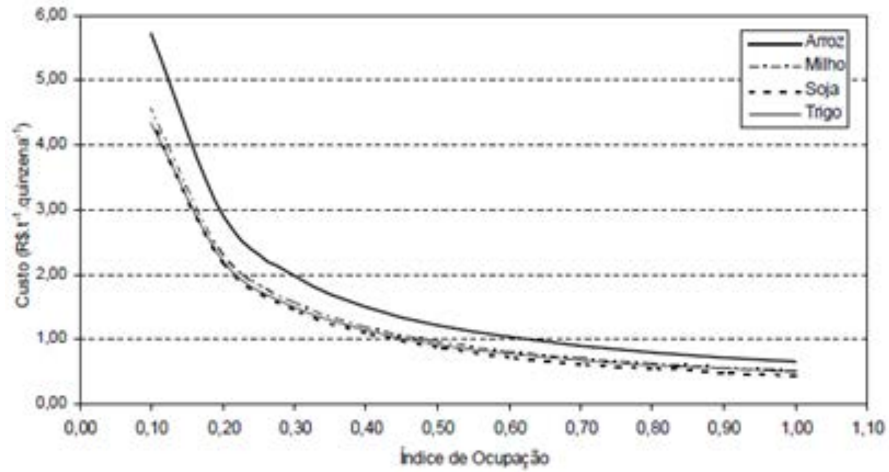
Costs of reception



Costs of cleaning

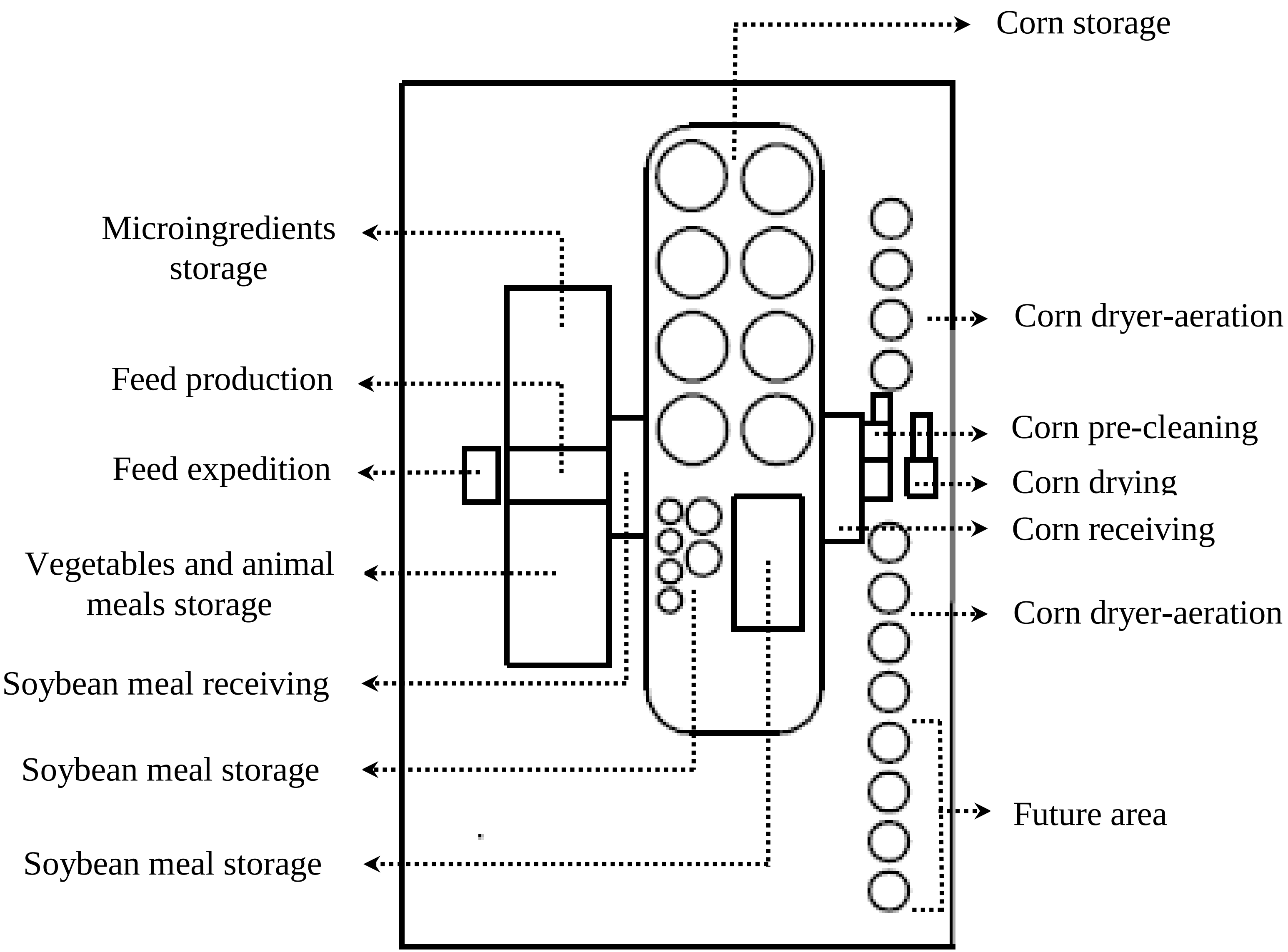


Costs of drying



Costs of storage

QUALITY CONTROL AND LOSS REDUCTION IN RAW PRODUCTION PROCESSES IN FEED MILL



POTENTIAL CONTAMINANTS AGENTS IN FEED MILLS: RISKS TO THE HEALTH OF THE HANDLERS

PAULO CARTERI CORADI[1], JOSÉ BENICIO PAES CHAVES[2], ADÍLIO FLAUZINO DE LACERDA FILHO[3]

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Introduction

The cleaner production provides for industry to generate financial gains through better use of raw materials, water, energy and non-waste generation. Feed industries have serious problems of physic-chemical contamination and microbiological, consisting mainly of products (raw materials and feed) and external agents such as water, air handlers, and equipment of the production system. Almost invariably, the best method of assuring water quality consists of avoiding contaminations of animal and human dejections, which contain a great variety of bacteria, viruses, and protozoa. The dust is present in the ambient air of many different industries such as grains, agricultural crops and animal feed processing. Agricultural dust contains proteins, microorganisms, pollen and plant fragments and the viable fraction tends to be attached with dust fraction. The objective of this study was to evaluate the microbiological contamination on the surfaces of equipments and hands surfaces of the handlers, water and ambient air inside of different sectors of feed production as possible points of cross-contamination.

Materials and Methods

The activities were developed in a feed mill for poultry, located in Minas Gerais state, Brazil. In the total were collected 90 samples of water, 65 samples on the hands surface of the employees (meals room, laboratory, grains storage, soybean meal), 88 samples on the surface of equipment and objects, and 93 samples in ambient air of each sector (meals room, laboratory, grains storage, soybean meal storage, micro ingredients, pellet mill, feed expedition) (Figure 1). Before sampling of the water, a cleaning of the points of collect was accomplished with aid of alcohol, leaving 3 minutes the water draining to eliminate any type of contamination that could interfere in the results of the analysis (Brasil, 1999). The sampling on the surfaces of object proceeded with the passage of a sterile swab on an area of 100 cm² using drained mold properly cleaned with alcohol. For the sampling of the ambient air, a petri plate was exposed opened during fifteen minutes in the area evaluated. The analysis of toxigenic fungi was performed by Dhingra & Sinclair (1995). The analyses of bacteria were realized by general method of the American Public Health Association-A.P.H.A. (Speck, 1984). The results obtained were compared with the microbiological norm (Table 1) to according Brasil (1990).

Table 1. Acceptable limit of contamination

Microorganisms	Acceptable limit
Bacteria	≤ 1,000 (CFU.100 ml⁻¹ or CFU.10 cm⁻² or Petri plate)
Fungi	≤ 100 (CFU.100 ml⁻¹ or CFU.10 cm⁻² or Petri plate)

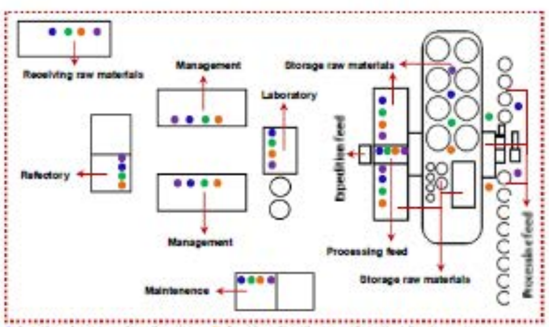

Figure 1. Partial feed milling plant and points of sampling.

Results and Discussion

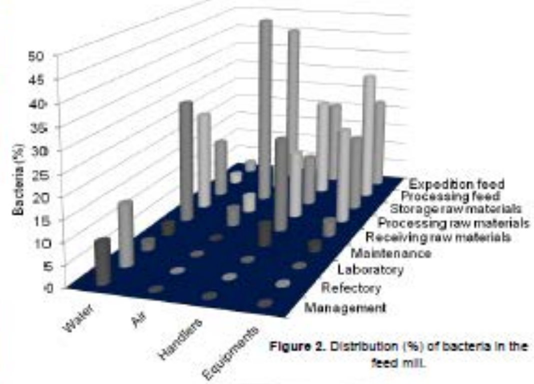

Figure 2. Distribution (%) of bacteria in the feed mill.

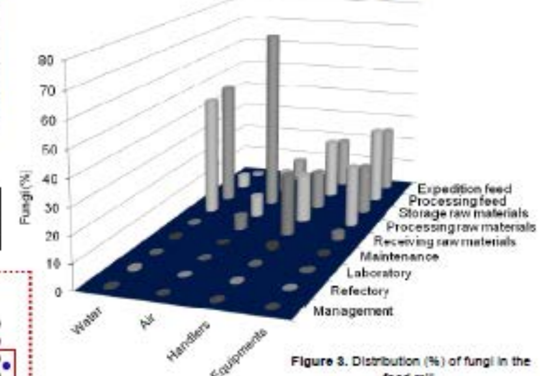

Figure 3. Distribution (%) of fungi in the feed mill.

Conclusion

The ambient of production of the feed mill presented high contamination levels, compromising the quality of work of the handlers.

Acknowledgements

The authors would like to thank the UFMS, CAPES and CNPq from Brazil, for its financial support.

QUANTIFICATION OF PHYSICAL LOSSES PRODUCTS IN A PLANT OF FEED

Paulo Carteri Coradi[1], Adílio Flauzino de Lacerda Filho[2], José Benicio Paes Chaves[3], Evandro de Castro Melo[4]

ABSTRACT

The aim of the study was to evaluate the quantity, costs and contaminations of the physical losses of products (corn, meals, flours, feeds, and micro ingredients) caused by the maintenance system utilized in equipment of the different stages of a feed production mill. The experiment was conducted in a feed industry with production capacity of 1,000 ton day^{-1}. Firstly, an assessment of the maintenance system used in the feed mill was performed, after the products losses were quantified in the external and internal sectors of the milling steps. Two methods were utilized for loss quantification: per sector and per equipment of the feed industry. Samples of the products were collected in different points of the area evaluated for counting of fungi and salmonella colonies, insects and mites. The results showed that a large number of maintenances were not performed within the programmed period, up to 70%. In addition, the equipment maintenance system utilized in the feed milling significantly influenced product losses, reaching 120 kg and costs of US$ 38 per hour worked. The microbiological analysis presented a high contamination index by fungi and salmonellas sp. (7,4 x 10^{4} CFU g^{-1}) in corn grain.

Keywords: control, industry, ingredients, processing, quality.

RESUMO

QUANTIFICAÇÃO DAS PERDAS FÍSICAS DE PRODUTOS EM UMA FÁBRICA DE RAÇÃO

O objetivo do estudo foi avaliar o quantitativo, os custos e as contaminações das perdas físicas de produtos (milho, farelos, farinhas, rações, e micro ingredientes), causada pelo sistema de manutenção utilizado nos equipamentos das diferentes fases de produção de uma fábrica de ração. O experimento foi realizado em uma indústria de rações com capacidade de produção de 1000 ton dia^{-1}. Em primeiro lugar, foi feito um levantamento do sistema de manutenção utilizado na fábrica de ração, após as perdas de produtos foram quantificados nos diferentes setores externos e internos da fábrica de ração. Dois metodos foram utilizados para quantificação das perdas: por setor e por equipamentos da indústria de rações. Amostras de produtos foram recolhidas em diferentes pontos da área avaliada para contagem de fungos e salmonelas, insetos e ácaros. Os resultados mostraram elevado número de manutenções não realizado dentro do período programado, chegando a 70%. Além disso, o sistema de manutenção de equipamentos utilizados na indústria de ração influenciou significativamente as perdas de produtos, chegando até 120 kg e custos de US$ 38 por hora de trabalho. A análise microbiológica apresentou um alto índice de contaminação de fungos e salmonelas sp. (7.4 x 10^{4} UFC g^{-1}) em grãos de milho.

Palavras-chave: controle, indústria, ingredientes, processamento, qualidade.

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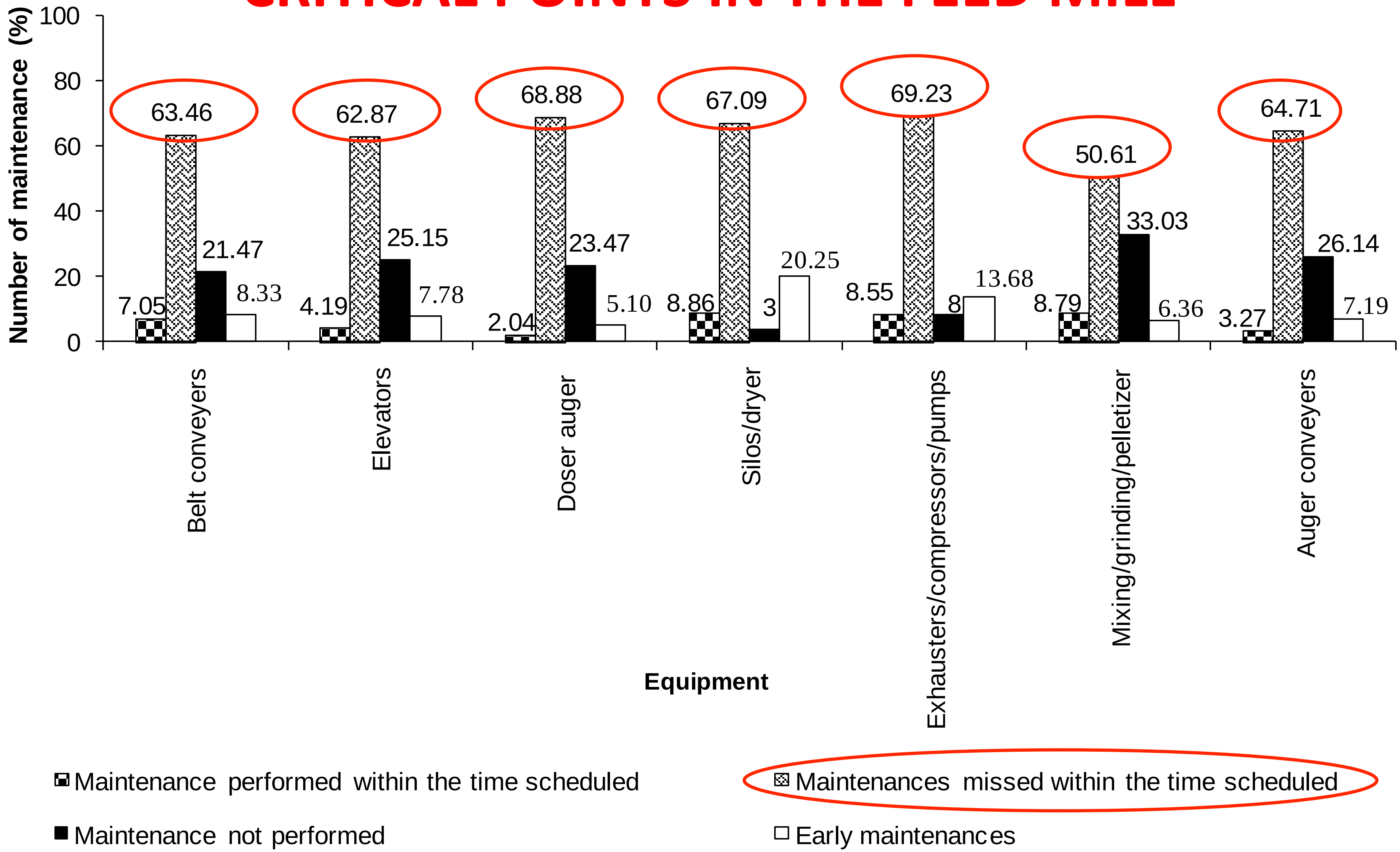
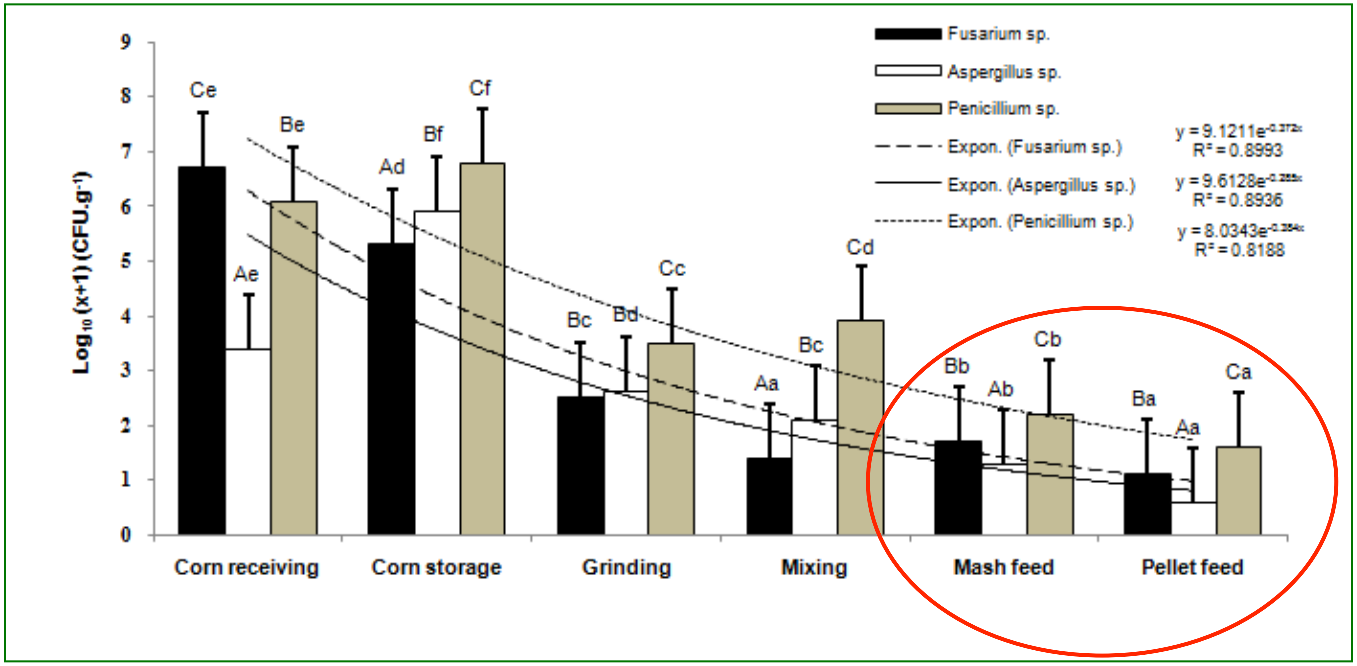
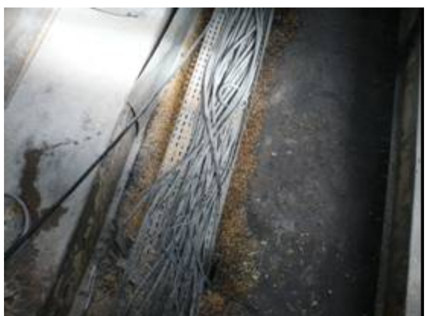
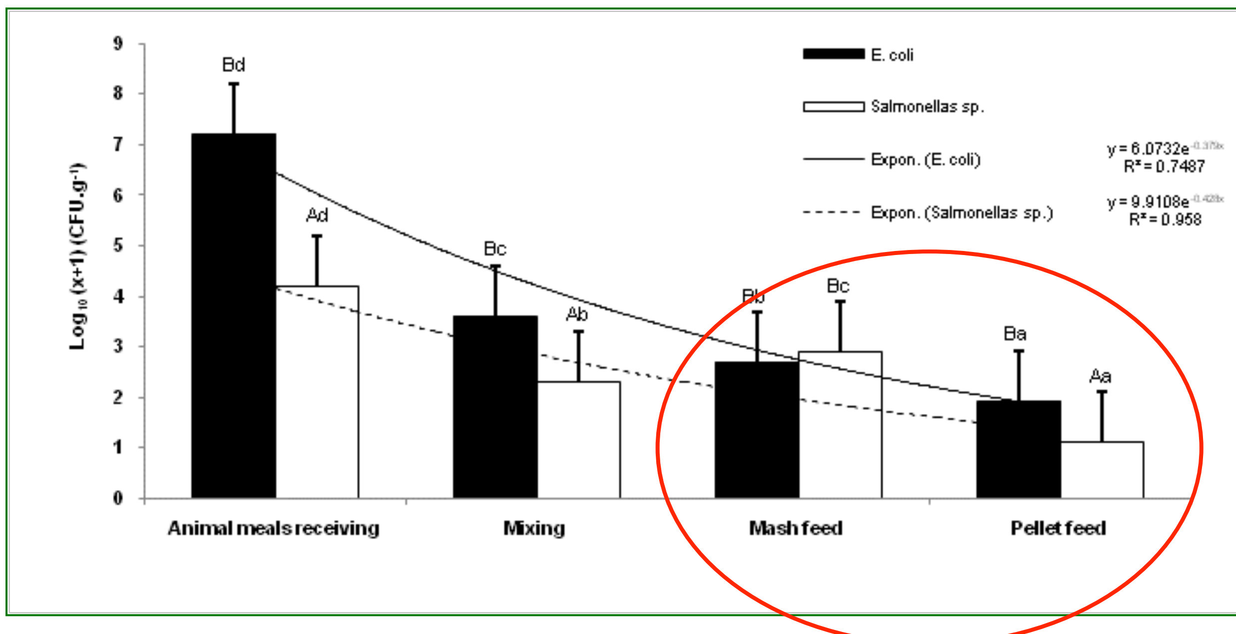
CRITICAL POINTS IN THE FEED MILL



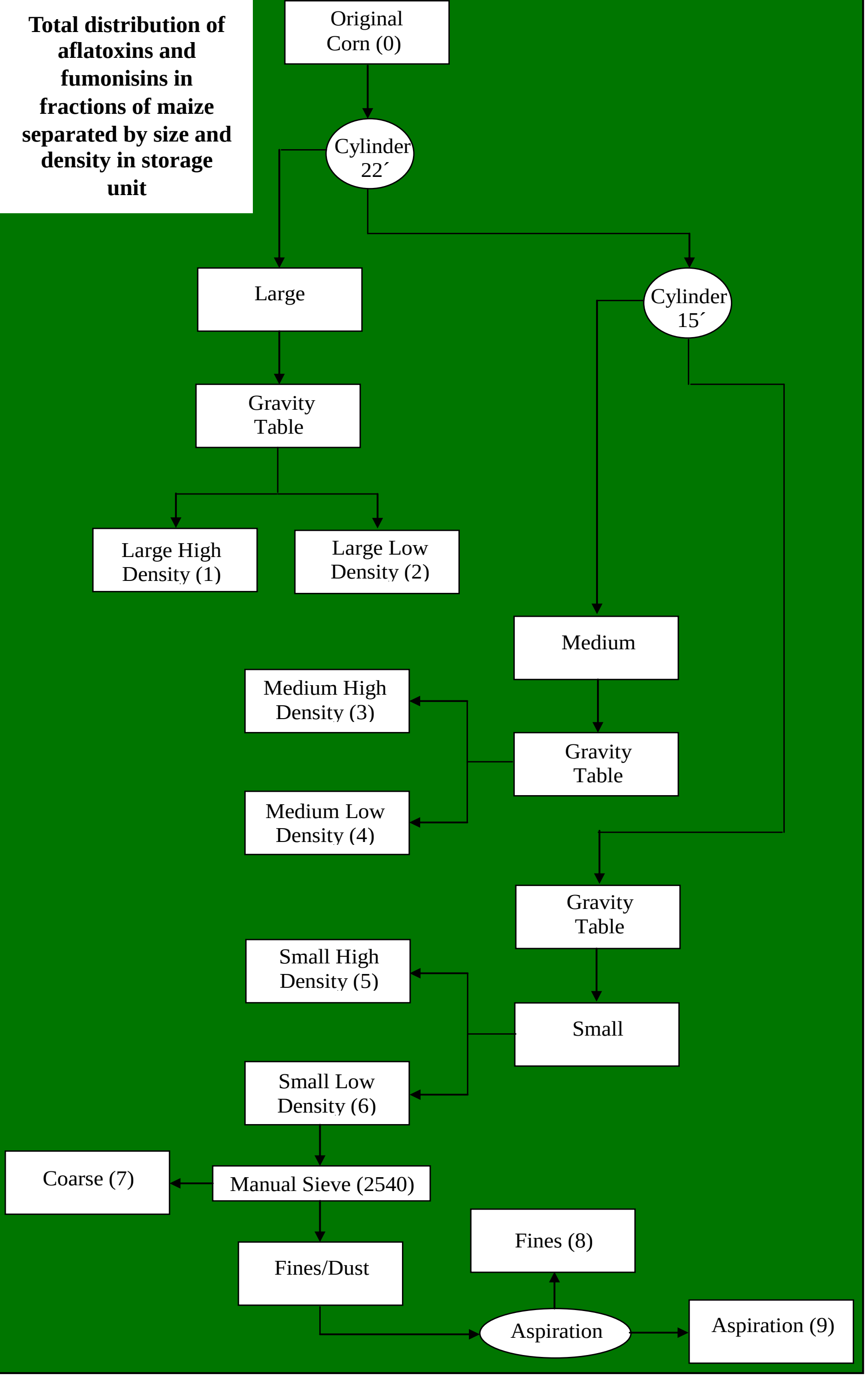


Distribution of fungi and bacteria in the production flow of products, by-products and feed.





Total distribution of aflatoxins and fumonisins in fractions of maize separated by size and density in storage unit



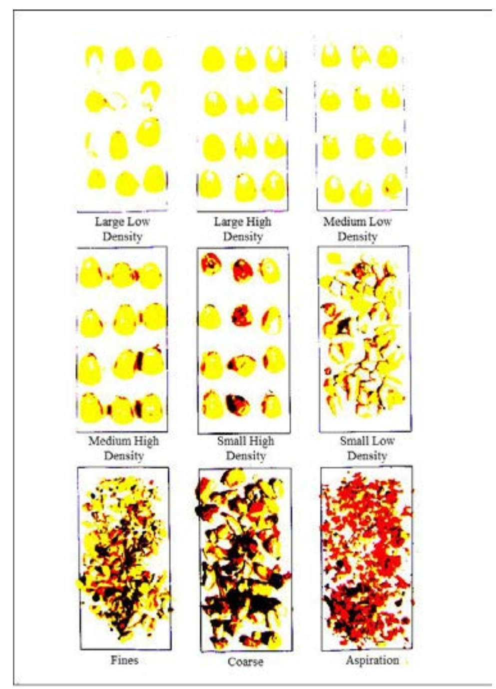

Journal of Food Process Engineering

EFFECTS OF THE PROCESSING ON THE DISTRIBUTION OF AFLATOXIN AND FUMONISIN LEVELS IN CORN FRACTIONS AND FEEDS

PAULO C. CORADI[1,2], DIRK E. MAIER[2], LAKSHMIKANTHA H. CHANNAIAH[2] and CARLOS CAMPABADAL[2]

ABSTRACT

PRACTICAL APPLICATIONS



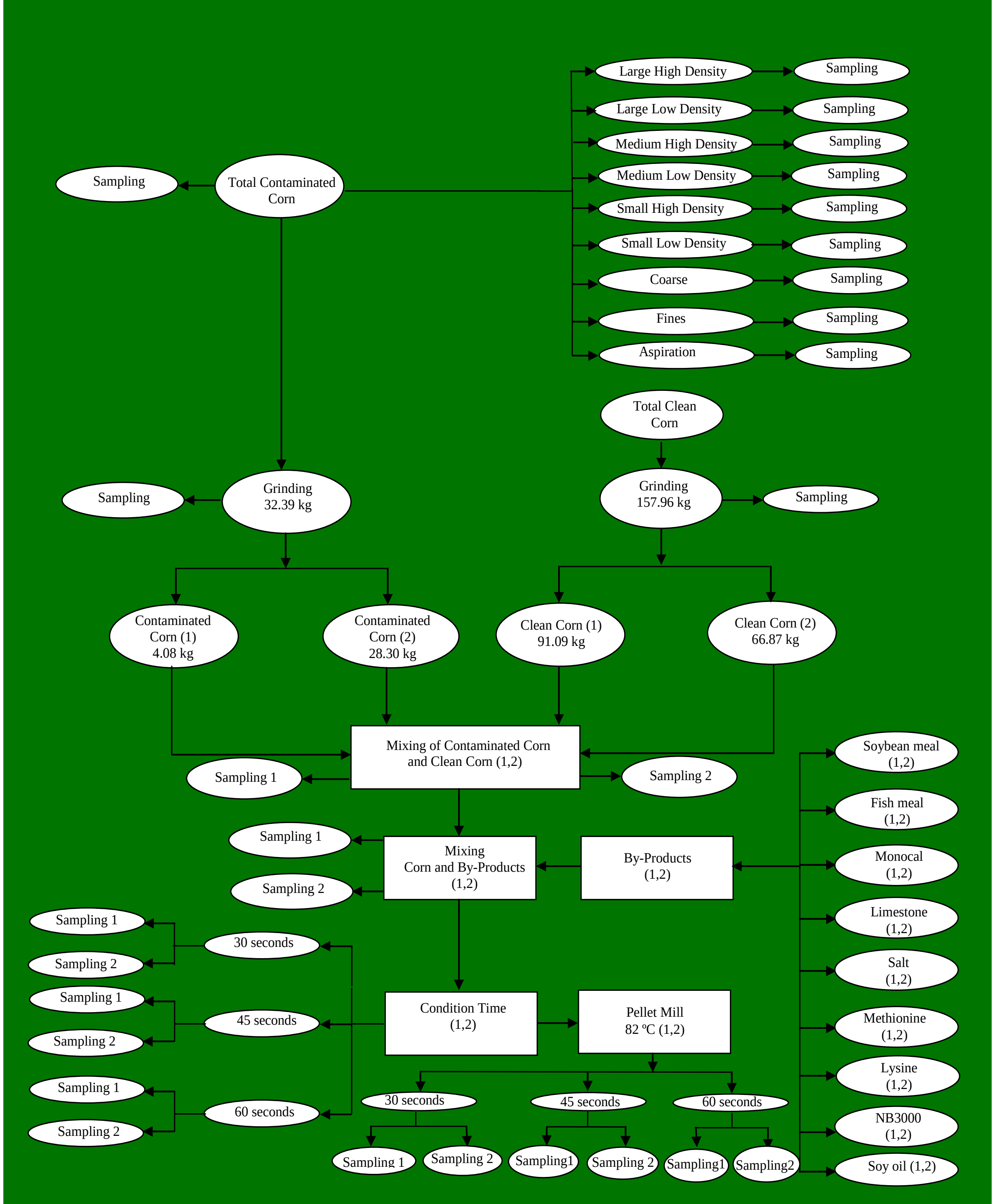
Total distribution of aflatoxins and fumonisins in fractions of maize separated by size and density in storage unit

Distribution of different levels of contamination in corn fractions

Separation	Physical Analysis				Microbiology Analysis		Mycotoxin Analysis	
	Fraction (kg)	Fraction (%)	Density ($g.cm^{-3}$)	Water Content (%)	Fusarium spp. (10^{-1}) (CFU).g^{-1}	Aspergillus spp. (10^{-1}) (CFU).g^{-1}	Total aflatoxin (ppb)	Total fumonisin (ppm)
Original Corn	35.250	100.00	1.2479 C	11.78 A	31.33 A	65.67 B	71.3 C	4.2 D
Large High Density	17.249	48.93	1.4295 D	11.71 A	27.33 A	25.33 A	18.0 A	0.5 A
Large Low Density	6.489	18.40	1.5027 D	11.78 A	31.67 A	59.00 B	29.8 B	0.7 A
Medium High Density	5.680	16.11	1.4193 D	11.91 A	46.67 B	86.33 C	96.3 D	1.3 B
Medium Low Density	3.432	9.73	1.2740 C	11.36 A	59.00 B	120.00 D	78.8 C	2.6 C
Small High Density	1.529	4.33	1.2057 C	11.74 A	57.33 B	236.33 F	85.0 C	2.9 C
Small Low Density	0.489	1.38	0.8805 B	11.52 A	139.67 C	171.33 E	98.5 D	9.5 E
Coarse	0.206	0.58	0.8112 B	11.07 A	131.45 C	177.35 E	160.3 E	9.4. E
Fines	0.111	0.31	0.7449 B	10.52 A	135.00 C	163.33 E	159.3 E	9.1 E
Aspiration	0.068	0.19	0.1158 A	10.46 A	128.67 C	171.00 E	166.0 E	12.6 F

Comparisons of contamination levels in corn fractions by density

Density ($g.cm^{-3}$)	Fractions (%)	Fusarium spp. (%)	Aspergillus spp. (%)	Aflatoxin (%)	Fumonisin (%)
1.4193 - 1.4295	83.44 D	13.97 A	14.10 A	16.15 A	5.14 A
0.8805 - 1.4193	14.06 C	15.37 A	29.45 B	18.36 A	11.32 B
0.7449 - 0.8805	2.27 B	53.66 B	42.31 C	46.87 B	57.61 D
0.1158 - 0.7449	0.19 A	17.00 A	14.14 A	18.70 A	25.93 C



Reductions of aflatoxins and fumonisins in pelleted and mashed rations using different feed times at pelleting temperature and in relation to different levels of initial contamination of maize used in the feed formulation for poultry

Reductions of aflatoxins and fumonisins in the pelleted and lean meal

Processing	Water Content (%)		Fusarium spp. 10^{-1} (CFU).g^{-1}		Aspergillus spp. 10^{-1} (CFU).g^{-1}		Total Aflatoxin (ppb)		Total Fumonisin (ppm)	
	Low	High	Low	High	Low	High	Low	High	Low	High
Mixing Corn	12.9 Bb	11.7 Ba	38.7 Ca	65.3 Cb	22.3 Ba	76.0 Bb	10.5 Aa	112.6 Cb	0.4 Aa	1.7 Ab
Mix. Feed Ingr.	10.8 Aa	10.6 Aa	27.7 Ba	55.0 Bb	24.7 Ba	75.0 Bb	9.2 Aa	86.3 Bb	0.7 Aa	2.2 Ab
Condit.Time	15.1 Ca	14.5 Ca	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	18.3 Ba	151.7 Db	5.3 Ca	14.5 Bb
Pellet Feed	12.9 Ba	12.7 Ba	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	8.5 Aa	49.5 Ab	2.6 Ba	2.5 Aa

Processing	Water Content (%)		Fusarium spp. 10^{-1} (CFU).g^{-1}		Aspergillus spp. 10^{-1} (CFU).g^{-1}		Total Aflatoxin (ppb)		Total Fumonisin (ppm)	
	Low	High	Low	High	Low	High	Low	High	Low	High
Mixing Corn	12.9 Bb	11.7 Ba	38.7 Ca	65.3 Cb	22.3 Ba	76.0 Bb	10.5 Ca	112.6 Db	0.4 Aa	1.7 Bb
Mix. Feed Ingr.	10.8 Aa	10.6 Aa	27.7 Ba	55.0 Bb	24.7 Ba	75.0 Bb	9.2 Ca	86.3 Cb	0.7 Aa	2.2 Bb
Condit.Time	15.6 Ca	16.1 Da	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	4.5 Ba	5.5 Ba	0.0 Aa	0.4 Aa
Pellet Feed	12.9 Ba	12.7 Ca	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	2.3 Aa	2.5 Aa	0.0 Aa	0.3 Aa

Comparisons of mycotoxin levels for different ration exposure times (30 seconds, 45 seconds, and 60 seconds) at the temperature of 82 ° C before pelleting

Processing	Water Content (%)		Fusarium spp. 10^{-1} (CFU).g^{-1}		Aspergillus spp. 10^{-1} (CFU).g^{-1}		Total Aflatoxin (ppb)		Total Fumonisin (ppm)	
	Low	High	Low	High	Low	High	Low	High	Low	High
Condit.Time (30 Sec.)	15.5 Aa	14.6 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	20.5 Ba	140.0 Bb	6.1 Ba	14.8 Bb
Condit. Time (45 Sec.)	15.1 Aa	14.5 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	18.3 Ba	151.7 Bb	5.3 Ba	14.5 Bb
Condit. Time (60 Sec.)	15.6 Aa	16.1 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	4.5 Aa	5.5 Aa	0.0 Aa	0.4 Aa

Comparisons of mycotoxin levels for the different ration exposure times (30 seconds, 45 seconds, and 60 seconds) at the temperature of 82 ° C after pelleting

Processing	Water Content (%)		Fusarium spp. 10^{-1} (CFU).g^{-1}		Aspergillus spp. 10^{-1} (CFU).g^{-1}		Total Aflatoxin (ppb)		Total Fumonisin (ppm)	
	Low	High	Low	High	Low	High	Low	High	Low	High
Pellet Feed (30 Sec.)	14.3 Bb	12.4 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	8.3 Ba	58.8 Bb	2.8 Ba	6.5 Bb
Pellet Feed (45 Sec.)	12.9 Aa	12.7 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	8.5 Ba	49.5 Bb	2.6 Ba	2.5 Ba
Pellet Feed (60 Sec.)	12.9 Aa	12.7 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	2.3 Aa	2.5 Aa	0.0 Aa	0.3 Aa

International Conference of Agricultural Engineering
XXXVII Congresso Brasileiro de Engenharia Agrícola
ASABE ILES VIII
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The use of Computational Fluid Dynamics (CFD) for the study of convective air heating in a broiler house

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ABSTRACT

The objective of this study was to evaluate heated air flow in a broiler house using a wood furnace indirect heating system. Experiments were conducted in a broiler house with the following dimensions: 100 m long, 12 m wide and 3 m high from the polyurethane lined floor. The wood burning furnace used for indirect heating measured 1.56 m in width, 2.6 m in length and 1.65 m in height. Tubing used to distribute the heated air measured 42 meters long and contained two orifices spaced at each meter. Air was heated to 200 °C and the flow rate was measured as 2,550 $m^3.h^{-1}$. In order to simulate the obtained data, the public domain CFD (Computational Fluid Dynamics) computer program was used, based on the determining principals of the Navier Stokes equations. All systems were considered dimensionless where temperature and natural convection flow data were analyzed. The obtained data allowed for the conclusion that the wood burning indirect heating system could not achieve uniform distributions of temperature, heat transfer, velocity and pressure along the length of the building. The convection cells showed that a large portion of heated air was lost to the upper region of the building, providing little use for poultry thermal comfort.

INTRODUCTION

The distribution of heated air inside broiler houses predominantly occurs due to convection and the following are brought into consideration: the heating system, the constructive conditions, the temperature and humidity of the air, the system isolation, ventilation system and chicken population density (ABREU, 1998; MORO, 1998; SANTOS, 2001). When choosing a heating system, cost should not be the only factor considered but also the heat production capacity and the effect that it will have on the air quality (HOFFMAN, 1987; NORONHA et al., 1995; RONCHI, 2004). There are various heating systems available for poultry house heating and each have their individual specifications, which include: gas turbo heaters, infrared bell heaters, high pressure bell heaters, low pressure bell heaters, wood furnaces with previously heated ambient air, charcoal bell heaters and wood furnace air reheaters (ANDRADE, 1982; LOPES, 2002; RONCHI, 2004). CFD (Computational Fluid Dynamics) is a computational technology with allows for the study of dynamic fluid flow in digital prototype experiments. The objective of this study was to evaluate the dynamics of heated air convective in the interior of a broiler house as a function of the wood furnace indirect heating system using CFD.

METHODOLOGY

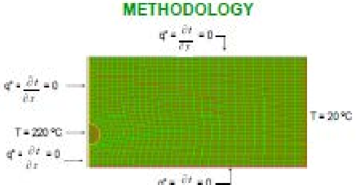

Figure 1. Distribution of heat flow inside the studied area

Table 1. Dimensions of the broiler house, temperature and physical parameters of the air

Simulated variables	Units	Values	Simulated variables	Units	Values
* Initial temperature (T_1)	°C	1	Electrical conductivity (k)	W/m °C	0,1
* Final temperature (T_2)	°C	0	Viscosity (v)	kg/ms	0,1
* Section length (L)	m	1	Thermal expansion coefficient (β)	1/k	13,88
Density (d)	Kg/m^3	1	Heat flow (q)	W/m^2	0
Specific heat (c_p)	J/kg °C	0,72	Acceleration of gravity (g)	m/s^2	10

* Dimensionless values (T1 = 220° C; T2 = 20° C; L = 100 m)

RESULTS AND DISCUSSION

The greatest amount of hot air mass was distributed above the heating tube and the coldest air formed a temperature gradient near the soil. The lowest temperatures were observed along the east wall where practically no convective heating was encountered. In Figure 3, the heat flow distribution can be observed inside the broiler house. Heat transfer presented behavior much like the temperature gradient distribution shown in Figure 2. This can be explained by Figures 4 and 5, where the velocity and pressure distributions are greatest along the walls of the building. Greater convective cells are formed in these regions compared to those in the central regions.

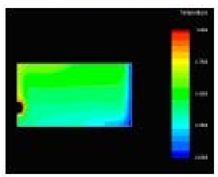

Figure 2. Dimensionless temperature distribution inside the poultry house.

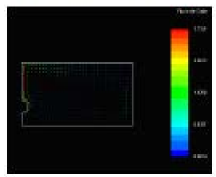

Figure 3. Dimensionless heat transfer inside the poultry house.

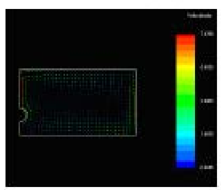

Figure 4. Velocity distribution inside the poultry house.

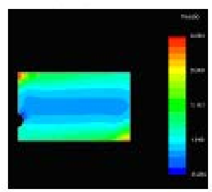

Figure 5. Dimensionless air pressure distribution inside the poultry house.

CONCLUSION

The wood furnace indirect heating system was not able to obtain a homogeneous distribution of temperature, heat transfer, velocity and pressure the length of the broiler house. The convection cells show that the greatest portion of heated air is found in the upper segments of the building, where it is of little use for chicken comfort.

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Thermal comfort evaluation in a broiler house utilizing Computational Fluid Dynamics (CFD) software

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ABSTRACT

The objective of this work was to analyze the thermal comfort of poultry inside a chicken coop, comparing pre-defined experimental heating data for chicks two weeks after birth with the effects of a wood furnace indirect heating system. The presented study was performed at a commercial poultry facility located near the city of Videira, Santa Catarina during the 2004 Brazilian winter. For this computer simulation study, the governing equations which analyzed temperature and heated air flow due to natural convection were considered dimensionless. The temperature and heat transfer data simulated by CFD were compared with experimental data. The obtained results concluded that a wood furnace indirect heating system could not guarantee ideal comfort temperatures for poultry chick during their first two weeks after birth.

INTRODUCTION

Brazilian poultry installations are typically constructed without adequate thermal insulation. This increases energy consumption for space heating and in many cases the optimal temperatures necessary for poultry production is not reached (MOURA, 2001; VIGODERIS, 2006). The optimal temperature range considered for poultry comfort is depended on age. During the first week after birth, temperature should be maintained between 32 and 34 °C, however, during the second week, optimal temperatures range from 28 to 32 °C (FREEMAN, 1965; JURKSCHAT et al., 1989; ÁVILA, 2004). At commercial farms, traditional heating systems are generally composed of gas brooders and furnaces, proving inefficient for the adequate heating of hatcheries (principally in the southern regions of Brazil), resulting in temperatures below the comfort range for birds (VIGODERIS, 2006). The CFD (Computational Fluid Dynamics) software is a technology utilized for process simulations, principally in the chemical, aerodynamic, food and environmental industries but also adaptable to various other engineering situations. Using this technique, it is possible to observe the efficiency of an indirect heating system with a wood furnace, functioning with an ideal considered temperature and the convective circulation of air inside the broiler house (ESCUDIER, et al., 2002). The objective of this study was to evaluate the dynamics of the convectively heated air inside a broiler house as a function of the wood furnace indirect heating system, attempting to maintain the pre-defined heating temperature necessary for broiler chicks during their first two weeks after birth.

METHODOLOGY

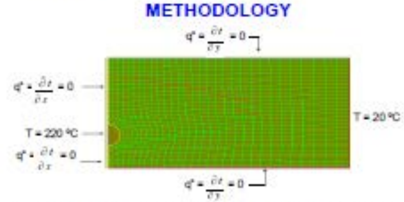

Figure 1. Heat transfer distribution inside the broiler house and boundary conditions.

Table 1. Dimensions of the broiler house, temperature and physical parameters of the air

Simulated variables	Units	Values	Simulated variables	Units	Values
*Initial temperature (T_1)	°C	1	Electrical conductivity (k)	W/m °C	0,1
*Final temperature (T_2)	°C	0	Viscosity (v)	kg/ms	0,1
*Section length (L)	m	1	Thermal expansion coefficient (β)	1/k	13,88
Density (d)	Kg/m^3	1	Heat flow (q)	W/m^2	0
Specific heat (c_p)	J/kg °C	0,72	Acceleration of gravity (g)	m/s^2	10

* Dimensionless values (T1 = 220° C; T2 = 20° C; L = 100 m)

RESULTS AND DISCUSSION

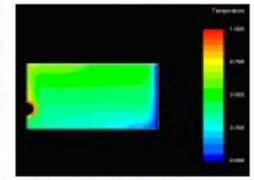

Figure 2. Dimensionless temperature distribution inside the building.

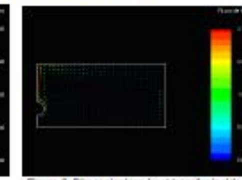

Figure 3. Dimensionless heat transfer inside the building.

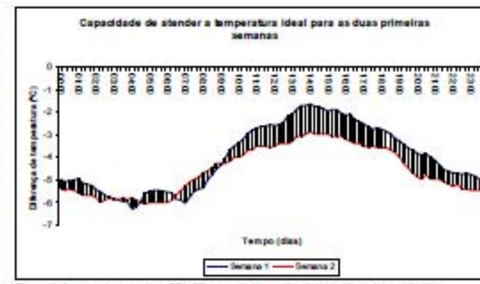

Figure 4. Average temperature (°C) difference between the detected temperature in the heated environment and the recommended temperatures for bird growth during the first and second weeks after birth.

CONCLUSION

The convection cells showed that a large portion of heated air was found in the upper region of the poultry house, of little use for bird thermal comfort. The evaluated wood furnace indirect heating system was not capable of guaranteeing ideal temperature for poultry thermal comfort during the first two weeks after birth.

ACKNOWLEDGEMENTS

CAPES
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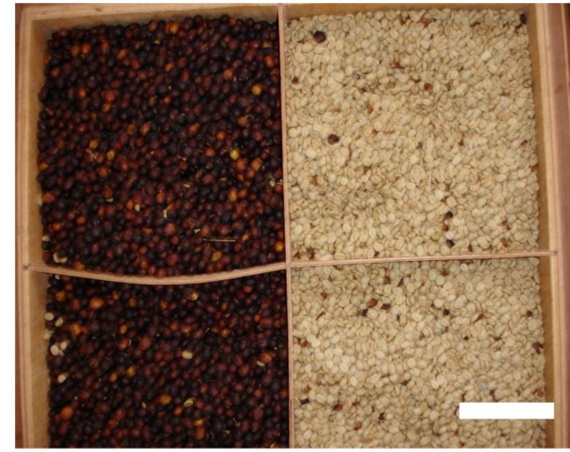
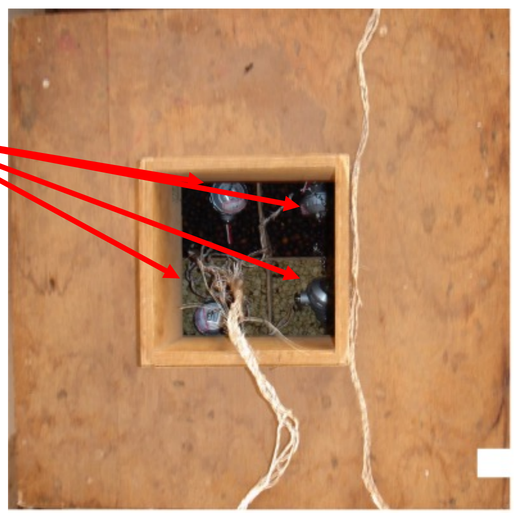
DRYING AND STORAGE COFFEE

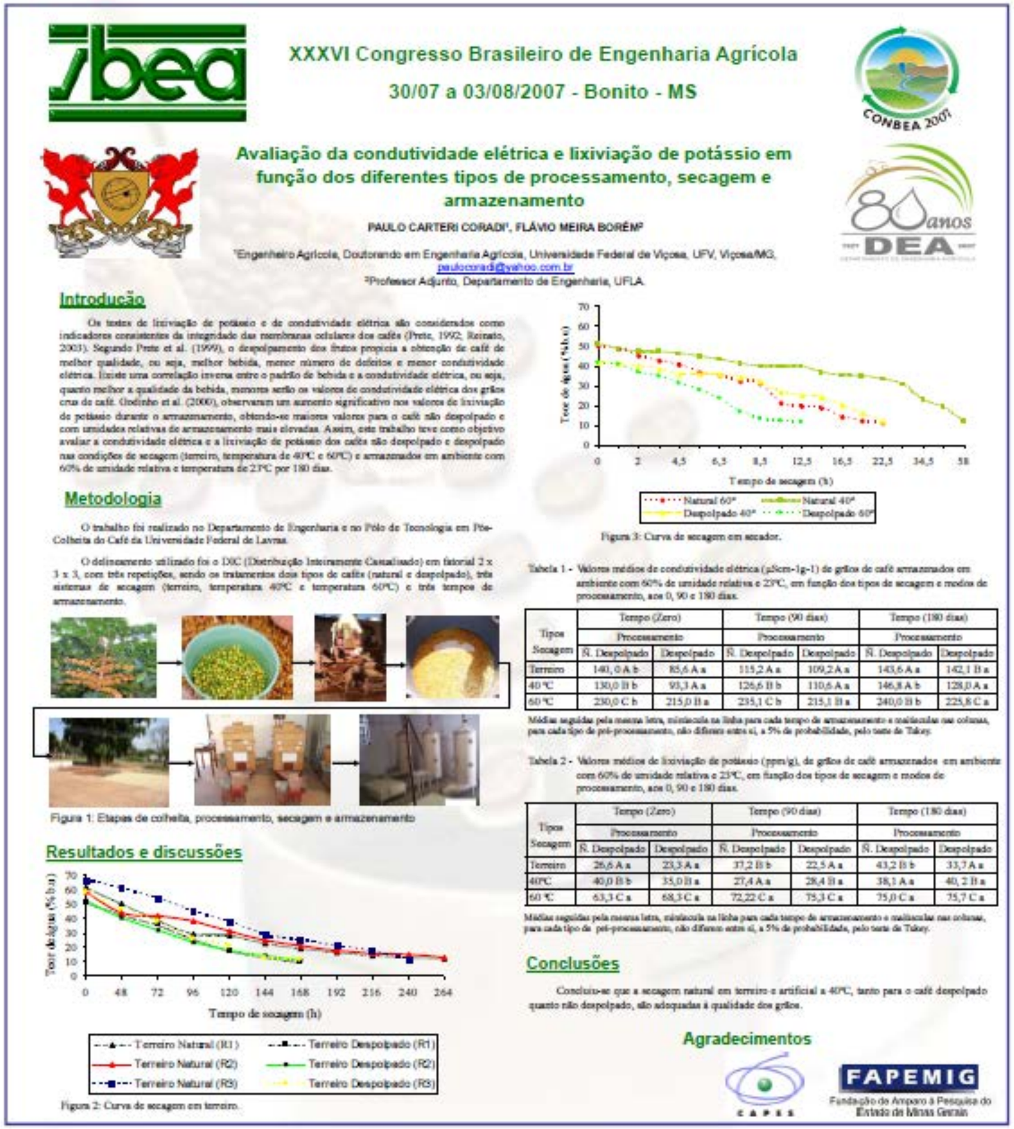


Termopares (tipo J)



Entrada do plenum

Entrada do ar de secagem



Beverage quality

T.S.[1]	Natural			Despolpado		
	Tempo			Tempo		
	Zero	90 dias	180 dias	Zero	90 dias	180 dias
Ter.[2]	74,3 B a	73,3 B a	74,1 B a	80,8 A a	80,3 A a	80,8 B a
40ºC	72,2 A B a	73,5 B a	73,4 B a	81,3 A a	80,2 A a	77,4 A a
60ºC	68,1 A a	70,8 A a	70,8 A a	79,6 A a	81,0 A a	78,0 A a

Sugar content

T.S.[1]	Natural			Despolpado		
	Tempo			Tempo		
	Zero	90 dias	180 dias	Zero	90 dias	180 dias
Ter.[2]	0,85 C b	0,75 C b	0,64 C a	0,47 C b	0,37 C a	0,38 B a
40ºC	0,64 B b	0,62 B b	0,58 B a	0,35 B b	0,32 B b	0,25 A a
60ºC	0,57 A b	0,47 A a	0,45 A a	0,27 A b	0,19 A a	0,22 A a

EFFECT OF DRYING AND STORAGE CONDITIONS ON THE QUALITY OF NATURAL AND WASHED COFFEE[1]

Paulo Carteri Coradi[2], Flávio Meira Borém[3], Reni Saath[4], Elizabeth Rosemeire Marques[5]

(Recceved: september 25, 2006; accepted: february 27, 2007)

ABSTRACT: The objective of the work was to evaluate alterations in the quality of natural and washed coffee under different drying conditions (coffee drying yard, temperature of 40°C and 60°C) and storage conditions at 60% of relative humidity, with controlled temperature of 23°C, at 90 and 180 days. The work was carried out in the Engineering Department and in the Coffee Post-Harvest Technology Pole of the Federal University of Lavras. The manual harvest of the coffee (*Coffea arabica* L.), Topázio variety, was selective. Part of the coffee was pulped and the other part was processed in the natural form. A portion of each type of coffee was submitted to drying on the yard and two other samples were processed in a mechanical dryer, at temperatures of 40°C and 60°C. After drying, the coffee was stored in an air-tight room, in which a stable relative humidity of 60% was maintained with a solution of magnesium nitrate. Quality evaluation, sensorial analyses, electric conductivity and potassium leaching tests, total titrable acidity, fatty acidity and total and reducing sugars determinations were carried out. The results showed that the coffee dried at 60°C, after 90 days storage, presented the poorest quality. The physical-chemical evaluations of the drying and storage conditions showed that washed coffee presents better quality when compared to the product in its natural form.

Key words: *Coffea arabica*, drying, storage, quality.

EFEITO DAS CONDIÇÕES DE SECAGEM E ARMAZENAMENTO SOBRE A QUALIDADE DO CAFÉ NATURAL E DESPOLPADO

RESUMO: *Objetivou-se com o presente trabalho avaliar as alterações na qualidade dos cafés natural e despolpado nas condições de secagem (terreiro, temperatura de 40°C e 60°C) e armazenamento de 60% de umidade relativa com temperatura controlada de 23°C, aos 90 e 180 dias. O trabalho foi realizado no Departamento de Engenharia e no Pólo de Tecnologia em Pós-Colheita do Café da Universidade Federal de Lavras. A colheita manual do café (Coffea arabica L), variedade Topázio, foi seletiva. Parte do café foi despolpado e outra parte, processada de forma natural. Uma parcela de cada tipo de café foi submetida à secagem em terreiro e as outras duas, às temperaturas de 40°C e 60°C em secador mecânico. Depois da secagem, o café foi armazenado em ambiente hermético, mantendo-se constante a umidade relativa de 60%, com solução de nitrato de magnésio. Para avaliação da qualidade, foram realizados análise sensorial, testes de condutividade elétrica e lixiviação de potássio, determinações de acidez titulável total, acidez graxa, açúcares totais e redutores. Pelos resultados obtidos, conclui-se que os cafés submetidos à secagem com temperatura de 60°C e armazenados a partir de 90 dias apresentaram as piores características de qualidade; as avaliações físico-químicas para as condições de secagem e armazenamento mostram que o café despolpado apresentou melhor qualidade, quando comparado com o produto na sua forma natural.*

Palavras-chave: Coffea arabica, secagem, armazenamento, qualidade.

1 INTRODUCTION

Coffee (*Coffea arabica* L) production in Brazil has increased significantly in the last few decades, with an increase of the production areas and the utilization of new technologies. The greatest difficulty found in the coffee production chain today is its great variation of prices (PINTO, 2006).

Producing high quality coffee in Brazil is not only a demand but an opportunity for the sector and a decisive factor also in the product's exportation.

Brazilian coffee exportation has been decreasing in the past decades, due partly to the increase of coffee production in other countries, but also to the poor quality of the Brazilian product sold

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Coffee Science, Lavras, v. 2, n. 1, p. 38-47, jan./jun. 2007

QUALIDADE DO CAFÉ NATURAL E DESPOLPADO APÓS SECAGEM EM TERREIRO E COM ALTAS TEMPERATURAS

Quality of natural and washed coffee after drying on ground and with high temperature

Flávio Meira Borém[1], Paulo Carteri Coradi[2], Reni Saath[3], João Almir Oliveira[4]

RESUMO

Objetivou-se no presente trabalho verificar a qualidade do café natural e despolpado durante a secagem em terreiro e secagem com ar aquecido a 40° e 60°C. O trabalho foi realizado no Departamento de Engenharia e no Pólo de Tecnologia em Pós-Colheita do Café da Universidade Federal de Lavras. A colheita do café, cultivar Topázio, foi seletiva. Parte do café foi despolpado e outra parte processado de forma natural. Uma parcela de cada tipo de café foi conduzida para a secagem em terreiro e outra parcela para secagem com temperaturas de 40°C e 60°C. Para avaliação da qualidade, foram feitos teste de condutividade elétrica e lixiviação de potássio; determinação de acidez titulável total; teste de acidez graxa; açúcares totais e redutores. Os resultados obtidos permitem concluir que: o tempo para secagem é afetado pelos diferentes tipos de secagem e processamentos; a condutividade elétrica, a lixiviação de potássio, a acidez titulável total e a acidez graxa aumentam com a elevação da temperatura de secagem, independente do tipo de processamento; os açúcares redutores e os açúcares totais diminuem com o aumento da tem peratura de secagem independente do tipo de processamento; a secagem com temperatura de 60°C afetou negativamente a qualidade do café.

Termos para indexação: Café, processamento, secagem e qualidade.

ABSTRACT

The present work has the aim of verifying the quality of natural and washed coffee during its drying with air heated at 40° and 60°C. The work was accomplished in the Engineering Department and in the Coffee Post-harvest Technology Pole at the Federal University of Lavras. The harvest of Topázio cultivar cultivar was selective. A part of the coffee was pulped and the other part processed in the dry method. A portion of each kind of coffee was led to drying on ground and the other portion for drying at temperatures of 40°C and 60°C. For quality evaluation, electric tests and potassium leaching, total titrable acidity; fatty acidity test, total sugars and reducing sugars were conducted. The results obtained in the present work allow to conclude that: drying time is affected by the different sorts of drying and processings; electric conductivity, potassium leaching, total titrable acidity and fatty acidity increase with increasing drying temperature independently of the kind of processing; reducing sugars and total sugars decrease with rise of drying temperature independently of the sort of processing; the drying at the temperature of 60°C affected negatively coffee quality.

Index terms: Coffee, processing, drying, quality.

(Recebido em 22 de setembro de 2006 e aprovado em 13 de abril de 2007)

INTRODUÇÃO

Com o aumento da produção brasileira de café ano após ano, torna-se inevitável a busca por novos mercados consumidores, principalmente com a exportação. Atualmente a produção de café com qualidade, valorizando-se mais os atributos sensoriais, organolépticos e higiênico-sanitário do produto, além dos aspectos relacionados à proteção ambiental e valorização social, está sendo o maior obstáculo encontrado, e essa é a principal exigência dos mercados consumidores internacionais.

Existem vários fatores que influenciam a qualidade final do café: características edafoclimáticas, cultivares, condução e manejo da lavoura, colheita, tipo de processamento, secagem e armazenamento (CARVALHO et al., 1994; CARVALHO & CHALFOUN, 1985).

O processamento do café passa a ser uma etapa importante dentro da pos-colheita, a separação dos frutos verdes e imaturos dos frutos cerejas é fundamental para se obter uma bebida de melhor qualidade e, para isto, precisam-se utilizar as mais diferentes técnicas de processamento (via úmida e via seca) (WINTGENS, 2004). A qualidade do café está muito envolvida com o aroma da bebida, isso acontece por causa da complexidade dos compostos dos cafés; mais de 800 compostos voláteis compõem a formação do aroma e sabor em forma de grupos

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Qualidade do café natural e despolpado após diferentes tipos de secagem e armazenamento[1]

Paulo C. Coradi[2], Flávio M. Borém[3] & João A. Oliveira[4]

RESUMO

Para se comparar as alterações na qualidade do café natural e despolpado em condições de umidades relativas de 60 e 80% e temperatura controlada de 23 °C aos 90 e 180 dias de armazenamento, realizou-se este trabalho no Departamento de Engenharia e no Pólo de Tecnologia em Pós-Colheita do Café da Universidade Federal de Lavras. A colheita do café, variedade Topázio, foi seletiva, enquanto uma parte foi despolpada e a outra processada de forma natural; no entanto, uma parcela de cada tipo de café foi conduzida para a secagem em terreiro e a outra parcela para secagem com temperaturas de 40 e 60 °C; após a secagem, o café foi armazenado em ambiente hermético mantendo-se constantes as umidades relativas de 60 e 80%. Para avaliação da qualidade foram feitas análises sensoriais, teste de acidez graxa e avaliação quantitativa da cor. Os resultados obtidos no presente trabalho permitem concluir que: a acidez graxa aumenta ao longo do tempo de armazenamento nas condições de 60 e 80% de umidade relativa; a descoloração do café é mais intensa ao longo do tempo de armazenamento para as condições de 80% de umidade relativa; aos 180 dias de armazenamento, a análise sensorial do café é menos afetada pela interação secagem, processamento e armazenamento, nas condições de 60% de umidade relativa.

Palavras-chave: topázio, umidade, temperatura, terreiro

Quality of natural and washed coffee after different types of drying and storage

ABSTRACT

For comparing the alterations in the quality of natural and washed coffee under 60 to 80% relative humidity conditions from and controlled temperature of 23 °C at 90 and 180 days of storage, this work was accomplished in the Engineering Department and Coffee Post-Harvest Technology Centre of the Federal University of Lavras. The harvest of coffee, variety Topazio was selective, while a part of the coffee was pulped and the rest processed in the dry method. However, a part of each type of coffee was ground dried and the rest dried at temperatures of 40 and 60 °C; after drying, the coffee was stored in an air-tight place with controlled air temperature and under different conditions of relative humidity (60 and 80%). For quality evaluation, a sensorial analysis, fatty acidity test and color quantity evaluation were done. The results obtained in the present work led to the conclusion that the fatty acidity increased with storage time at 80% relative humidity; coffee discoloration was more marked at 60 and 80% of relative humidity; at 180 days of storage, the sensorial analyses of coffee was less affected by the interaction among drying, processing and storage in the conditions of 60% relative humidity.

Key words: topazio, humidity, temperature, ground

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Original Articles

Evaluation of Electrical Conductivity as a Quality Parameter of Lemongrass Leaves (*Cymbopogon citratus* Stapf) Submitted to Drying Process

Paulo Carteri Coradi, Evandro de Castro Melo & Ronicely Pereira da Rocha

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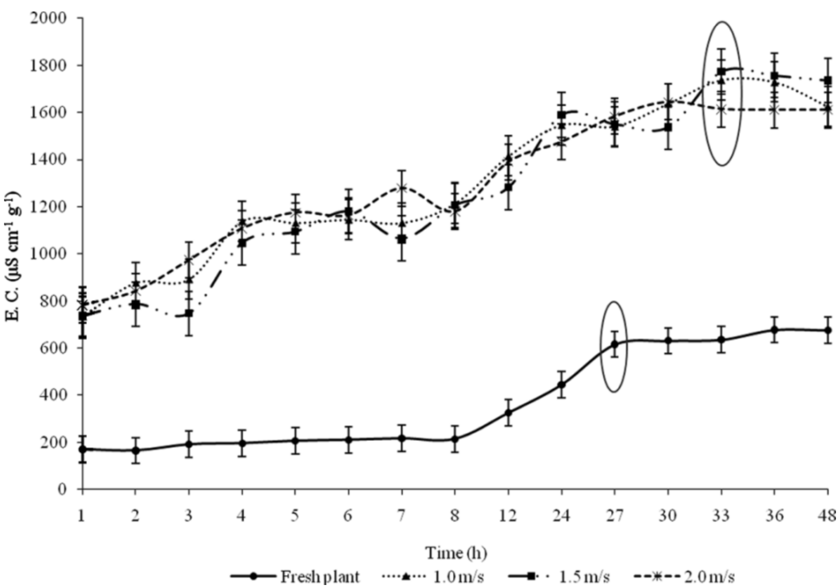


ELECTRICAL CONDUCTIVITY OF LEMONGRASS LEAVES

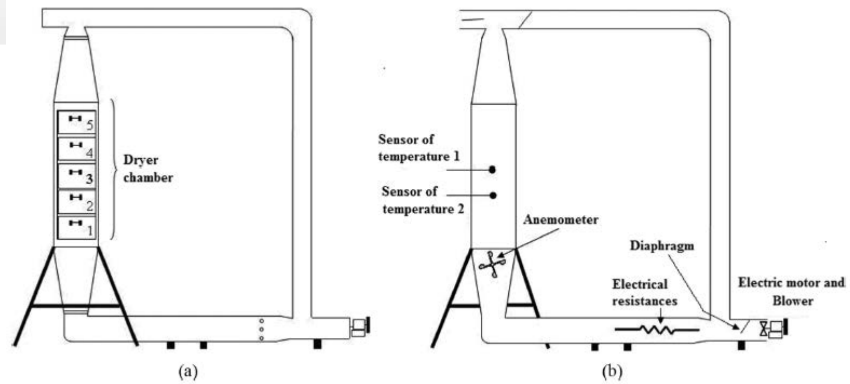
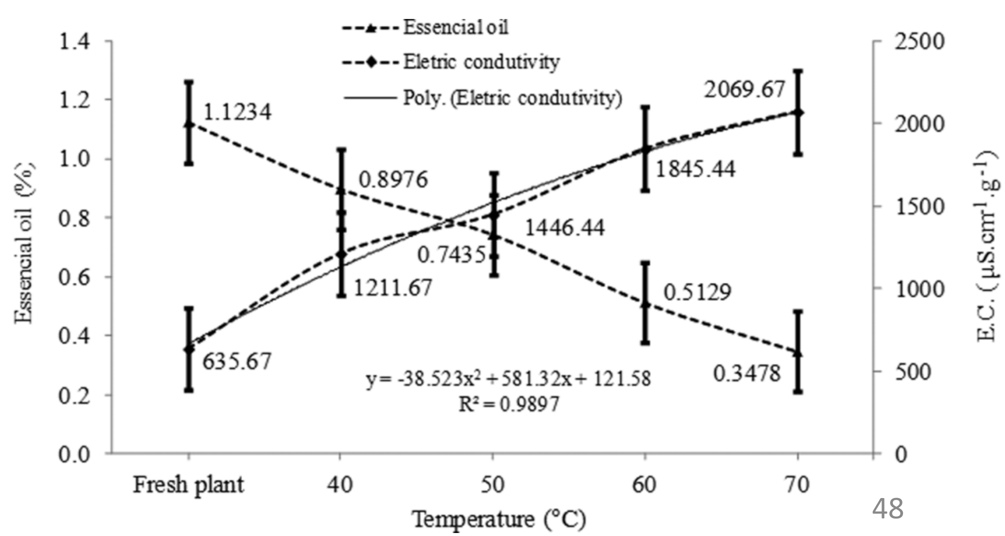
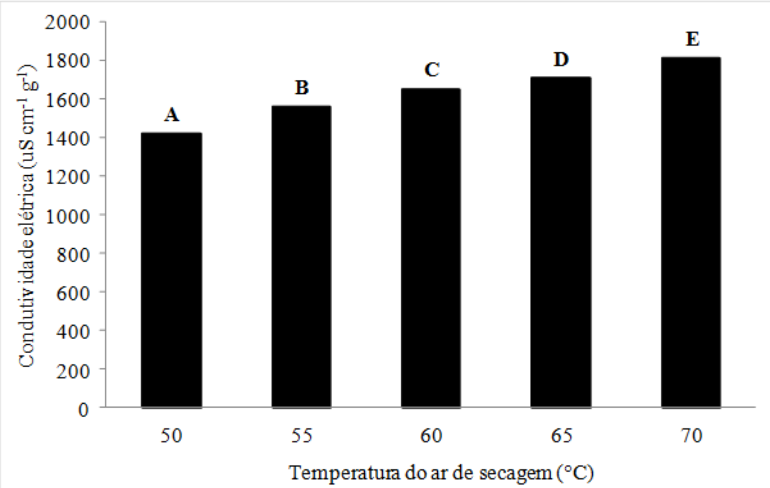
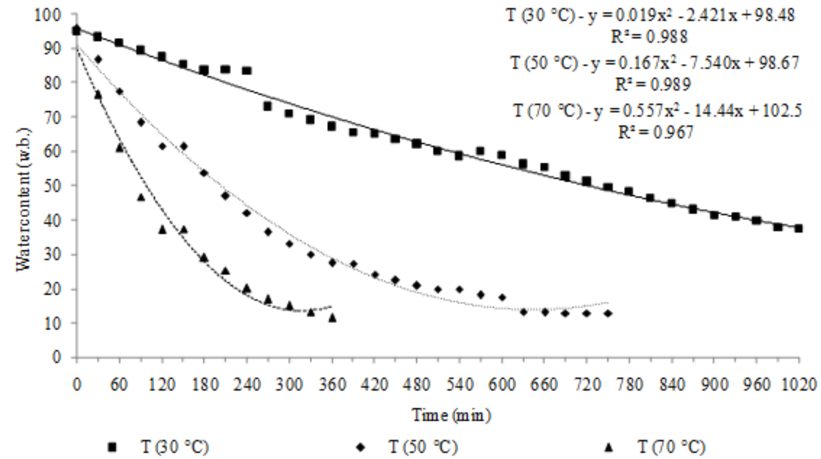


FIG. 1. (a) Front section of dryer and (b) front view of dryer.





A
B
C
D
E
Condutividade elétrica (uS cm-1 g-1)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50
55
60
65
70
Temperatura do ar de secagem (°C)



T (30 °C) - y = 0.019x² - 2.421x + 98.48
R² = 0.988
T (50 °C) - y = 0.167x² - 7.540x + 98.67
R² = 0.989
T (70 °C) - y = 0.557x² - 14.44x + 102.5
R² = 0.967
Watercontent (w.b.)
Time (min)
T (30 °C)
T (50 °C)
T (70 °C)

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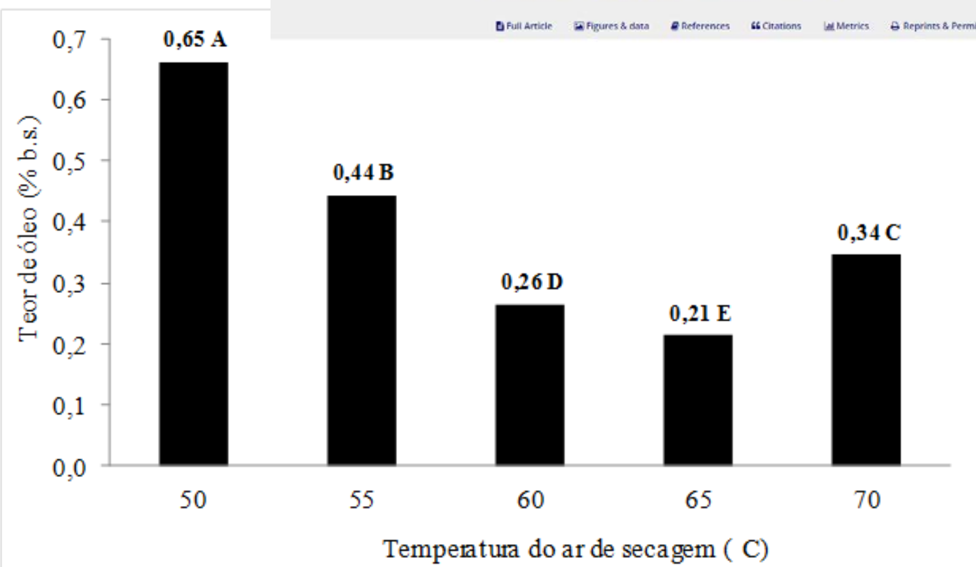
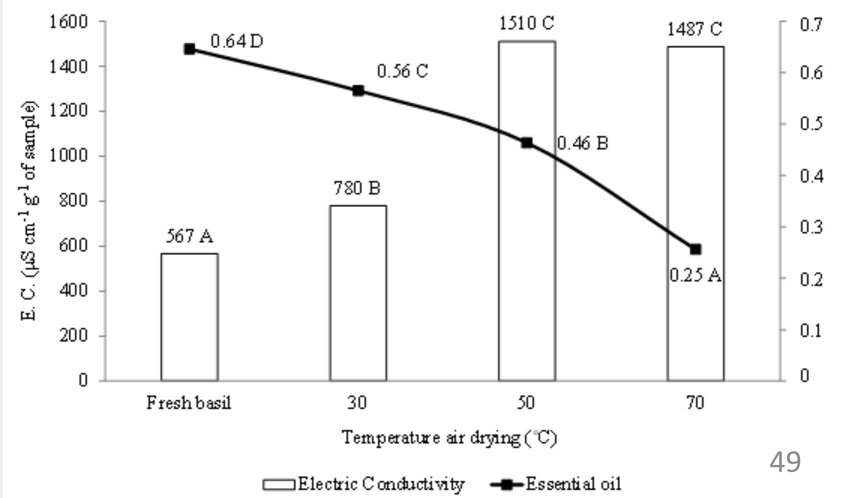


0,65 A
0,44 B
0,26 D
0,21 E
0,34 C
Teor de óleo (% b.s.)
0,0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
50
55
60
65
70
Temperatura do ar de secagem (C)



0.64 D
0.56 C
0.46 B
0.25 A
567 A
780 B
1510 C
1487 C
E. C. (µS cm-1 g-1 of sample)
Essential oil (%)
Fresh basil
30
50
70
Temperature air drying (°C)
Electric Conductivity
Essential oil

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Quality of seeds of jatobá-do-cerrado processed and stored in diferents forms

Qualidade de sementes de jatobá-do-cerrado processadas e armazenadas em diferentes formas

Paulo Carteri Coradi[1*]; Taísa Lopes Lacerda Pereira[2]; Lucas Jandrey Camilo[3]

Abstract

The preservation of the physical and chemical quality of jatobá-do-cerrado seeds during processing and storage is essential to the restocking of vegetation in degraded areas. Since no scientific studies have analysed the optimal post-harvest conditions for jatobá-do-cerrado seeds, this study aimed to evaluate the physical and chemical quality of jatobá-do-cerrado seeds following different types of processing: with pulp, without pulp (scarification), without pulp (fermentation) and at different storage temperatures (10 and 23 °C) and different packaging (tetrapack, paper, plastic, PET bottles and glass bottles), over six months. The physical and chemical constituents of jatobá-do-cerrado seeds varied according to the packaging conditions. An increased storage time reduced the quality of the seeds. Seeds with pulp showed better physical characteristics during storage. The pulping processing of seeds by mechanical scarification increased the acidity and ash content, but led to the highest percentage of crude protein during storage at 23 °C. The fermentation method of seed pulping positively affected seed quality during storage at 10 °C. Permeable packaging (paper bags and tetrapack) led to a greater reduction in seed quality than that in glass bottles, PET bottles or plastic bags. The best conditions for the processing of jatobá-do-cerrado seeds was fermentation and the best storage condition was in waterproof packaging (glass or PET bottles).

Key words: Post-harvest. Packaging. Temperature.

Resumo

A preservação da qualidade física e química no processamento de sementes de jatobá-do-cerrado e armazenamento são fundamentais para o repovoamento de vegetação em áreas degradadas. Como não existem estudos científicos que comprovem as melhores condições na pós-colheita de sementes de jatobá-do-cerrado, este estudo teve como objetivo avaliar a qualidade físico-química das sementes jatobá-do-cerrado, em diferentes formas de processamento com polpa, sem polpa (escarificação), sem polpa (fermentado) e condições de temperatura de armazenamento (10 e 23 °C) e embalagens (tetrapack, papel, plástico, garrafas PET e embalagens de vidro), ao longo de seis meses. Os constituintes físicos e químicos das sementes de jatobá-do-cerrado variaram de acordo com as condições avaliadas e embalagem. O aumento do tempo de armazenamento reduziu a qualidade das sementes. As sementes com polpa mantiveram melhor as características físicas ao longo do tempo de armazenamento. O processo de despolpamento das sementes pela escarificação aumentou o índice de acidez e cinzas, porém apresentou as maiores porcentagens de proteína bruta nas condições de acondicionamento com temperatura de

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Table 2. Chemical quality of jatobá seeds processed in different forms and stored in different conditions.

Storage temperature	10 °C			23 °C		
	Time (months)			Time (months)		
Storage time	Zero	Three	Six	Zero	Three	Six
Crude protein (%)						
With pulp	10.18 bA	9.71 aA	9.71 aA	10.18 bA	9.32 aA	9.32 aA
Without pulp (scarified)	10.69 bA	10.11 aA	10.11 aA	10.69 aA	11.30 bB	11.30 bB
Without pulp (fermented)	10.05 aA	11.41 bB	11.41 bB	10.05 aA	11.19 bB	11.19 bB
Ashes (%)						
With pulp	2.53 bB	1.83 aC	1.83 aC	2.53 bB	1.91 aB	1.91 aB
Without pulp (scarified)	2.39 bB	1.64 aB	1.64 aB	2.39 bB	1.69 aA	1.69 aA
Without pulp (fermented)	2.17 bA	1.34 aA	1.34 aA	2.17 bA	1.56 aA	1.56 aA
Index acidity (ml NaOH 1N)						
With pulp	6.73 aB	9.73 bB	9.73 bB	6.73 aB	9.15 bB	9.15 bB
Without pulp (scarified)	4.63 aA	6.11 bA	6.11 bA	4.63 aA	6.40 bA	6.40 bA
Without pulp (fermented)	4.28 aA	6.31 bA	6.31 bA	4.28 aA	6.44 bA	6.44 bA

*Means followed by the capital letter in the column for each processing type and lower line for each storage time, do not differ at 5% probability.

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Fundect

FAPERGS Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul

+ POSTHARVEST + FOOD DISTRIBUTION + FOOD SECURITY – LOSSES = SUSTENTABLE SYSTEM

GRACIAS! THANK YOU! OBRIGADO!

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