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# The diatomaceous earth treatment effects in the nutritional composition of maize grains

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## Abstract

The diatomaceous earth has been used for many years as a non chemical alternative for controlling stored grain insects in silos, mills, and related areas. Several researches have showed modifications on the grain physical properties influenced by the diatomaceous earth treatment. However, it's unknown its effects considering the quality of the grain nutritional composition. The research aimed to verify the noncommercial Brazilian diatomaceous earth influence in the lipids and total nitrogen rates of the maize grains. The experiment was conducted using five diatomaceous earth dosages (250, 500, 750, 1,000 and 1,250 g.t$^{-1}$) and a control without any treatment. Each treatment was composed by 200 g of grains repeated four times, and conducted as a randomized complete block. The plastic pots were stored for ninety days. Samples were taken out throw a soxlet device at the 0, 30, 60 and 90 days in order to check the lipids and total protein rates. It was observed an interaction between the dosage and time. The longer the time the lower the lipids dosage rate in the grains, but the nutritional variation doesn't affect the corn quality. It was not observed the statistical variation of the nitrogen rates within the tested dosages. But, despite of the non nitrogen variation rate, it was observed a slight reduction on this nutritional component during the experiment conduction. New studies might be conducted in order to observe the diatomaceous earth influence over others maize grains nutritional components.

*Key words:* Nutritional composition, diatomaceous earth, Maize grains.

## Introduction

The diatomaceous earth comes from fossil deposits of diatomaceous algae (sedimentary layers of phytoplankton), which naturally have a fine silica layer, being possible to be from the sea or from rivers. The preparation of the diatomaceous earth for commercial use is done by the extraction, drying and milling of the fossil material, which results in dry dust, of a fine grading.

The treatment of seeds and or grains with diatomaceous earth has some advantages in relation to the conventional chemical treatment, like: the control of the many pests that attack stored seeds and grains; long residual effects; the substitution of chemical insecticides; both preventive and curative, during the storage; the

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control of pest populations resistant to chemical insecticides (Korunic, 1999).

Alternative methods for the control of stored grains pests are being emphasized in order to reduce the usage of chemical products, decrease the potential of human exposure and reduce the speed and the development of the resistance of the pests to insecticides (Korunic, 1999). The use of inert dusts based on diatomaceous earth to control pests in stored seeds and grains represents a substantial advance in the storage sector, since it answers the demands of users for efficient products and which respect their health and the environment. It is all about a safe product for the user and of a lasting insecticide effect, since it does not lose its effectiveness throughout time (Ebeling, 1971).

The diatomaceous earth kills the insects by desiccation, due to its adsorption and abrasivity characteristics. It adheres to the epicuticule of the insects, driving them to dehydration, in consequence to the absorption of waxes from the lipid layer by the silica crystals or by cuticule abrasion. When the wax molecules from the superficial layer are adsorbed by the silica particles, the protective lipid layer is tore, which allows the evaporation of the water from the body of the insects (Golob, 1997; Korunic, 1998).

The use of diatomaceous earth for the control of insects in stored grains has shown some limitations, which have been described by Wilson (1945). There has been an increase in the resting angle of wheat treated with diatomaceous earth, the flowability has decreased, a dusty atmosphere has been created and it is then hard to remove the diatomaceous earth from the grains. La Hue (1967) has shown disadvantages regarding the reduction in the weight of the treated product by the decrease of the density of the wheat, maize, barley and rye grains treated with different formulations of diatomaceous earth.

The diatomaceous earth can absorb lipids from the surface of almonds (McGaughey, 1972). As a result, the diatomaceous earth particles are unavailable or greatly reduced for the absorption of the insects' cuticular lipids, decreasing the expected effectiveness. Studies from the same author with different diatomaceous earth deposits used for the control of *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) in rice had different results in the effectiveness of killing of the insects. (Ebeling, 1971).

The objective of this study was to evaluate the influence of treatments with different dosages of diatomaceous earth in the nutritional composition (nitrogen and lipids) of maize grains for a period of storage of 90 days.

## Materials and methods

For the experiment, the DEKALB-214 hybrid was used, from the Farm Experimental Gralha Azul, located in the municipality of Fazenda Rio Grande – PR, without treatment with insecticides. The product was clean and its moisture level was around 17 – 22 %. The material was dried till it got to a moisture level of 13 %. The experiment was accomplished with five dosages of diatomaceous earth (250, 500, 750, 1,000 and 1,250 g.t-1), a non-commercial product, and a control (without the application of diatomaceous earth) in 200 g of maize. The material was conditioned in plastic recipients closed with metallic web, at ambient temperature (around 25 ºC), for a period of 90 days. In the first day of treatment and in the 30$^{th}$, 60$^{th}$ and 90$^{th}$ days after the treatment, a sample was taken and the lipid level and total protein level from the maize grains was determined.

The methodology used for the analysis of the nutritional components (lipids and total nitrogen) followed the Kjeldahl procedures. For the analysis of lipids in the maize grains, the soxlet balloon was weighed, cleaned and dried in a drier at a temperature of 105 ºC and conditioned in dessicator till ambient temperature. Samples of 2 g of maize were weighed in regular filter paper, packed and placed inside cellulose cartridges sealed with cotton. The cartridge was placed inside a lipid extractor. For the extraction, 200 mL of ethylic ether were used in a soxlet balloon, the extractor and the balloon were fit to the condensator and the refrigeration water from the condensator was released for 120 minutes. The cellulose cartridge was taken out and once again the extractor was fit to the condensator to separate the ether from the extract, collecting the ether. The balloon with the extract was taken to a drier at a 105 ºC temperature and was kept there for 2 hours, then it was taken out in dissecator, cooled at ambient temperature and then weighed. For the analysis of total nitrogen, the digestion and distillation of the nitrogen in the maize grains were performed. The digestion was performed with 0.2 g of triturated maize and 1 g of catalyst (sodium sulphate + copper sulphate, 10:1) in digestion tube. 3 mL of sulphuric acid and 2 mL of hydrogen peroxide were added. The tube was taken to the digester at 50 ºC, and each 30 minutes the temperature was increased in 50 ºC till it would reach 350 ºC, keeping it for the period of 1 hour. In the distillation, the digested sample was hydrated with 5 mL of DI water and the tube was placed in the distillator. The sample was neutralized with 25 mL of sodium hydroxide at 40 %.

For the statistical analysis of the results, the experimental design was used, entirely casualized with four repetitions, ANOVA and Tukey Test for the comparison of means.

## Results and discussion

The statistical analysis of the results show that in the higher dosages of diatomaceous earth and throughout the time in which the samples were taken, there was a reduction in the amount of lipids in the maize grains. (Table 1). There was no significant difference in the amount of nitrogen between the dosages of diatomaceous earth, but throughout the time there was a discreet reduction of nitrogen (Table 2).

**Table 1.** Variation of the lipid level in maize stored for 90 days, treated with different dosages of diatomaceous earth.

| | Days after treatment | | | |
|---|---|---|---|---|
| DE g $t^{-1}$ | 0 | 30 | 60 | 90 |
| 0 | 4.8 Aa * | 4.7 Aa | 4.7 Aa | 4.7 Aa |
| 250 | 4.7 Aa | 4.6 Aa | 4.1 ABab | 3.6 Bb |
| 500 | 4.9 Aa | 4.2 ABab | 3.8 Bb | 3.1 Cc |
| 750 | 5.1 Aa | 4.6 Ab | 4.0 Abc | 3.2 Cd |
| 1,000 | 4.8 Aa | 4.1 ABb | 3.7 Bc | 2.9 Dd |
| 1,250 | 4.9 Aa | 4.2 ABb | 3.9 ABc | 3.1 Cd |

* Means followed by the same capital characters in the columns and same lower-case characters in lines, do not differ in between by the Tukey Test, at a 5 % probability.

**Table 2.** Variation of the total nitrogen level in maize stored for 90 days, treated with different dosages of diatomaceous earth.

| | Days after treatment | | | |
|---|---|---|---|---|
| DE g $t^{-1}$ | 0 | 30 | 60 | 90 |
| 0 | 1.65 a * | 1.59 b | 1.51 c | 1.49 c |
| 250 | 1.63 a | 1.54 b | 1.49 b | 1.44 c |
| 500 | 1.67 a | 1.59 b | 1.49 c | 1.43 c |
| 750 | 1.65 a | 1.55 b | 1.50 b | 1.42 c |
| 1,000 | 1.66 a | 1.55 b | 1.50 b | 1.41 c |
| 1,250 | 1.65 a | 1.55 b | 1.50 b | 1.42 c |

* Means followed by the same lower-case characters in the lines do not differ in between by the Tukey Test, at a 5% probability.

Korunic et al. (1996) treated wheat grains with diatomaceous earth (0,3 g of Protect-It™ per grain kilogram) and there were no changes in the analytical and leveling properties of the wheat. The same authors treated barley with 0,9 g of Protect-It™ per grain kilogram and there were no changes in malt. These results suggest that the diatomaceous earth used in the recommended dosages for each grain do not affect the final product of the treated grains.

Subramanyam et al. (1994) say that there are few studies which have tested the effects of the treatment of diatomaceous earth in the layers of the grain and its influence in the treatment surface.

## Conclusion

The results from these experiment showed that the lipids level vary according to the dosage of diatomaceous earth applied in the grains, throughout the storage period. However, the nitrogen level did not have a significant influence in relation to the treatment. Further studies are necessary to check the influence of diatomaceous earth in other nutritional components of maize grains.

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