

CORN STORAGE AT FARM LEVEL

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ABSTRACT

The corn cultivars "Centralmex", "Azteca" and "Dentado Composto" were evaluated during two consecutive years under different harvesting periods and submitted to storage. Tests on moisture, germination, vigour, sanity, protein, ethereal extract, starch and carotenoid were carried out for each harvesting period. These tests were equally repeated at every three months after storage period. From the results obtained corn harvest is not recommended before completing 120 days from planting due to the high seed moisture content as well as for the insufficient gross protein and ethereal extract formation in the seed. Seed moisture content was reduced to 12% after a period of 6 months storage. To maintain the physical qualities (germination and vigour) acceptable, and the biochemical characteristics (protein, ethereal extract, starch and carotenoid) satisfactory, it is recommended to keep beans in hermetic tins with a relative moisture environment around 70%.

INTRODUCTION

The maize (*Zea mays* L.) is a crop of large importance for Brazil mainly in north East Region, where it is largely used for human and animal feeding. Thou it represents one of the main source of carbohydrate and proteines in the composition of the basic alimentar diet (KALCKMANN & PEREIRA, 1953). The maize occupies the second place in economic importance for Brazil (ANUÁRIO ESTATÍSTICO DO BRASIL, 1984). In Pernambuco state, the maize has been planted around, mainly, by farmers of low income in Agreste and Sertão Regions (JOHNSON, 1978). According to the Anuário Estatístico do Brasil, 1984, the maize production in Pernambuco State increases 2.440% in relation to 1983 being produced 301.945 t grains. This year, it occupies third place among the crops; although in the next year the production has decreased to 196.199 t, occupying 4º place in the state agriculture production according to INSTITUTO DE DESENVOLVIMENTO DE PERNAMBUCO, 1986.

The insects and others deterioration agents, as fungi and rodents are the main factors responsible for 12% of losses, among other factors thar have negative influence in the crop performance (EMPRESA BRASILEIRA DE PESQUISA AGROPE-

CUÁRIA, 1984; FARONI et al, 1983; ROA 1979 and VILLA & ROA, 1979). The practice of drying plants is largely used by the farmers in our state, because de meteorological conditions will allow this type of practice and its minimum costs are according small farmer conditions. However, this practice of drying can be inicial cause of great infestations of insects and metabolic fungi activities (HALL, 1980; JOHNS & BROWN, 1941 and MEJIA, 1979). Even when the inicial infestations took place at low levels, they can eventually be of great importance and be transformed in great losses during storage period, when new pests can be generated (MACHADO et al 1977; PUZZI, 1973 and SALGADO & SOUZA, 1982). Although this practice of drying plants, has been frequent, there is no information yet on quantifying the caused damage by deterioration agents, when the practice has been used.

MATERIALS AND METHODS

This study was runned in the period of 1983/84 and repeated in 1984/85. It was splitted into two parts. The first part iniciated in may by planting Centralmex, Azteca and Dentado Composto cultivars and the second part, their storage in november in the same year. The planting was done at Normandia Farm and it was supervised by Caruaru Research Unity form IPA's Enterprize. No experimental design was adopted in the field, and the main purpose of this planting was to obtain the seeds for storage.

The first harvest was done 110 days away from planting. The second and the third were done 120 and 150 days away from planting, respectively. The subsequent harvests were each 30 days up to fifth harvest, which occurs 210 days away from planting.

In each harvest samples of seeds were taken for humidity, germination, vigour, sanity, crude protein ethereo extract, starch, and carotenoides analysis, the restant of the sample was stored. A randomized block design was used, with 3 replications.

For humidity analysis it were used two samples of 100g each placed into 105°C for 24hrs (BRASIL, 1976).

For germination tests it were used 4 replications of 100 seed each, placed on sand substract and put into auclave for 1 hour at 120°C and after placed into aluminum tray (42 x 28 x 3 cm). The first counting was 7 days after planting, and considered normal plants (BRASIL, 1976). The vigour test was similar to germination test, being the first counting done 4 days after planting.

The sanity test was runned at the seed laboratory from Empresa IPA. For the test of incidence of *Sitophilus zeamais*, the seeds with an egg, larve, pupe, or adult insect inside were considered attached, and also all hole of insects.

The biochemical analysis, as follows: ethereo extract, crude protein, starch and carotenoides were runned at the Centro de Tecnologia Agrícola e Alimentar CTA/EMBRAPA.

The rest of harvested seeds, were stored in closed cans, gallon type, with capacity of 3,8 liters, aproximatelly.

RESULTS AND DISCUSSION

Table 1 shows the humidity harvest results obtained at 110, 120, 150, 180 and 210 days after planting in 1983 and 84. One observes that the seed humidity was very high, being necessary supplementary drying in the sun, in order to reduce the seed humidity to 12%, before its storage.

It is considered initial storage the last harvest done at 210 days after

planting. At this moment, it was done all analysis for other harvest samples in order to process its storage.

The results for all storage periods are as follows:

HUMIDITY

In relation to humidity level, this varies between the start storage period (the month) up to the final stage period (6 months) being independent the studied cultivar.

The two-year analysis showed a significant result at 5% level for stored seeds in 1983, because they were stored with 12,14% medium level, possibly. The statistical analysis was not significant for cultivar x harvest time interaction. One justifies the seeds being stored in closed cans but at relative humidity of 70%, average temperature 23,6°C, average maximum and minima 28,1°C and 19,3°C, respectively; which are the characteristics of Vale do Ipojuca - Caruaru micro-region. The variations among the analysis was due to the process of humidity determination. This result is in agreement to PIMENTEL *et al* (1978) working with bean; corn and sorghum in seed conservation, for a 12 months period in Agreste zone of Pernambuco, State, Brazil.

VIGOUR

The obtained results for vigour in harvested and stored seeds in 1983 were statistically significant at 5% level of probability for "Centralmex" cultivar, being this cultivar better than "Azteca" and "Dentado Composto" cultivars. In 1984, there was no significance among cultivars. For twoyear analysis the "Centralmex" cultivar was superior than "Azteca" one, but statistically equal to "Dentado Composto" as shown in Table 2.

GERMINATION

The obtained average values in two years of work for germination referred to 120 to 210 days harvest after planting were satisfactory between 80 to 95% in the final period with 6 months of storage.

The statistical analysis was not significant for "Centralmex" "Azteca" and "Dentado Composto" cultivars they show identical behavior for this parameter. However, in 1983, the cultivar "Dentado Composto" showed a germination of 95,60% and it was highly superior to "Azteca" and "Centralmex" cultivars which have shown germination of 90,66 and 90,33% respectively, as shown Table 3. Also in this Table, one can see that the "Centralmex" and "Azteca" cultivars, harvested with 150 and 180 days after planting showed similar statistically results in the harvests. The harvests 110 and 120 days after planting were different from the above. One concludes that this cultivars harvested 150 and 180 days after planting they will be recommended. However, the "Dentado Composto" cultivar, harvested 110 and 180 days after planting were significantly different from that 210 days and showed no difference between the two. One concludes that late harvest will be prejudicial.

In relation to the harvest, one verifies that the seed harvested 150 days after planting differs statistically from those harvested 110 and 120 days, respectively. However, the harvests of 120, 180 and 210 days were similar at 1% level of probability. This showed that 110 days harvest caused subsequent problems. In relation of two-year (1983 and 1984) period there was no significant differences and the time of storage for 6 months was different only in relation of stored-seed (0 months). One emphasizes that the interaction: harvest time x storage period was significant at 5% level of probability.

SANITY

Was observed incidence of fungi **Penicillium**, **Aspergillus**, **Rhizopus** and **Curvularia** but they did not contribute from percent germination reduction. The level of attack of wood-earm was 10% in the "Dentado Composto" cultivar harvested 210 days after planting and stored for 6 months.

PROTEIN

In 1983 and 1984, the level of protein in "Centralmex" cultivar was higher than in others at 1% level of probability as shown in Table 4. The harvest at 110 days after planting was significantly inferior to other at 1% probability indicating that prior harvest results in worse protein formation in maize seed.

ETHEREO EXTRACT

In the two-year period there were no significant results for this matter either for cultivar or storage period. The interaction cultivar x harvest time have shown significant differences at 1% level of probability, as follows. The cultivars "Centralmex" and "Azteca" harvested from 120 to 210 days after planting were different statistically from harvest at 110 days. There is no difference between the two. The cultivar "Dentado Composto" harvested from 150 to 210 days showed no difference among them. The harvest at 110 days seed to be prejudicial in the extract ethero formation, and for "Dentado Composto" cultivar later harvesting is not recommended (Table 5).

STARCH

In the starch analysis, there were no significant results for studied characteristics, this might be because the starch can form in the seed of maize before physiological maturation, without considering the type of cultivar and the storage period of 6 months which does not affect its nutritional value.

CAROTENOID

The carotenoid analysis is shown in Table 6.

- a) The cultivar "Azteca" harvested 110 days after planting was superior to "Dentado Composto" cultivar at 1% level of probability;
- b) In 1984, the cultivar "Centralmex", harvested 120 days after the planting, was superior to "Azteca" and "Dentado Composto" cultivars. In two-year (1983 and 1984) analysis, the same harvest, were superior to "Dentado Composto" cultivar at 1% level of probability;
- c) The harvests done up to 150 days after planting did not show any significant difference statistically. One concludes that the level of carotenoids in the maize seed has its maximum at the physiological maturation that is, 120 days after planting and this level is constant during storage period.

TABLE 1. Humidity average obtained values in seed harvest time of maize (*Zea mays* L.) cultivars Centralmex, Azteca and Dentado Composto. 1983 - 1984.

| Harvest time (days after planting) | Harvest Humidity/Cultivar | | | | | |
|---------------------------------------|---------------------------|------|----------|------|--------------------|------|
| | "Centralmex" | | "Azteca" | | "Dentado Composto" | |
| | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 |
| 110 | 37,5 | 50,0 | 41,9 | 42,0 | 45,2 | 36,0 |
| 120 | 32,0 | 31,0 | 35,2 | 33,7 | 32,5 | 39,0 |
| 150 | 15,7 | 14,0 | 17,9 | 18,6 | 15,2 | 14,4 |
| 180 | 14,1 | 13,8 | 14,0 | 14,2 | 13,7 | 13,6 |
| 210 | 13,4 | 13,6 | 13,9 | 14,7 | 13,2 | 13,6 |

TABLE 2. Vigour average obtained values in harvest time of maize (*Zea mays* L.) and cultivar and storage period in months (conjunt analysis of two years).

| Harvest time | Vigour (%) |
|-------------------------------|------------|
| 110 | 44,67 c |
| 120 | 54,06 a |
| 150 | 51,89 ab |
| 180 | 48,11 bc |
| 210 | 45,00 c |
| Cultivars | Vigour (%) |
| "Centralmex" | 51,47 a |
| "Dentado Composto" | 49,13 ab |
| "Azteca" | 45,63 b |
| Storage period (in months) | Vigour (%) |
| 0 | 61,33 a |
| 3 | 53,00 b |
| 6 | 31,90 c |

Values followed by the same letter are not significantly different by Tukey's test at 5% level probability.

D.m.s. - Tukey - 5% Cultivars = 3,79 Time = 5,74 Period=3,79 C.V.=12,50%

TABLE 3. Germination average obtained values in mayze cultivars: "Centralmex", "Azteca" and "Dentado Composto", harvested in five different time 1983.

| Harvest time (days after plantings) | Germination %/ Cultivars | | |
|--|--------------------------|-----------------|---------------------------|
| | "Centralmex" (%) | "Azteca" (%) | "Dentado Composto" (%) |
| 110 | 90,66 c | 90,33 c | 95,66 a |
| 120 | 92,66 c | 92,66 c | 94,66 a |
| 150 | 97,00 a | 97,00 a | 95,33 a |
| 180 | 96,66 ab | 96,66 ab | 95,00 a |
| 210 | 93,33 bc | 93,33 bc | 89,66 b |

Values followed by the same letter are not significant different by Tukey's test at 1% level of probability.

TABLE 4. Variance analysis results obtained for crude proteine in corn seed by harvesting time and by cultivar (Two years period).

| Harvest time | Crude Proteine (%) |
|--------------|--------------------|
| 110 | 9,57 b |
| 120 | 10,15 a |
| 150 | 10,21 a |
| 180 | 10,24 a |
| 210 | 10,12 a |

| Cultivars | Crude Proteine (%) |
|------------------|--------------------|
| Centralmex | 10,57 a |
| Dentado Composto | 9,78 b |
| Azteca | 9,64 b |

Values followed by the same letter are not significantly different by Tukey's test at 5% level of probability.

D.m.s. - Tukey - 5% Cultivars = 0,27 Times = 0,50 C.V. = 2,20%

TABLE 5. Ethered extract average obtained values in mayze cultivars Centralmex, Azteca and Dentado Composto, harvested in five different times (Two years period).

| Harvest time | Ethered extract %/Cultivars | | |
|-----------------|-----------------------------|----------|--------------------|
| | "Centralmex" | "Azteca" | "Dentado Composto" |
| 110 | 3,99 b | 4,04 b | 4,13 c |
| 120 | 4,38 a | 5,59 a | 4,23 b |
| 150 | 4,38 a | 4,50 a | 4,40 ab |
| 180 | 4,49 a | 4,46 a | 4,40 ab |
| 210 | 4,56 a | 4,52 a | 4,59 a |

Values followed by the same letter are not significantly different by Tukey's test at 5% level of probability.

D.m.s.

Times = 0,23
 Cultivars = 0,19
 C.V. = 3,17%

TABLE 6. Carotenoid average obtained values in mayze cultivars Centralmex, Azteca and Dentado Composto, harvested in five different times (Two years period).

| Cultivars | Harvest time (days after planting) | | | | |
|--------------------|------------------------------------|---------|-------|-------|-------|
| | 110 | 120 | 150 | 180 | 120 |
| "Centralmex" | 1,002 ab | 1,623 a | 1,275 | 1,785 | 1,422 |
| "Azteca" | 1,395 a | 1,372 a | 1,512 | 1,640 | 1,577 |
| "Dentado Composto" | 0,780 b | 0,878 b | 1,438 | 1,395 | 1,523 |

Values followed by the same letter are not significant different by Tukey's test at 5% level of probability.

D.m.s.

Cultivars = 0,408
 Times = 0,494
 C.V. = 16,74%

CONCLUSIONS

The following conclusions can be drawn under the conditions this has been done:

1. The maize seed of "Centramex", "Azteca" and "Dentado Composto" cultivars can be broken from 120 days after planting and stay in field up to 180 days after the planting, with prejudices.
2. The maize seeds of all studied cultivars harvested from 120 days after the planting and containing a reduced humidity level of 12,0% stored in closed can may maintain physic qualities (vigour and germination) in acceptable levels and biochemical characteristics (proteine, extract ethe reo, starch and caratenoides) in satisfactory conditions after a period of 5 months storage.

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LE STOCKAGE DU MAÏS A LA FERME

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Résumé

Les cultures de maïs des variétés "Centralmex", "Azteca" et "Dentado Composito" ont été étudiées au cours de deux années consécutives en tenant compte de périodes différentes de moisson, pendant la période de stockage. Les essais menés ont porté sur le degré d'humidité, la germination, la vigueur, l'état sanitaire, le contenu en protéines, en extraits d'éther, en amidon et en caroténoïdes critères qui ont été réalisés pour chaque période de conservation étudiée. Ils ont été effectués tous les trois mois après le début du stockage. Les résultats obtenus permettent d'avancer que la récolte du maïs n'est pas à recommander avant une durée de 120 jours à compter des semences, en raison de la teneur en eau trop élevée à la récolte autant que de l'insuffisance de la teneur en protéines brutes ainsi que de la formation d'extraits à éther dans les grains. Le taux d'humidité s'est abaissé de 12 % après une durée de stockage de

6 mois. Pour maintenir dans des limites satisfaisantes les qualités physiques (germination et vigueur) et les caractéristiques biochimiques (protéines, extraits à éther, amidon et caroténoïdes), il est recommandé de conserver les graines dans les cellules hermétiques ayant un taux d'humidité relative environnant d'à peu près 70 %.