NUTRITIONAL QUALITY OF MAIZE STORED IN WOODEN GRAIN SILO

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ABSTRACT

Grain storage has as objective, the uninterrupted availability of grain of adequate quantity and quality at all time. The situation in the grain producing areas of Nigeria is currently that of considerable losses during post-harvest grain handling. The study looks into quality changes in maize (Zea mays) stored in wooden silo for three months (June to September). Changes in the nutrient content such as crude protein, crude fibre, lipid, carbohydrate and ash were investigated. Crude protein, crude fibre, lipid and ash reduced by 0.9-1.03%, 0.7-0.9%, 0.30% and 0.4% respectively while carbohydrate increased by 1.64-1.77% during the storage period. This reduction resulted from heat damage of the germ portion of some kernels, respiration, oxygenation of the unsaturated lipids, denaturizing of protein, sedimentation of colloids and rancidity of lipids. From this investigation, it has been found that maize grains can be stored for more that 3 months before deterioration due to mould growth and insect attack in Minna located in the tropics.

Keywords: Nutrients, Maize, Storage, Silo, Wood

INTRODUCTION

Nigeria produces a wide variety of agricultural products such as cereal grains, root and tuber crops, vegetables, fruits and numerous dairy products (Ashafa, 1986) but losses at storage is as high as 50% (Igbeka, 1983). The major reason is lack of adequate and appropriate storage facilities to cope with the peculiar environmental conditions of the tropics. This situation forces the farmers to keep a small portion of their grains and quickly disposes the rest in the market at reduced prices during the season.

The Federal government of Nigeria in 1987 in her efforts toward ensuring availability of grains year round embarked on the erection of 25,000 tonnes Strategic Grain Reserve using metallic silo in all the states of the country (Talabi, 1996). Under the Nigerian climatic condition these metal silos have been found to be associated with the development of hot spots due to high temperature fluctuations, caking of grains, mould growth in addition to high cost of importation, technical and management problems.

Attempts have been made in the past to develop suitable storage structures using locally available materials for the construction of such structures (O'Dorid, 1971; Lasisi, 1975; Igbeka, 1983; Aderibigbe *et al.*, 1985; Mijinyawa, 1989; Osunade, 2000 and Alabadan, 2005). Some measures of success have been achieved.

The objectives of this study are to investigate how the nutritional quality of maize grains stored in wooden grain is affected.

MATERIALS AND METHODS

Description of Silo Used

The material used in the construction of the wooden silo is plywood that is made up of 5 plies. The constructed silo had a capacity of $1.87m^3$ and can contain 1 tonne of shelled maize. It is hexagonal in shape, with the inscribed circle being of 1.4m diameter and each side measured 0.81m while the height is 1.10m. There are six columns of 1.4m long that serve as a foundation (Alabadan, 2005).

Storage of Maize Grains

The maize grains used for this experiment were bought from the central market, Minna, Niger State Nigeria.

The silo was located in Minna, Nigeria. Nigeria has a warm humid climate made up of two seasons. The wet season ranges between April to October while the dry season lasts from November to March. Minna is located in longitude $6^o25'$ to $6^o40'$ East and latitude $9^o30'$ and $9^o45'$ North. The average monthly temperature is 28.5^oC for the wet season and 38.9^oC for the dry season. Average monthly rainfall is 409.0mm in August and none in February and March (FAAN, 2003).

The inside of the wooden silo was fumigated to ensure that it was free of insect before loading. A low concentration of 3 tablets of Phostoxin and 0.3kg of copex was used for 5 days for the grain bulk during storage to prevent insect attack. Phostoxin is a general fumigant with good penetrating ability. It traces may remain after fumigation but are almost completely removed during cleaning and milling. Rat fed exclusively on fumigated wheat treated with high concentrations of Phostoxin showed no adverse effects after 3 months (Sinha and Muir, 1973).

Collection of Grain Samples

150g of maize grains each were collected from the top and bottom of the 300kg maize grain bulk in the silo using non-compartmented grain probe once a month for three months. This was done from June to September.

Determination of Percentage Maize Nutritional Composition

The crude protein, fat, crude fibre and ash content of the stored maize were determined using the Official Methods of the Association of Official Analytical Chemists (AOAC, 2003) while the total carbohydrate was determined by using estimation by difference which has proved reliable (Fleck, 1976). Two way ANOVA was used for the analysis while the Duncan Multiple Range test was used to present the means.

RESULTS AND DISCUSSIONS

Results of Nutrient Composition and Proximate Analysis

All the parameters determined were for top and bottom for each month except for the zero month. The results of the analysis are as shown in Tables 1 to 5.

Table 1 summarizes the percentage compositions of the Protein nutrients and the proximate analysis of the maize (top and bottom) in the three months. Tables 2, 3, 4 and 5 contained percentage Lipid, Carbohydrate, Fibre and Ash contents in the stored maize respectively.

Table 1: Protein Constituents of Stored Maize Grain

Storage Period (months)	% Protein		Row Mean
	Top	Bottom	
0	10.53	10.53	10.53^c
1	10.50	10.48	10.49^c
2	10.00	10.00	10.00^b
3	9.63	9.50	9.57^a
Column Mean	10.17^a	10.13^a	

Table 2: Lipid Constituents of Stored Maize Grain

Storage Period (months)	% Lipid		Row Mean
	Top	Bottom	
0	4.82	4.82	4.82^d
1	4.80	4.79	4.80^c
2	4.60	4.60	4.60^b
3	4.50	4.50	4.50^a
Column Mean	4.68^a	4.68^a	

Table 3: Carbohydrate Constituents of Stored Maize Grain

Storage Period (months)	% Carbohydrate		Row Mean
	Top	Bottom	
0	82.83	82.83	82.83^a
1	82.90	82.95	82.93^a
2	83.80	83.82	83.81^{ab}
3	84.47	84.60	84.54^b
Column Mean	83.50^a	83.55^a	

Table 4: Fibre Constituents of Stored Maize Grain

Storage Period (months)	% Fibre		Row Mean
	Top	Bottom	
0	2.65	2.65	2.65^c
1	2.64	2.63	2.64^c
2	2.60	2.60	2.60^b
3	2.58	2.56	2.57^a
Column Mean	2.62^a	2.61^a	

Table 5: Ash Constituents of Stored Maize Grain

Storage Period (months)	% Ash		Row Mean
	Top	Bottom	
0	1.82	1.82	1.82^c
1	1.80	1.78	1.79^c
2	1.60	1.58	1.59^b
3	1.40	1.40	1.40^a
Column Mean	1.66^a	1.65^a	

a, b, c and d = means in the same column and row carrying different superscript are significantly different. ($P< 0.05$)

DISCUSSION OF RESULTS

From the tables, it was observed that at the zero month of storage, the nutritional compositions of the stored maize remained constant and was not significantly different for both top and bottom samples.

The value of protein remains the same for both top and bottom samples of maize at the zero and second months of storage. However, there is a reduction at the bottom when compared to the top for first and third months. There was no significant difference between the top and bottom samples. Also, the zero and first months were not significantly different but there were significant differences between the first, second and third months of storage as seen from Table 1.

There was no significant difference in the percentage lipid content of the stored maize for both top and bottom samples as contained in Table 2. However, there were significant differences between the months of storage.

From Table 3, the carbohydrate value remained the same for both top and bottom samples of stored maize at the zero month of storage. There was no significant difference between the values of the zero and first months but there are significant differences between the first, second and third months of storage.

Crude fibre value remains the same for both top and bottom samples of stored maize at the zero month of storage. The values of the top and bottom during the months of storage were not significantly different as seen from Table 4. The values for the months differ significantly between the first, second and the third months. The fibre content values in the zero and first do not differ significantly.

The values of ash in the zero month of storage for both top and bottom samples with the same superscript (a) as seen from the Table 5 indicates that there was no difference in the ash value of the stored maize. It can be seen that there was no significant difference in the ash content of maize samples at the zero and first month of storage, but the value of ash indicates significant differences between the first, second and third of storage.

From the Tables 1 to 5, it can be seen that the values of protein, lipid, fibre and ash decreased slightly with increase in storage while the value of carbohydrate slightly increased. The reason for the increase in total carbohydrate relative to other nutrient content of stored grain is that in most cases, the endosperm containing carbohydrate is usually less affected by infestation than the embryo portion of the kernel which is heavily affected.

The embryo is a highly nutritious portion of the seed containing proteins, fats and vitamins. When attacked by insects or exposed to excessive heat due to increased temperature, damage of the germ portion of the grain (embryo) take place and the grain seed becomes unviable for planting. Once the germ is damaged, the seed is considered pathologically dead hence it looses part of its ability to resist deterioration. The grain death is due to the degeneration of protein which, in turn, is influenced by decay of components in the cell nucleus. In addition, the germs contain high percentage of fat which could promote rancidity (oxidative and sometime ketonic) which leads to loss of fat content.

Respiration in grain bulks or the breakdown of organic matter occurs aerobically to produce energy, carbon dioxide and water. The direct effects of this respiration are the loss of weight of the grain, increase in the moisture content of the grain, rise in the level of carbon dioxide in the intergranular air and a rise in the temperature of the grain. Drying leads to oxygenation of the unsaturated lipids while excessive drying leads to denaturizing of protein, sedimentation of colloids and rancidity of lipids. All the products of these degenerations will results to reduction in the quality and quantity of the stored products.

From visual observation, there was no indication of insect infestation at the onset of the experiment but the possibility of some of the grains harbouring the eggs of the insect before storage could not be ruled out. The grain is not a fresh one and the storage conditions before purchase could not be ascertained. However, infestation rate were generally low and below the minimum for stored grains in Nigeria (SON, 1989).

From Figure 1, the temperatures at the top and bottom of the wooden silo followed the pattern of the ambient temperature variations. The temperatures of the grain bulk at the top of the silo were higher than the temperatures at the bottom. However, there were no significant differences between these temperatures during the storage period. The maximum recorded temperatures were 31, 31.5 and 28.8 ^{0}C for the ambient, top and bottom of the silo respectively. The minimum temperatures were 19, 24 and 15.8 ^{0}C for the ambient, top and bottom of the silo respectively. The corresponding temperature variations were 12, 7.5 and 13 ^{0}C for the ambient, top and bottom of the silo. The smaller variation at the top of the silo may be due to the air space above the bulk that is associated with high temperature values due to accumulated heat. This place is known to be potential danger zone for the bulk.

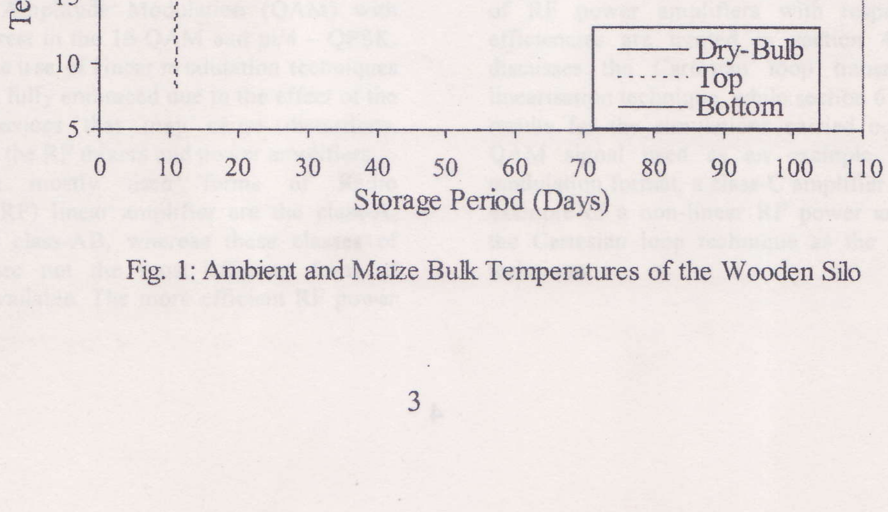

Fig. 1: Ambient and Maize Bulk Temperatures of the Wooden Silo

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This work showed that there are significant reductions in the nutrient contents of stored maize with increasing storage period but no significant differences between the samples from the top and bottom of the silo. This slight reduction can be attributed to the heat damage arising from temperature outside the silo and heat generated by the grains, ageing and degeneration of the constituents due to respiration over the storage period, which affected the germ portion of the grain.

Recommendations

The maize needs to be stored for longer storage period to further ascertain its quality and also the suitability of the wooden silo for the purpose. Due to its ability to maintain fairly uniform temperature variations within the storage period when compared to metal, wooden silo would be easily adoptable by the small farmer who produces only a few tonnes of maize during the harvests.

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