THE DETERIORATION OF COMMERCIAL MAIZE (*ZEA MAYS*) BY INSECTS AND FUNGI

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INTRODUCTION: Maize, *Zea-mays* L., is a staple food among millions of Nigerians. When fresh, maize is eaten boiled or roasted. When dry, it is made into porridge (akamu, ogi) or into a white solid (agidi, eko). Because the moisture content of fresh maize at the time of harvest in southern Nigeria ranges from 22 to 32% between May and July, maize thus stored becomes mouldy. Insect infestation of the grain is further aggravated by rodents during storage and distribution. In addition to biochemical changes which insect infestation causes to stored grains, discolouration and mycotoxicosis often result from fungal attack.

Most earlier data on losses in stored grains have come from laboratory studies. This paper, however, examines the changes caused by insects and moulds to maize during storage and distribution in open markets in the hope that the findings will draw the attention of farmers and distributors to improved drying methods, better handling and distribution systems; while to the consuer an awareness of quality in his choice of foods.

MATERIALS AND METHODS: Maize on the cob was purchased from three major open markets in Ibadan, in May 1978. Ibadan was chosen being a cosmopolitan city and a major distribution centre for foods in southern Nigeria. Apparently uninfested cobs were then separated from the infested.

I. Physical measurements

(i) Insect population. From each market sample 20 subsamples each of 5 cobs were examined and the total number of adult insects recorded.

(ii) Kernel damage. The cobs from (i) above were shelled and mixed thoroughly and the number of damaged kernels/100 of grain was recorded in 20 subsamples.

(iii) Viability of the maize was determined in apparently clean as well as in infested grains from each market by observing the emergence of hypocotyl in 5 subsamples each of 20 grains of clean and 20 of infested maize placed on moistened Whatman No. 1 filter paper in a petri dish at 27±1°C.

(iv) Mould types. Five samples of clean, and 5 of infested maize each of 20 grains were put on moistened Whatman No. 1 filter paper in petri dishes, covered, and

incubated under the near ultraviolet light to hasten sporulation. Mycelial growth was observed and spores identified.

2. Biochemical measurements
   (i) Free fatty acids. Infested and apparently clean maize grains were ground separately. From each separate portion 6 samples of 5 g were analysed for free fatty acids according to the method of the American Association of Cereal Chemists (1962).
   (ii) Reducing sugars. Soluble carbohydrates were determined by the method of the Association of Official Agricultural Chemists (1950) while sucrose was extracted using the modified anthrone method of Firby et al. (1973).
   (iii) Uric acid was determined according to Eichhorn et al. (1961).

RESULTS. In the commercial maize samples examined, *Sitophilus oryzae* (L.) and *Sitophilus zeamais* Motschulsky accounted for 92% of the total insect population while *Tribolium castaneum* (Herbst.) and *Rhizopertha dominica* (F.) accounted for 6 and 2% respectively. In Table I percentage kernel damage increased with insect infestation

TABLE I.

Insect population, kernel damage and viability in commercial samples of maize

Market	Insect Population	Kernel Damage	Viability (% Germination)	
			Apparently clean	Infested
Sango	48.2	41.0	100	26
Dugbe	36.4	35.5	94	36
Oja Oba	15.4	23.5	98	50

of the grain. Free fatty acids in infested maize was 4.5 mg. KOH per 100 g grain compared with 1.3 mg KOH per 100 g in the apparently clean samples. True uric acid content (mg./100 ml) was 2.05 in infested samples. Insect-infested maize grains were also found to contain moulds belonging to the genera *Aspergillus*, *Penicillium*, *Rhizopus*, and *Fusarium* in a descending order of prevalence.

DISCUSSION AND CONCLUSION. Insects and fungi in agricultural commodities have often caused quantitative loss in addition to undesirable changes. Advanced technological means for detecting insect infestations of grains have received wide attention. However, apart from the prohibitive cost of introducing such technology to developing nations, the need for its use at present is questionable since a large proportion of agricultural produce contains readily observable infestations.

This study shows that maize sold on open markets in Ibadan had physical damage and reduced viability. Increase in fat acidity value in the commercial samples showed that the oily material in the maize must have suffered oxidative degeneration leading to rancidity during storage and distribution.

Uric acid, a major component of insect excreta, has been used as an index of insect infestation of grains (Coombs, 1973; Subramanyan et al., 1955) although creatinine, guanine and allantoin may also be present. It has, however, not been reported whether storage fungi produce uric acids in fungal-infected stored produce. It can thus be reasonably assumed that the increase in uric acid in the commer ial maize sold in Ibadan is probably due only to insect attack. The presence of small quantities of uric acid in the apparently clean samples could have been due to undetected insect infestation. Purine and adenine also presumably come only from insect infestation. Therefore the low value of 1.3 mg KOH/100 g must be explained by undetected infestation in the "apparently clean" samples. On open markets in southern Nigeria, maize cobs with apparent insect infestation are usually sorted from the bulk before sales hence the overall mean percentage insect population, kernel damage, and biochemical changes will be higher than we have observed.

In addition to the already observed infestation, the lipolytic properties of the infecting moulds may have contributed to the increase in fat acidity value in the infested maize. Increase in fat acidity value is a useful measure of deterioration. For example, Pingale et al. (1954) recorded a rise of 44, 46 and 49 mg KOH per 100 g of wheat infested by three different insects compared to 19-37 mg KOH per 100 g in uninfested wheat.

Although insect activity in stored grains which results in heating and increased grain moisture encourages the growth of fungi, stored products insects can also be responsible for the introduction and dissemination of storage fungi in a produce (Agrawal et al. 1957, 1958). Mycotoxicosis especially by the *Aspergillus* group has been a major cause for concern (Forgass et al. 1959, 1966) hence fungal attack of maize meant for consumption becomes very important if we consider that porridge, a popular weaning diet all over the country which is also a major light meal for adults comes from maize. It is in the light of this that farmers and distributors of maize must consider seriously improved maize drying methods, and better handling and distribution systems to obviate a possible threat to health.

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