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Deteriorative changes in groundnut seeds in storage

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Groundnut seeds (*Arachis hypogaea*), variety 'Nizam' were stored in gunny bags in laboratory under ambient conditions for one year. Various qualitative and quantitative changes were noted in seeds as a result of fungal invasion mainly by species of *Aspergillus*.

Key words : Groundnut seeds, Deteriorative change, Storage, Fungal invasion

INTRODUCTION

Groundnut (*Arachis hypogaea*), world's second largest source of edible oil, accounts for about 31.7% of total global production in India. In tropical countries the hot and humid conditions, prevailing through most part of the year, are responsible for various deteriorative changes in the oil seeds by fungi (Mondal *et al.*, 1981 ; Nandi *et al.*, 1982). Varied amounts of lipase produced by these fungi bring about different level of changes in quality and quantity of oil (Bose and Nandi, 1982 ; Mondal and Nandi, 1984).

In the present investigation, the deteriorative change of groundnut seeds during storage by fungi, has been evaluated to suggest improvement in seeds management.

MATERIALS AND METHODS

Groundnut seeds of variety 'Nizam' was purchased from local markets in Burdwan during December, 1989 and stored in the laboratory in small gunny bags (10 kg) for 1 year under fluctuating temperature (24°C—38°C) and relative humidity (65—90%) of the atmosphere.

Moisture content of the seeds was calculated by oven drying triplicate samples of 80 ±1°C for 48 hrs and expressed in percentage on dry wt. basis (Anon, 1966).

Germinability was determined by randomly placing 100 surface sterilized seeds in Petri dishes containing three layered, moist, sterilized filter-papers and incubated at 30±1°C for seven days (Anon, 1966).

Mycoflora in seeds was recorded by surface-sterilizing with 2% sodium-hypochlorite, washed in sterilized distilled water and plating them on malt-agar (2%) following De-Tempe (1962).

Carbohydrate in seeds was determined following Viles and Silverman (1955) and McCready *et al.* (1955) and crude protein following Lowry *et al.* (1951) and these were expressed in terms of percent. Chitin was estimated following Nandi (1978) and represented as μg/g of dry wt.

Oil was extracted by petroleum either (b. p. 40—60°C) by Soxhlet method for 6 hrs (Meara, 1955). Fat acidity value (F. A. V.) and saponification value (S. V.) in oil were determined following AOAC (1980). Iodine value (I. V.) was determined following Tom's method described by Meara (1955).

RESULTS AND DISCUSSION

The initial moisture of groundnut which was 6.71% at harvest (Dec., 1989), after an initial decrease, increased to 8.35% after eight months which incidentally corresponded to the rainy months of the year (Table 1). Increase of seed moisture evidently resulted from absorption of moisture to attain equilibrium with the prevailing high atomospheric relative humidity. Neergaard (1977) reported, seeds with high oil content to possess lower moisture than those with protein and starch.

Seed germinability, which is known to be an indicator of deterioration, decreased slowly in the present study from the initial 84% to 63% after nine months and then completely lost after twelve months of storage (Table 1). Seedling biomass also decreases as storage progressed. Decrease in germination was accompanied by simultaneous increase in fungal infection and growth as was evident from infection in all seeds after nine months. Increased fungal growth in seeds showed concomitant rise in chitin content from the initial 91 μg g to 197.5 μg g in longer storage as well as during the rainy season.

From the beginning, storage fungi belonging to different species of *Aspergillus* were (Fig. 1) predominant in seeds and only in a few case field fungi like

Mucor and some members of Deuteromycetes were recorded. Comparatively lower occurrence of field fungi probably resulted from absence of favourable level of fairly high seed moisture and/or their elimination in competition with the storage fungi. *A. flavus*, *A. niger* and *A. candidus*, which proved

Table 1. Changes in moisture, germinability, seed and seedling biomass of groundnut in storage for one year

Storage (Months)	Moisture* (%)	Germination** (%)	Dry wt. of shoot** (g)	Dry wt. of root** (g)	Seed biomass*** (g)	Loss in dry wt.***
1	6.71 (± 0.140)	84	3.700	2.300	9.329 (± 0.014)	—
2	6.24 (± 0 020)	83	2.984	2.163	9.266 (± 0.033)	0.063 (± 0.032)
3	7.11 (± 0.639)	82	3.600	2.281	9.163 (± 0.059)	0.166 (± 0.045)
4	6.27 (± 0.014)	79	3.800	2.581	9.264 (± 0.063)	0.065 (± 0.028)
5	6.01 (± 0.044)	73	3.200	2.550	8.945 (± 0.195)	0.384 (± 0.042)
6	7.34 (± 0.081)	71	1.444	1.040	8.881 (± 0.386)	0.448 (± 0.284)
7	6.25 (± 2.932)	69	1.540	1.400	8.988 (± 0.281)	0.341 (± 0.206)
8	8.5 (± 2.598)	63	1.500	1.300	8.495 (± 0.199)	0.834 (± 0.376)
9	8.65 (± 0.128)	47	1.115	1.005	8.487 (± 0.195)	0.842 (± 0.189)
10	6.98 (± 0.016)	15	0.310	0.200	8.766 (± 0.175)	0.563 (± 0 177)
11	7.16 (± 0.218)	5	0.240	0.130	8.411 (± 0.129)	0.918 (± 0.107)
12	8.36 (± 0.365)	—	—	—	8.166 (± 0.059)	1.163 (± 0.096)

* Mean of three replicates ** Seedlings from 100 seeds *** Mean of three replicates of 10 g of initial wt.

to be dominant species in the present study, are known to be frequent invaders of different seeds under the Indian condition and are instrument in deteriorating both their physical and chemical qualities. Higher loss in dry wt. of seed corresponded closely to the increased seed moisture and accelerated fungal activity leading to depletion of major food reserves.

Carbohydrate content in the seed, which was 17.5% initially, decreased to 14.75% and 12.42% after six and twelve months respectively. Soluble sugars remained more or less unchanged throughout the experimental period. The insoluble sugar which was 11.2% at harvest, however, decreased prominently to 6.02% after twelve months (Table 2). Loss of insoluble sugar which was fairly high showed evident correlation with increased catabolic activities of the storage fungi under the prevailing temperature that proved congenial for their growth (cf. Golubchuk *et al.*, 1965). Reduction of starch content showed distinct correlation with the activation of starch hydrolysing enzymes (unpubl.).

Total protein which was 25% at harvest, increased marginally to 26.4% after three months, but again decreased to 21.5% (Table 2). This increase

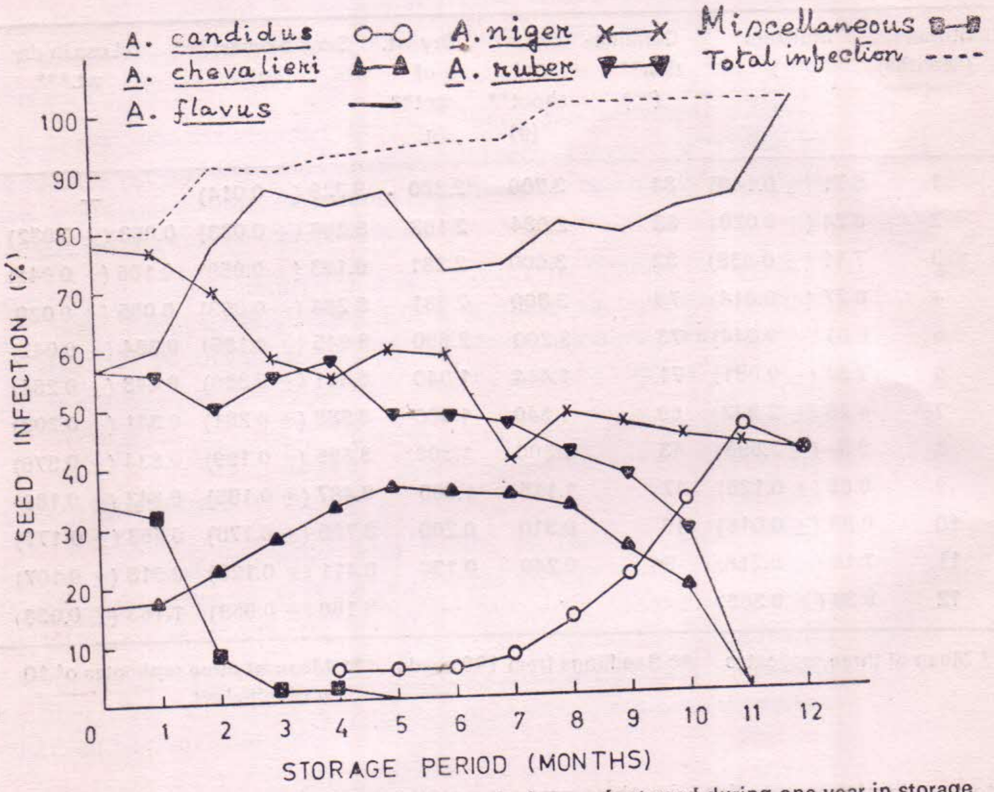

Fig. 1. Types of mycoflora and infection (%) of groundnut seed during one year in storage

in protein content might be due to relatively slower rate of its deterioration than that of carbohydrate at the earlier stage. Proteolytic enzymes produced by the fungi, hydrolysed the seed protein to polypeptides and free amino acids (unpubl.) which served as primary source of readily available C and N required for metabolism and growth of the fungi (cf. Robinson *et al.*, 1974) and were subsequently converted to fungal protein. This evidently kept the relative level of total protein only marginally different from the initial.

Initial oil content (45%) decreasee slowly to 43.5% after twelve months. The colour of the oil changed from golden-yellow at harvest to pale-yellow after twelve months. Oil became more transparent and less sticky as storage progressed (Table 3). Characters like FAV, SV, IV of oil extracted from the seeds at the initial stage, corresponded to those of the literature value (Wealth of India, Vol. I). In all cases, these increased slowly during

Table 2. Changes in carbohydrate (%), protein (%) and chitin (μg/gm)* of groundnut seed in storage for one year

Storage period (Months)	Carbohydrate (%)*			Protein* (%)	Chitin* (μg/g)
	Sol. sugar	Insol. sugar	Total carbo.		
1	6.30	11.20	17.50 (± 0.866)	25.00 (± 0.305)	91.0 (± 2.309)
2	6.30	10.90	17.20 (± 0.923)	25.20 (± 0.611)	97.5 (± 2.027)
3	6.50	10 90	17 40 (± 0.754)	26.40 (± 0.692)	109.5 (± 2.598)
4	6.40	10.10	16.50 (± 1.299)	25.86 (± 0.266)	114 0 (± 1.443)
5	6.41	8.74	15.15 (± 0.550)	24.53 (± 1.572)	129.0 (± 1.732)
6	6.00	8.75	14.75 (± 1.950)	24.80 (± 3.354)	140 5 (± 3.775)
7	6.75	8.85	15.60 (± 0.200)	24.13 (± 3.365)	153.0 (± 2 565)
8	6.15	8.20	14 35 (± 0.150)	22 80 (± 2.566)	171.0 (± 4.509)
9	7.42	8.60	15.02 (± 0.825)	22.26 (± 1.748)	180.0 (± 2.843)
10	7.35	6.85	14.20 (± 1.458)	23.60 (± 2.433)	190.0 (± 2.620)
11	7.05	6.52	13.57 (± 1.025)	21.60 (± 0.800)	195.1 (± 2.848)
12	6.40	6.02	12.42 (± 0.825)	21.60 (± 0.880)	197.5 (± 3.04)

* Mean of three replicates

the first six months and then at a much faster pace (Table 3). Loss of oil content in storage are known to be due to enhanced oxidative or hydrolytic activities of the enzymes of the fungi (unpubl.) resulting in the production of free fatty acids (cf. Mondal and Nandi, 1984) as was evident from increased free fatty acid units in oil. Increased saponification values in deteriorated oil reflected increase in fatty acids and short chain glycerides in accordance with earlier observation of Bose and Nandi (1982) in safflower, sesame and rapeseed. Higher unsaturation of the fatty acids were reflected from corresponding increase of the iodine values. Changes in colour of the partially deteriorated oil was due to pigmentation of the invading fungi. Oxidation of the fat may also partly be responsible for the change in oil colour.

Table 3. Changes in the quality of groundnut oil in storage for one year

Storage (Months)	Oil content* (%)	Fat activity value*	Saponification value*	Iodine value*
1	45.0	1.147 (± 0.059)	171.57 (± 2.037)	89.32 (± 4.941)
2	44.5	1.355 (± 0.046)	161.28 (± 2.141)	88.87 (± 4.630)
3	44.2	1.409 (± 0.209)	158.48 (± 2.144)	90.12 (± 4.130)
4	44.0	1.533 (± 0.220)	161.98 (± 1.215)	103.97 (± 1.889)
5	44 2	1.589 (± 0.099)	162.45 (± 1.533)	109.52 (± 0.801)
6	44.1	1.692 (± 0 073)	166.19 (± 1.072)	110 99 (± 1.317)
7	44.0	1.888 (± 0 182)	180.92 (± 4 285)	117.33 (± 4.103)
8	43.8	1.841 (± 0.065)	175.54 (± 1.017)	124.67 (± 5.746)
9	43.5	2.333 (± 0.205)	192.84 (± 1.457)	127.70 (± 4.629)
10	43.5	2.449 (± 0.121)	191.67 (± 4.947)	126.26 (± 2.851)
11	43.6	2 449 (± 0.178)	198.45 (± 3.903)	128.38 (± 2.328)
12	43.5	2.655 (± 0.413)	204.99 (± 1.018)	132.44 (± 4.033)

* Mean of three replicates

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