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FUNGAL INFECTION OF PROCESSED ARECANUTS [1]

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INTRODUCTION

Arecanuts (*Areca catechu* L.) are damaged by fungi and insects during the course of processing as well as in storage. This renders the nuts unsuitable for chewing. The market value of such affected nuts is considerably low because of its inferior quality.

Lal and Chandra (6) reported *Aspergillus niger arecae* causing storage rot of arecanuts. Fungi like *Aspergillus* sp., *Thielaviopsis* sp., and *Diplodia* sp. were isolated from rotting husks (1). Jaleel and Govindarajan (4) reported that fungi gained entry into the kernel through germ portion. Studies by Srivastava *et al.* (7) showed that the fungus *Subramanella arecae* was associated with fruit rot of arecanut in storage. It was reported (2) that the normal microflora associated with skin and husk were predominantly aerobic bacteria and fungi like *Penicillium* sp., *Aspergillus* sp., and *Mucor* sp. Thus, the previous studies were confined to fungal infection of ripened fruits in transit or in storage. No concerted effort was made to study the fungal infection of processed nuts. Hence a project was launched (3) to study the source of fungal infection of 'Chali' (dried kernel), the fungi involved in the damage, the extent of damage and to evolve suitable methods to prevent such infection as well as to fix up quality standards for the sale of the produce in the market, the results of which are presented in this article.

MATERIALS AND METHODS

The harvested ripe nuts, meant for 'Chali' preparation were used for the study. The drying yard unless otherwise stated consisted of compacted soil. Ten samples of 30 nuts each drawn from a single lot of ripe nuts harvested and sun-dried on a drying yard were cut into two halves and examined for fungal infection. Unless otherwise specified, samples were drawn on the

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40th day of sun-drying. Infection and damage were recorded by visual observation. Microscopic examination followed by isolation of fungi by dilution plate technique on Potato Dextrose Agar were adopted for identifying the fungi involved in damage.

For quick drying of arecanuts a mechanical drier (6) was used, at temperatures ranging between 60° and 62°C.

To study the extent of moisture loss from the nuts at different intervals of drying on the drying yard, ten lots of nuts weighing 5 kg each were weighed individually at 5-day interval till the 40th day of drying. The loss in weight of the nuts was recorded as the moisture per cent removed during the respective time interval. The moisture percentage of kernel in storage was determined using Universal Moisture Meter.

Results

Symptomatology and Etiology: On the drying yard, the husk as well as the kernel are the target of attack by different fungi.

The first site of infection in a kernel by the fungi is the embryo itself. The invading fungi ramify in this tissue and later spread to the adjoining white core of the endosperm. After complete disintegration of the white core, the fungal hyphae attack the lamella of the rumination. In severe cases of infection, the disintegration of the endosperm is total and complete leaving a hollow cavity in such affected kernels.

The following species of fungi were observed to infect processed nuts, in addition to previously recorded species :

i) Aspergillus flavus (I M I 146954), *ii) A. fumigatus* (I M I 148816), *iii) A. chevalieri* (I M I 146954), *iv) Botryodiplodia theobromae* (I M I 148817) and *v) Rhizopus* sp. (I M I 148818).

The affected 'Chali' when cut into two halves, would present different discolourations at the white core depending upon the fungi involved in the attack. Thus, *Aspergillus niger* is characterised with the presence of black mass of spore heads; yellow in colour in the case of infection by *A. chevalieri*; yellowish green in the case of *A. flavus*; velvetty green in the case of *A. fumigatus*. In the case of infection by *Penicillium* sp., the affected tissues show a felty olive-green growth over them. Infection by *Botryodiplodia theobromae* is discerned by the presence of grey to greyish black mycelial mass inside; and in the case of *Rhizopus* sp. and *Mucor* sp. the central white core presents cobwebby mass of hyphae which are yellowish grey or grey in colour. The mean percentage of infection by different fungi from ten lots of nuts examined in January-February, 1983 is given in Table 1.

TABLE 1 – Mean percentage of infection from ten lots of 'Chali' (dried nuts) by different species of fungi (data recorded during January–February, 1969).

	Aspergillus sp. *	*B. theobromae*	*Mucor* sp.	*Penicillium* sp.	*Rhizopus* sp.	*T. paradoxa*	Total
Infection %	6.4	19.3	0.7	1.3	1.8	0.2	27.9

*Includes *A. niger, A. flavus, A. fumigatus, A. chevalieri*

It is evident from the table, that majority of infection was by *B. theobromae* followed by *Aspergillus* sp.

Extent of damage: The fungal infection will be either mild or moderate or severe, according to the time of infection.

Ripe arecanuts after harvest during different months were sundried on the drying yard for 40 days for satisfactory drying. The data on the mean percentage of infection on the 40th day of sundrying during different months together with the relevant meteorological observations are given in Table 2.

TABLE 2. Mean percentage of fungal infection in processed nuts and meteorological data during different months.

Month	Infection %	Range of temp. (°C) Max.	Min	Humidity % (range)	Total rainfall (mm)
October, 1969	61.5	26.0–35.0	19.1–22.3	56.8–91.4	156.8
November, 1969	52.8	31.0–34.5	15.4–32.6	46.9–87.7	54.4
December, 1969	43.8	31.0–35.0	12.7–22.9	49.6–86.8	0.0
January, 1970	31.5	31.4–35.8	14.9–18.6	38.2–85.7	0.0
February, 1970	21.0	32.5–36.5	16.0–20.9	48.1–91.9	0.0
March, 1970	25.7	33.8–37.8	19.1–24.1	50.7–90.2	1.2

It may be seen that the infection of processed arecanuts was highest during October–November (61.5 and 52.8% respectively) and gradually declined

to 21.0 per cent in February. However, there was a slight increase in infection in March (25.7%). In October and November, a total rainfall of 156.8 mm and 54.4 mm respectively, was received. Besides the temperature was low coupled with higher humidity which might be contributory causes for higher infection during October-November.

Stage of nut and infection: In order to find out at what stage the nuts contract fungal infection, nuts were harvested from ten palms at random at monthly intervals starting from button stage to the ripe stage. From each palm ten nuts were collected at random from the bunches. They were washed in distilled water to remove dirt and dust and cut into two halves with a sterile knife. The kernel was separated from the husk and both were cut into smaller bits for convenience. They were surface sterilised with 0.1 per cent mercuric chloride followed by rinsing in sterile water and then plated on oats agar medium in petri dishes. No fungus was found to emerge from the kernel. From the husk, however, the tissues at the stylar end alone showed occasionally *Gloeosporium* sp.

Source of infection: In order to study when and from where exactly the infection takes place, the following investigations were undertaken.

Ripe nuts were harvested without allowing them to fall on the ground, surface sterilised with formalin and dried in a hot air oven at 65°C for 63 hours. The nuts were then analysed as usual for fungal infection and they were absolutely free from fungal infection.

In another trial carried out in November, 1969, ripe nuts were harvested by the commercial method of harvesting, i. e., by dropping them on the ground below. The harvested nuts were divided into two equal lots. One lot was used for sun-drying in the drying yard as usual and the other lot dried in the mechanical drier at 60° to 62°C. The nuts were analysed for fungal infection. The mean percentage of infection of nuts dried on the mechanical drier was 3.6 as against 54.7 in the drving yard. Only *A. niger* was observed in nuts dried in mechanical drier whereas in nuts dried in the drying yard fungi like *A. flavus*, *B. theobromae*, *Rhizopus* sp. etc. were also observed in addition to *A. niger*.

An analysis of nuts kept on the drying yard during November-December 1969 for assessing the moisture loss and fungal infection showed that the mean percentage of infection on the 5th and 40th days was 28.3 and 42.6 respectively (Table 3). The corresponding values for moisture loss were 34.4 and 62.6 per cent respectively.

TABLE 3. Fungal infection and moisture loss in nuts up to 40th day of drying. (Mean of 10 lots each weighing 5 kg initially)

	Time interval in days								
	0	5	10	15	20	25	30	35	40
Weight of nuts (kg)	5.0	3.3	2.7	2.4	2.2	2.1	2.1	1.9	1.9
Moisture loss (%)	0.0	34.4	46.8	51.6	55.6	57.2	59.0	61.4	62.6
Infection (%)	0.0	28.3	34.6	†	39.8	†	41.2	†	42.6

† Infection was not recorded on 15th, 25th and 35th day.

Storage and infection: To find out the rate of increase in fungal infection in nuts under storage and its possible relationship with moisture content in nuts during storage, dried nuts were stored in (1) jute bags, (2) polythene-lined jute bags, (3) air tight bins provided with $CaCl_2$ at bottom and (4) farmer's store room (in jute bags). The nuts under treatments 1 to 3 were kept in a room provided with false ceiling with wooden planks, whereas the farmer's store room was provided with *Pukkah* ceiling without any ventilator. The data collected from May to September (which is the usual storing period) are given in Table 4.

TABLE 4. Per cent infection of nuts in storage and moisture content (%)

Treatment	May 1970		June 1970		July 1970		August 1970		Sep. 1970	
	Infection	Moisture	Infection	Moisture	Infection	Moisture	Infection	Moisture	Infection	Moisture
1. Jute bags	16.0	9.5	19.3	11.8	25.3	23.4	28.3	15.6	32.3	15.6
2. Polythene-lined jute bags	16.0	9.5	16.3	11.0	19.0	11.5	20.3	12.6	22.0	13.1
3. Air-tight bins	16.0	9.5	15.3	10.9	16.3	11.3	17.7	11.6	17.7	11.3
4. Farmer's method	21.7	8.9	22.3	11.3	26.0	12.7	28.7	13.5	30.0	14.3

It may be seen that least percentage of infection (upto 17.7%) was obtained in air-tight bins, where the moisture percentage was also lowest. Storing in polythene-lined jute bags was second best since the maximum infection

obtained was 22.0 per cent. The infection of nuts stored in plain jute bags increased from 16.0 to 32.3% with increase in moisture content from 9.5 to 15.6%.

Discussion

Though some studies have been made on the rotting of arecanut husk during transit (1,7), relatively little work has been done on the fungal infection of processed nuts. The present investigations showed that majority of infection in nuts occurred during initial days of drying itself. It was seen that loss of moisture in drying nuts was maximum during the first 5-10 days of drying, presumably from husk. Moisture loss from endosperm which is seated deep inside occurs slowly. These facts may induce the invading fungi to penetrate deep into the kernel from the husk in the initial days of drying itself. Moreover, the kernel which is rich in nutrients serves as a better substratum than husk for the growth of fungi.

The percentage of infection was found to vary in different months, maximum infection being in October-November. This may be attributed to to the low temperature coupled with the rains received during this period which might have created a congenial atmosphere for the development of fungi. On the other hand, in February-March the temperature was higher and there were no rains. The present studies show that the infection of processed nuts can be reduced considerably by quickened drying with mechanical drier at higher temperature. The infection was reduced to 3.6 per cent when dried in mechanical drier as against 54.7 per cent when sun-dried. When nuts were harvested eliminating soil contact and dried in air oven, they were completely free of fungal infection. These results show that there is a need for change in the approach to drying yard techniques and harvest methods in order to bring down the fungal infection of processed nuts. Sun-drying of nuts on cement floor, brick floor etc. where drying will be quicker may be thought of. This may help not only in quickened drying but also minimising contact with fungi.

Summary

Arecanuts (*Areca catechu* L.) are damaged by fungi during the course of processing on the drying yard or later in storage rendering the nuts unsuitable for chewing. The damage due to fungal infection in processed nuts was beyond 60 per cent. There was no incipient fungal infection at any stage of development of the nut. On the other hand the nuts contracted fungal infection from the soil at the time of harvesting and also from the drying yard. The majority of infection took place during the initial days of sun drying.

The percentage of infection differed in different months, maximum being in October-November and minimum in February-March. The extent of damage was dependent upon factors like temperature, humidity and rainfall. Maximum percentage of infection was caused by *Botryodiplodia theobromae* followed by *Aspergillus* sp. Fungal infection could be reduced by eliminating soil contact with the nuts at the time of harvest and also by drying in a mechanical drier. possibility of reducing fungal infection in nuts by drying on cement floor etc. where drying will be quicker is indicated. Storing nuts in jute bags lined with polythene was found to be better than jute bags alone in reducing fungal infection in storage.

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