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Storage mycoflora of oilseeds: a review

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Abstract
Present paper deals with the review of storage seed mycoflora

Keywords: Seed, seed borne-fungi, marathwada

INTRODUCTION

In Maharashtra state, oil seeds are cultivated in both Kharif and Rabbi seasons. Out of which groundnut (*Arachis hypogaea* L.), sunflower *(Helianthus annus* L.*),* safflower (*Carthamus tinctorius* L.), sesame (*Sesame indicum* L.) and soybean (*Glycin max* L.*)* are major oil seed crops. After harvesting seeds are stored in different storage conditions and if these storage conditions are not proper various microbes like viruses, bacteria, fungi and nematode are interacted with these seeds. Among these microbes, fungi play a dominant role in decreasing quality and longetivity of the seeds. Fungi cause various abnormalities to the seeds like discolored seeds, damaged seeds, shrunken seeds, undersized, rotted seeds and reduced in germinability. Fungal organisms plays significant role in infection, altering quality and longevity of seeds during the storage [1]. Such seeds are not fit for human consumption and rejected at industrial level. This ultimately affect on the yield and economy of the country. To facilitate the readers to look at their areas of interest more easily, the data in the present review have been organised in various sections as follows:

Groundnut (*Arachis hypogaea* L.)

Groundnut (*Arachis hypogaea* L.) is called as the 'King of oilseeds'. It is one of the most important food and cash crops of India in terms of production. India is the second largest producer of groundnuts after China. It accounted for 35.99 per cent of the oilseeds production of the country during 2007-08. Gujarat is the largest producer contributing 25 per cent of the total production followed by Tamil Nadu (22.48 per cent), Andhra Pradesh (18.81 per cent), Karnataka (12.64 per cent) and Maharashtra (10.09 per cent) during 2006-07. Groundnut contains on an average 40.1 per cent of fat and 25.3 per cent of protein and is a rich source of calcium, iron and vitamin B complex like thiamine, riboflavin, niacin and vitamin A. It is used not only as a major cooking medium for various food items but also for manufacture of soaps, cosmetics, shaving creams and lubricants. In fact, it plays a pivotal role in the oilseed economy of India. The major groundnut-producing countries of the world are India, China, Nigeria, Senegal, Sudan, Burma and the USA. Out of the total area of 18.9 million hectares and the total production of 17.8 million tonnes in the world, these countries account for 69% of the area and 70% of the production. India occupies the position, both in regard to the area and the production in the world. About 7.5 million hectares is put under it annually and the production is about 6 million tonnes. 70% of the area and 75% of the production are concentrated in the four states of Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka. The oil content of the seed varies from 44 to 50 per cent, depending on the varieties and agronomic conditions. Groundnut oil is edible oil. It finds extensive use as a cooking medium both as refined oil and Vanaspati Ghee. It is also used in soap making and manufacturing cosmetics and lubricants, olein, stearin and their salts. Kernels are also eaten raw, roasted or sweetened. They are rich in protein and vitamins A, B and some members of B_2 group. Their calorific value is 349 per 100 g. The residual oilcake contains 7 to 8 per cent of N, 1.5 per cent of P_2O_5 and 1.2 per cent of K_2O and is used as a fertilizer. It is an important protein supplement in cattle and poultry ratios. It is also consumed as confectionary product. The cake can be used for manufacturing artificial fibre. The haulms (plant stalks) are fed (green, dried or silaged) to livestock. Groundnut shell is used as fuel for manufacturing coarse boards, cork substitutes etc. Groundnut is also of value as rotation crop. Being a legume with root nodules, it can synthesise atmospheric nitrogen and therefore improve soil fertility.

Storage seed mycoflora

It is clear from the literature that during storage oilseeds increase in their mycoflora and its components were found to be variable with condition of storage. In this link, *Rhizopus* spp., *Penicillium* spp. and *Sclerotium bataticola* and *Fusarium* spp. were isolated from stored groundnut [2] while, same species except *Fusarium* and *Sclerotium bataticola* on groundnut seed were reported [3]. Hundred samples of groundnut seeds were screened [4]. Observations of these samples revealed that they were infected with various fungi viz., *Aspergillus* spp., *Rhizopus* sp., *Penicillium* spp., *Macrophomina* sp. and *Fusarium* sp. ranged from 0.0 to 100, 0.0 to 80, 0.0 to 20 and 0.0 to 15% respectively. On the other hand several fungi were isolated [5] apart from earlier workers. They detected *Alternaria alternata, Mucor* sp., *Chaetomium* sp., *Stemphylium* sp.,

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Fusarium solani, F. oxysporum, F. moniliforme from groundnut while, storage fungi like *Alternaria citri, Macrophomina phaseolina, Rhizoctonia solani, Fusarium solani, F. oxysporum*, *Aspergillus flavus* and *A. niger* were found predominant on groundnut [6].

Soybean (*Glycin max* L.)

Soybean [(*Glycin max* L.) Merrill] is cultivated as commercial crops and plays an important role in Indian economy. It is third important oilseed crop next to groundnut and mustard. Soybean is grown in almost all the parts and is third major oilseed crop of India [7]. In Maharashtra soybean crop is cultivated in both in Kharif and Rabbi seasons for its commercial importance. Popularity of this crop is due to abundance (43%) high quality protein and a rich source of oil with high unsaturated fatty acids and with no cholesterol [8]. Soybean is classified as "poor storer" as it looses viability drastically under warm and humid conditions. Under hot and humid storage conditions, oilseeds frequently become invaded by storage fungi [9; 10 and 11]. In the presence of seed-borne pathogens, several types of abnormalities occurred in the seed. Such seeds are rejected by seed industry and agriculture [12]. Fungi are the major cause of spoilage in stored grains and seeds in the technologically advanced countries, because insects and rodents are effectively controlled [13]. Investigations on soybean indicated the occurrence of large number of storage fungi in relation to storage period [14]. There are some reports, as soybean contains 20% oil, which boost the vigor of pathogenic fungi resulting in biodeterioration.

Storage seed mycoflora

Improper storage conditions make the soybean seed vulnarable to storage fungi. Several pathologists have reported the associated mycoflora of soybean during storage. Storage fungi like *Aspergillus niger, Curvularia lunata*, *Colletotrichum* sp., *Fusarium oxysporum, F. solani* and *Penicillium* sp. were found to be associated with soybean seeds [15]. Similarly, from sixteen varieties of soybean from different localities *Macrophomina phaseolina, Fusarium sp.* and *Aspergillus sp.* were dominantly occurred on soybean cultivars were reported [16] while, *Aspergillus flavus, A. amstelodami*, *A. sydowi*, *A. versicolor, A. niger* and *A. terreus* were isolated from soybean [17]. *Fusarium* spp. viz., *F. moniliforme, F. subglutinans, F. semitectum, F. proliferatum, F. clamydosporum, F. avenaceum* and *F. acuminatum* from 140 samples of stored sorghum were also recovered. Similar results were also reported [18]. Soybean cultivars were screened against different storage conditions, where they found that field fungi were replaced by storage fungi like, *Aspergillus, Penicillium, Rhizopus, Mucor* and *Chaetomium* etc. Similarly, *Aspergillus, Rhizopus, Penicillium, Curvularia, Fusarium, Alternaria* spp. were isolated from stored soybean seeds [19]. On the other hand, soybean cultivar was screened for seed mycoflora where only two species from *Aspergillus* genera viz., *Aspergillus flavus, A. niger* and *Alternaria alternata* were dominant [20]. Similarly, maize samples showed high incidence of *Fusarium moniliforme, Verticillium alboatrum, Trichoderma harzianum* and *Sclerotium rolfsii* [21]. Whereas, niger seeds were infected by *Aspergillus flavus, A. fumigatus, Alternaria alternata* and *Chaetomium* sp. [22].

Sunflower (*Helianthus annus* L.)
Storage seed mycoflora

Sunflower (*Helianthus annus* L.) is mainly grown for its oil. Sunflower was introduced in India as an oilseed crop for the first time in 1969. In 2008-09, world sunflower seed production was 33.3 million tons, around 8.5% of the total oilseeds production of world. European Union, Russia, Ukraine, Argentina, United States, China, India and Turkey are the major producers of sunflower seed in the world market. Country wise, usually production of Russia is the highest followed by Ukraine. EU-27 is considered as the largest producer of sunflower seed in world when the production of all its member states is put together. Sunflower oil is healthy and natural edible oil known for its light and odorless characters, rich in Vitamin E, sunflower oil is derived from sunflower seed carrying nearly 45-50% oil content. The protein content is around 25% and sunflower meal is used as a protein source in animal feed preparation. The oil is used for culinary purposes, in preparation of vanaspati ghee and in the manufacture of soaps and cosmetics. Sunflower oil is considered as healthy oil. It is especially recommended for heart patients. Its cake is rich in protein and is used as a cattle and poultry feed. Sunflower oil is the non-volatile oil expressed from sunflower seeds. Sunflower oil is commonly used in food as a frying medium.

Several workers putforth the list of storage fungi of sunflower. In this regard, sunflower seeds were screened to study the incidence of fungi which gave the occurrence of *Alternaria alternata*, *Aspergillus flavus, A. niger, Curvularia lunata, Fusarium moniliforme, Penicillium citrinum, Macrophomina phaseolina* and *Rhizopus nigricans* with sunflower seeds [23]. Same types of fungi including species of *Cladosporium* and *Drechslera* have been reported from sunflower seeds [24 & 25].

Sunflower seeds are highly contaminated with fungi which attack the plants at different stages of development and subsequently during harvesting and storage [26 & 27]. *Absidia corymbifera*, *Alternaria alternata*, *Aspergillus flavus*, *A. niger*, *A. terreus*, *Chaetomium bostrychodes, C. globosum*, *Emericella nidulans*, *Fusarium pallidoroseum, F. solani, Macrophomina phaseolina, Penicillium* spp., *Rhizoctonia solani* and *Rhizopus stolonifer* were predominantly isolated from sunflower [28]. Some other pathogenic fungi were also isolated such as *Curvularia lunata*, *Myrothecium roridum*, *Phoma oleracea* and *Verticillium dahliae* from sunflower seeds. Recently, 13 phytopathogenic fungal species including *Alternaria alternata, A. helianthi, Aspergillus flavus, A. fumigatus, A. niger, Curvularia lunata, Drechslera tetramera*, *Fusarium solani, F. moniliforme*, *Macrophomina phaseolina*, *Mucor mucedo, Penicillium* and *Rhizopus* spp. from stored sunflower varieties were isolated [29].

Safflower (*Carthamus tinctorius* L.)
Storage seed mycoflora

The important safflower (*Carthamus tinctorius* L.) growing countries, besides India are the USA, Mexico, Ethopia, Spain, USSR and Australia. In India, it occupies 590,000 hectares with a production of nearly 130,000 tonnes. Over 98% of the area is concentrated in the states of Maharashtra (04.4%), Karnataka (26.0%) and Andhra Pradesh (8.0%). The crop is now cultivated primarily for its seeds which yield oil, though at one time it used to be grown for the extraction of a dye also. The seeds are edible and are eaten after roasting. Their oil content varies from 24 to 36 per cent, depending on the variety, soil, climate and other conditions. The cold-pressed oil is golden yellow and is used for culinary purposes, or for making soap. The oil obtained by dry hot distillation is black

and sticky and is used only for greasing well ropes and leather goods exposed to water. Safflower oil has also good dying properties and therefore it is used in the manufacture of paints, varnishes and linoleum. It can be mixed with white paint without any after-yellowing effects. The cake, particularly from decorticated seed is used as a concentrated cattle feed and that from undecorticated seed is sometimes used as a manure.

During harvest infection was mostly included by the field fungi, including *Alternaria* sp., *Curvularia* sp. etc. Their number decreased gradually during storage, because they were replaced by storage fungi, mainly by different species of *Aspergillus* as found by earlier workers [30 & 31]. Same fungi including species of the genera *Fusarium, Phoma, Bipolaris* and *Colletotrichum* have been reported from grain mold [32]. From stored safflower, same fungi were confirmed where eleven fungal species were isolated from different genera i.e. *Alternaria, Curvulara, Fusarium, Rhizopus, Aspergillus, Chaetomium* and *Helminthosporium* from safflower [33].

Sesame (*Sesame indicum* L.)
Storage seed mycoflora

India, China, Sudan, Mexico, Turkey, Burma and Pakistan are the important sesame (*Sesame indicum* L.) producing countries. India ranks first, both in the area and production of sesame in the world. The annual area put under it in India is about 2-5 million hectares (45 per cent of the world hectarage) and the total production is nearly 52 thousand tonnes. Sesame is grown on 21 lakh hectares in only eight states, viz. Uttar Pradesh (673,000), Rajasthan (562,000), Madhya Pradesh (345,000), Andhra Pradesh (237,000) Maharashtra (139,000), Gujarat (118,000), Tamil Nadu (117,000) and Orissa (103,000. Among other states only Karnataka has a sizable area (68,000) under sesame. In the remaining states it is grown only on a small area and hence is a very minor crop there. The sesame seed is a rich source of edible oil. Its oil content generally varies from 46 to 52 per cent. Its grains may be eaten fried, mixed with sugar or in the form of sweet meats. Sesame oil is used as a cooking-oil in southern India. It is also used for anointing the body, for manufacturing perfumed oils and for medicinal purposes. Sesame-cake is a rich source of protein, carbohydrates and mineral nutrients, such as calcium and phosphorus. The cake is edible and is eaten avidly by working classes. It is also a valuable and nutritious feed for milch cattle.

Sesame seed is being attacked by several fungal pathogens; many of them are seed-borne [34]. Seed-borne pathogens like *Alternaria dianthicola, Aspergillus flavus, A. ustus* and *Macrophomina phaseolina* were detected on sesame [35]. *Alternaria sesami, A. sesamicola, A. tenuis* and *A. longissima* were detected in Korean seed samples of *Sesamum indicum* [36]. Similarly, *Aspergillus flavus, A. niger, Curvularia lunata, Fusarium moniliforme, Penicillium rubrum* and *Rhizopus nigricans* were isolated from sesame seeds [37] while, sesame seed were found to be only associated with *Penicillium citrinum* and *Fusarium* sp. [38]. On the other hand, *Cercospora sesami, Alternaria sesamicola, Curvularia lunata* and *Fusarium* spp. were reported from sesame [39]. From this literature survey it is clear that out of five oilseeds, lot of work have been done on isolation of soybean seed mycoflora.

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