

Kodo poisoning

and its management

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Kodo millet is a nutriceal, and staple food for many tribal and economically weaker sections in India. It is one of the hardiest crops, drought tolerant with high yield potential and excellent storage properties. But, its production and consumption are on the decline due to various factors. Kodo poisoning is one of the major factors impeding its consumption and this problem needs an immediate attention for effective management. The fear of kodo poisoning has emerged as a serious economic constraint for kodo millet cultivation, consumption and popularisation. This article would help in management of kodo poisoning thereby enabling its prevention, and enhancing the consumption and popularisation.

Keywords: *Aspergillus*, Cyclopiazonic acid, *Fusarium*, Kodua poisoning, Mycotoxin

MANY small grained annual grasses of the rainfed ecosystem, commonly referred as small millets are ancient grains, which fed the human population before wide spread adoption of fine cereals. Looking at the nutritional benefit of such grains along with other millets, they are collectively called nutri-cereals. Kodo millet (*Paspalum scrobiculatum*) is one such nutri-cereal grown on marginal and degraded lands producing high grain yields even with limited water. In India, it is grown largely in tribal regions and under poor environments, and finds place in the diet of poor people either as whole grains or in the preparation of traditional food products like idli, dosa, chapati, pongal, soup, etc. Apart from food uses, several medicinal properties of its grains as well as leaves are also known.

Despite all the beneficial properties, the kodo millet cultivation or consumption is limited by an enigma called kodo poisoning. Some early reports suggested that grains of kodo millet were poisonous and not fit for consumption based on a few poisoning incidences that had taken place in some of the kodo millet cultivating regions of North India, especially Uttar Pradesh and Madhya Pradesh. This had happened due to the consumption of kodo millet grains whose maturing and harvesting had coincided with rainfall, resulting in fungal infection of the grains leading to poisoned kodo locally known as Matawna kodoo or Matona kodo. Limited research studies on this aspect concluded that it was solely due to the contamination of the seeds with mycotoxin producing fungi belonging to *Aspergillus*

and *Penicillium* genus. The association of the mycotoxin, cyclopiazonic acid (CPA), with kodo millet seeds causing kodo poisoning was first identified during mid-80s and so far, no studies have shown kodo millet grains producing any inherent toxin naturally inside grain leading to poisoning. To enhance the consumption and production of kodo millet, the management strategies for prevention of kodo poisoning have been discussed in this article.

Management

In integrated management system, mycotoxins contamination should be minimized in every phase of production, harvesting, processing and distribution. Prevention through pre-harvest management is the best method for controlling mycotoxin contamination. Although, if contamination prevails, the risk associated with the toxins must be managed through post-harvest methods.

Pre-harvest management: Pre-harvest mitigating strategies include breeding for resistant cultivars. There have been several efforts to breed resistant cultivars for reduced mycotoxin contamination in several crops. In case of sorghum for management of grain mold disease complex, using host plant resistance was the major focus for development of less susceptible varieties and hybrids. In case of kodo millet, screening for mycotoxin (CPA) resistance needs to be initiated to manage the CPA contamination before harvest like in other crops. The common pre-harvest management practices for

mycotoxins in sorghum or maize or peanut are good crop management practices, such as crop rotation, timely planting and harvesting, adjusting the planting date to avoid end-of-season rains coinciding with the harvest time, maintaining the optimal plant population in the field, taking necessary precautions to control the pest and diseases of the crop by adopting pest management practices, harvesting the crop at right maturity (18–20% moisture in the grains) and avoiding over maturity of the crop. These cultural practices can very well be used in kodo millet for reducing or avoiding the contamination by CPA in the field.

Post-harvest management: Kodo poisoning can be minimized by employing proper post-harvest grain management practices. In the post-harvest control measures, drying, storage and processing are the significant aspects where contamination can be prevented in grains. Drying is an important step in ensuring good quality grain that is free of fungi and microorganisms. The harvested field crops should be dried as quickly as possible to recommended moisture levels of 10–13% for cereals. During storage, the moisture, temperature and relative humidity of the grains are the three main factors to be controlled to keep the growth of fungi in control. A relative humidity of 70% or less and grain moisture content of 12% or less will reduce the growth of storage molds and their toxins. Water activity of less than 0.7 will not favour any fungal growth/mycotoxin production in the grains. Proper drying of harvested kodo millet immediately and avoiding further moisture contact by storing in dry, air tight conditions can prevent the fungal contamination to a great extent.

Temperature is another key factor that prevents the growth of molds in the stored grains. Ideally, grain should be cooled after drying and maintained at 1–4°C for the duration of storage. At low or cold temperature, fungal contaminants are not killed, but their growth and metabolism are minimal. Levels of mycotoxins in contaminated commodities prior to consumption can be reduced by food processing methods such as wet and dry milling, grain cleaning, autoclaving, roasting, baking, frying, extrusion cooking, etc. It has been reported that in case of rainfall affected kodo millet, it was never eaten as flour but as rice and was well washed before being cooked which produced no bad effects.

To prevent poisoning, grains must be carefully removed from the glumes, lemma and palea or in other words milled before cooking. When different rice cooking methods used by Indians were compared, it was found that pressure cooking at 15 psi for 5 min gave maximum destruction (72%) of aflatoxin in comparison to the method of ordinary cooking (50%) and cooking with excess water (50%). Pressure cooking of rice not only destroyed the maximum amount of aflatoxins but also preserved nutrients in rice. These management practices can be effectively used for mitigating mycotoxin in different food grains. As CPA is also a secondary metabolite of *Aspergillus* and *Penicillium*, like aflatoxins, it may be presumed that similar practices can

be employed for reducing the CPA contamination in kodo millet.

Bio-management: Different microorganisms have been tested to limit fungal development and mycotoxin production as a possible alternative method. These microorganisms may control plant diseases through one or more mechanisms like induction of host resistance to the disease by production of antimicrobial compounds or direct antagonism to the pathogens and competition with pathogens for space and nutrients. Bio-control agents have been tested successfully as control agents for cereal diseases caused by *Fusarium* species. *Trichoderma* was found efficient in inhibition of mycotoxin production in rice by *Fusarium culmorum* and *F. graminearum*. Inhibition of 6 major rice fungal pathogens has been achieved by the use of *Streptomyces corchorusii* strain UCR3-16. In managing the grain mold pathogens in sorghum, *Trichoderma viride*, *T. harzianum* and *Pseudomonas* spp. showed promising results both at laboratory and field levels. As kodo poisoning is caused by different strains of *Aspergillus*, the above practices may be useful and can be practiced to reduce or minimize the contamination of mycotoxin, CPA.

Way forward

So far studies have been mainly concentrated on detecting the causal organism and its toxin, CPA. Though many other agricultural crops suffer from CPA contamination, major adverse effects have been recorded only in kodo millet because of lack of scientific management. Agro-climatic requirements of the crop, micro-climates surrounding seed, chemical composition of grain, husk and leaves are some of the aspects that should get immediate research attention to unveil the mystery of kodo poisoning. In addition to CPA, *Aspergillus* species also produces aflatoxin. Any synergistic effect of co-presence of CPA and aflatoxins on kodo millet needs further investigation. Efforts should also be made to examine all parts of the plant including green leaves, grain with husk, dehulled grain and fodder for finding out if traces of CPA occur naturally in the crop.

SUMMARY

To reduce the risk of CPA contamination, integrated management system needs to be adopted for kodo millet and utmost care should be taken at every stage of the crop (pre-harvest to processing) to limit poisoning. Pre-harvest management of mycotoxin contamination is vital to harvest clean grains and to maintain contamination levels near to zero. Breeding for cultivars or traits showing resistance to fungal infection and use of antifungal crop protection chemical agents that are non-toxic to human beings are important measures that can be thought of to nullify kodo millet poisoning and popularising the crop.

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