Evaluation of Seed Health Status of Some Selected Podded and Root Vegetables in Bangladesh

Abstract

Evaluating the seed health status of selected vegetables in Bangladesh is crucial for sustainable agriculture and food security, as seed-borne pathogens can significantly reduce crop yield and quality. Identifying and mitigating these pathogens at the seed level helps prevent their spread, protect genetic resources, and reduce reliance on chemical interventions. It provides valuable insights into pathogen prevalence and diversity, supporting the development of effective management strategies for healthier crop production. The seed health status of podded vegetable crops, such as yard long beans and country beans, and root vegetables, including bottle gourds, sweet gourds, and sponge gourds, was examined in 2015 at the Seed Health Laboratory (SHL) of Sher-e-Bangla Agricultural University. Loose seeds from each crop were collected from various wholesale seed markets in Dhaka. Two seed health assessment methods recommended by ISTA were employed: dry seed examination and the blotter method. The prevalence of seed-borne fungi varied significantly across different vegetable seeds, depending on the seed category and source. Six seed-borne fungi were identified in the examined seeds of three vegetable crop groups: *Rhizopus* spp., *Aspergillus niger*, *Aspergillus flavus*, *Fusarium* sp., *Chaetomium* sp., and *Alternaria* spp. All six fungi were detected in the seeds of podded vegetables, while five were found in the seeds of leafy vegetables. Using the blotter method, seeds from Alo Bij Vander exhibited the highest level of fungal infection, whereas seeds from Bismillah Seed Store showed the lowest level. Among the crops, radish seeds displayed the highest frequency of seed-borne fungi, while yard long beans had the lowest. Based on the findings, it was evident that the health condition of loose vegetable seeds was substandard. However, further research with more representative seed samples from various markets across Bangladesh is necessary to provide a comprehensive understanding of seed health in relation to different seed sources.

Keywords: *Seed health, podded vegetables, root vegetables, mitigating, radish seeds*

1. Introduction

In Bangladesh, vegetables represent a promising and vital category of crops due to their quick production cycle, high nutritional value, and low production costs. Among agricultural inputs, seeds are the most critical factor influencing crop yield. Ensuring the availability of healthy, high-quality seeds is therefore of paramount importance. Pathogen-free or healthy seeds are considered essential for optimal plant growth and maximum yield. The health of seeds can be affected by pathogens in several ways: through direct infection, contamination with pathogenic propagules on or within the seeds, or concurrent contamination [1]. Pathogenic propagules can hinder seed germination, leading to seedling infections and subsequent disease development in later plant stages. This makes the presence of pathogens in seed lots a significant concern. As a result, high-quality, disease-free seeds are deemed indispensable for successful crop production. Vegetable seeds, in particular, are prone to rapid degradation during storage and are highly susceptible to disease attacks. For a crop to be healthy, the seeds must meet critical quality criteria: they should be pure, viable, and in excellent condition. Studies suggest that under consistent production conditions, using high-quality seeds can increase vegetable yields by as much as 30% [2].

In Bangladesh, only about 10% of the seeds used for agricultural production are supplied by government or semi-government organizations. The remaining 90% of the nation's seed requirements are met by farmers' own seed stocks, which often fail to meet necessary quality and health standards. One of the most significant challenges to achieving sustainable agricultural production is the widespread use of unhealthy, low-quality seeds, coupled with the effects of seed-borne diseases [3]. It is estimated that in Bangladesh, 2–3% of the total seeds stored annually are lost to rot caused by bacteria and fungi, leading to an economic loss of approximately Taka 430 million [4]. Currently, over 100 different crops are cultivated in the country, and these are susceptible to more than 500 diseases. Many of these major diseases—affecting key crops such as rice, wheat, maize, jute, sugarcane, cotton, potato, tomato, okra, mustard, beans, peanuts,

sesame, black gram, and chickpeas—are predominantly seed-borne and seed-transmitted. These diseases result in an annual yield loss valued at approximately $250 million USD [5].

In Bangladesh, the widespread cultivation of vegetables, including podded and root varieties such as beans, peanuts, and sesame, plays a vital role in the nation's agricultural economy, nutrition, and food security. Beans are an important source of plant-based protein, essential amino acids, and micronutrients, contributing to improved dietary diversity and addressing malnutrition in both rural and urban populations. Peanuts are another key crop, providing not only high levels of healthy fats and proteins but also serving as a raw material for various food and industrial products, including oil and animal feed, which bolster the agricultural economy. Sesame, known for its oil-rich seeds, holds a significant place in Bangladesh's crop production due to its high market value and demand in both domestic and international markets.

Despite their importance, the production of these crops is severely threatened by seed-borne diseases, which compromise yield and quality, directly impacting farmers' income and the national economy. With over 90% of seeds sourced from farmers' own stocks, the unchecked circulation of low-quality, pathogen-infested seeds exacerbates these challenges, leading to recurrent crop losses. Such losses further strain the livelihoods of smallholder farmers, who make up the backbone of Bangladesh's agricultural sector. Addressing seed health issues is critical to enhancing productivity and ensuring the sustainability of these crops, which collectively contribute to national economic growth, food security, and export potential.

Furthermore, the adoption of improved seed health practices can increase the resilience of these crops to diseases, reducing the reliance on chemical pesticides and promoting environmentally friendly farming practices. Ensuring healthy seeds can also help meet the growing demand for these crops, both locally and globally, while boosting their nutritional and economic contributions. Investing in research and interventions to improve seed health will not only enhance the yield and profitability of crops like beans, peanuts,

and sesame but also strengthen Bangladesh's position in the competitive agricultural markets.

To assess seed health, a variety of techniques are employed, including dry seed examination, blotter testing under incubation, agar plate testing, water agar plate testing, deep-freezing blotter testing, and symptom-based seedling testing. Additional methods include microscopic observation of suspensions (e.g., washing tests), whole embryo count techniques, growing-on tests, indicator plant tests, and serological tests, among others. The present study aims to evaluate the quality and health status of loose podded and root vegetable seeds collected from the wholesale markets in Dhaka, Bangladesh. Specifically, the objectives are to identify the prevalence of seed-borne fungi associated with loose seeds of selected vegetables and to assess the overall seed health status of various vegetable crops.

2. Materials and Methods

2.1. Experiment site

Loose seeds of each crop were collected from various sources within the wholesale seed markets in Dhaka. The experiments were carried out at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), located in Sher-e-Bangla Nagar, Dhaka-1207. The study was conducted over a period spanning from November 2014 to April 2015.

2.2. Collection of seeds

Loose seeds from two different categories of vegetables (podded and root) were collected from three shops located in Siddik Bazar, Dhaka. The seeds for each crop were sourced from Mithila Seed Enterprise, Alo Bij Vander, and Bismillah Seed Store.

2.3. Vegetable Categories

Seeds from two different categories of vegetables were analyzed to assess their health and quality. The categories included:

i) Podded vegetables**:** Country bean and yard long bean

ii) Root vegetable**:** Radish

2.4. Detection and identification of seed borne pathogens

Two seed health testing methods, namely dry seed inspection and the blotter method, were employed to detect seed-borne pathogens in the selected vegetable seeds.

2.4.1. Inspection of dry seeds

The seeds were visually inspected, and the sample was divided into three components: pure seed**,** seeds of other crops, and inert matter**.** According to the International Rules for Seed Testing (1999), inert matter includes soil, sand, stones, various types of plant debris, sclerotia, and smut or bunt balls of fungi. Although categorized as “inert” in these rules, such materials often carry viable and infective fungal structures that are pathologically significant.

2.4. 2. Blotter method

A working sample of 400 seeds was subjected to the blotter test to detect seed-borne fungi, following the International Rules for Seed Testing [6]. In this method, sterilized plastic Petri dishes (9 cm in diameter) and Whatman No. 1 filter paper were used. The Petri dishes containing treated seeds were incubated in the laboratory at a temperature of 22°C for 7 days. During incubation, the seeds were exposed to an alternating cycle of 12 hours of near-ultraviolet (NUV) light and 12 hours of fluorescent daylight.

2.5. Design of experiments and Statistical Analysis

A Completely Randomized Design (CRD) was used for this experiment with four replications. Data were analyzed using the MSTAT-C computer package program. The level of significance and analysis of variance (ANOVA) were performed following the methods outlined by Gomez and Gomez [7], and treatment means were compared using Duncan’s Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Seed health status of podded vegetables

Fungi were detected in the podded vegetable seeds collected from various seed shops in Siddik Bazar, Dhaka, and the results are presented in tables, plates, and figures. The podded vegetables studied include country bean and yard long bean. The prevalence of seed-borne fungal infections varied depending on the vegetable seeds, with different levels of fungal presence observed in each type of seed.

3.1.1. Seed health study of Country bean (*Phaseolus vulgaris*)

3.1.1.1 Health status of country bean seed by inspection of dry seed

Hollow and discoloration of seeds were observed in seeds collected from Mithila Seed Enterprise, while shriveling was noted in seeds from Alo Bij Vander. Reduced seed size was observed in seeds from Bismillah Seed Store (Table 1). Black dots were present on the seeds collected from Mithila Seed Enterprise and Alo Bij Vander, but fruiting structures were absent on the seeds collected from Bismillah Seed Store (Table 1).

For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, out of 40.0 grams, 36.0 grams (90.0%) were pure seeds, while 4.0 grams (10.0%) were inert matter, and no other seeds were present (0%). From Bismillah Seed Store, the pure seeds accounted for 38.0 grams (95.0%), inert matter was 2.0 grams (5.0%), and no other seeds were detected (0%). Similarly, seeds collected from Alo Bij Vander contained 34.0 grams (95.0%) of pure seeds, 2.0 grams (5.0%) of inert matter, and no other seeds were present (Table 1).

Table 1. Health status of country bean seed by inspection of dry seed

Name of seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	36	90	4	10	0	0	Black dots	Hollow and discoloration of seeds
Alo Bij Vander	40	34	85	6	15	0	0	Black dots	Shrivelling of seeds
Bismillah Seed Store	40	38	95	2	5	0	0	-	Reduction of seeds

3.1.1.2. Prevalence of seed-borne fungi of Country bean identified by blotter method

The incidence of *Aspergillus niger* ranged from 6.0% to 7.0%. The highest incidence (7.0%) was observed in seeds collected from Bismillah Seed Store, which was similar to seeds collected from Mithila Seed Enterprise. The lowest incidence (6.0%) was found in seeds collected from Alo Bij Vander. The incidence of *Aspergillus flavus* ranged from 7.5% to 8.5%. The highest incidence (8.5%) was observed in seeds from Alo Bij Vander, which was identical to seeds from Mithila Seed Enterprise. The lowest incidence (7.5%) was observed in seeds from Bismillah Seed Store (Table 2). The incidence of *Alternaria* sp. ranged from 2.0% to 3.0%. The highest incidence (3.0%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in seeds from Mithila Seed Enterprise. The lowest incidence (2.0%) was observed in seeds collected from Bismillah Seed Store (Table 2). Among the sources, no statistically significant differences were observed for seed-borne infections of *Rhizopus* spp. *Fusarium* sp. and *Chaetomium* sp.

Table 2. Prevalence of seed-borne fungi of country bean identified by blotter method.

Seed sources	Seed borne infection (%)							Total seed borne fungal infections (%)
	***Rhizopus* spp.**	***Aspergillus niger***	***Aspergillus flavus***	***Fusarium* sp.**	***Chaetomium* spp.**	***Alternaria* spp.**	***Unidentified bacterium***	
Mithila Seed Enterprise	2.5	6.5ab	8.0a	2.0	1.0	2.5a	2.0	24.5
Alo Bij Vander	2.5	6.0b	8.5a	2.0	1.0	3.0a	2.0	25.0
Bismillah Seed Store	2.5	7.0a	7.5b	2.0	1.0	2.0b	2.0	24.0
LSD 0.5	-	0.923		-	-	0.385	-	-
Level of significant	NS	*	*	NS	NS	*	NS	-
CV%	-	11.79	14.45	-	-	6.28		

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

3.1.2. Yard long bean (*Vigna ungulculata*)

3.1.2.1 Health status of Yard long bean seed by inspection of dry seed method

Deformed seeds were observed in seeds collected from Mithila Seed Enterprise, while wounds were noted on seeds collected from both Alo Bij Vander and Bismillah Seed Store (Table 3). Black dots were present on seeds from Mithila Seed Enterprise, cottony structures were found on seeds from Alo Bij Vander, and no fruiting structures were observed on seeds from Bismillah Seed Store (Table 3). For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, 37.0 grams (92.5%) were pure seeds, 2.7 grams (6.75%) were inert matter, and 0.3 grams (0.75%) were other seeds. For seeds from Bismillah Seed Store, the pure seeds accounted for 38.0 grams (95.0%), inert matter was 1.7 grams (4.25%), and 0.3 grams (0.75%) were other seeds. Similarly, seeds from Alo Bij Vander contained 36.0 grams (90.0%) of pure seeds, 3.7 grams (9.25%) of inert matter, and 0.3 grams (0.5%) of other seeds (Table 3).

Table 3. Health status of yard long bean seed by inspection of dry seed

Seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	37	92.5	2.7	6.75	0.3	0.75	Black dots	Deformed seed
Alo Bij Vander	40	36	90	3.7	9.25	0.3	0.75	Cottony structure	Wounded seed
Bismillah Seed Store	40	38	95	1.7	4.25	0.3	0.75	-	Wounded seed

3.1.2.2 Prevalence of seed-borne fungi of yard long bean identified by Blotter method

The incidence of *Aspergillus flavus* ranged from 8.0% to 9.0% (Table 4). The highest incidence (9.0%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in seeds from Mithila Seed Enterprise. The lowest incidence (8.5%) was observed in seeds collected from Bismillah Seed Store. Among the samples, no

statistically significant differences were observed for seed-borne infections of *Rhizopus* spp., *Aspergillus niger*, *Fusarium* sp., and *Chaetomium* spp.

Table 4. Prevalence of seed-borne fungi of yard long bean identified by Blotter method.

Sources name	Seed borne infection (%)					Total seed borne fungal infections (%)
	***Rhizopus* spp.**	***Aspergillus niger***	***Aspergillus flavus***	***Fusarium* sp.**	***Chaetomium* spp.**	
Mithila Seed Enterprise	3.0	4.0	8.5ab	3.5	4.0	23%
Alo Bij Vander	2.5	4.0	9.0a	3.5	4.0	23%
Bismillah Seed Store	3.5	4.0	8.0b	3.5	4.0	23%
LSD 0.5	0.923	-	0.753	-	-	
Level of significance	NS	NS	*	NS	NS	
CV%	19.20	-	5.55	-	-	

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

3.1.2.3. Total seed borne fungal infections (%) of podded vegetables of different seed sources

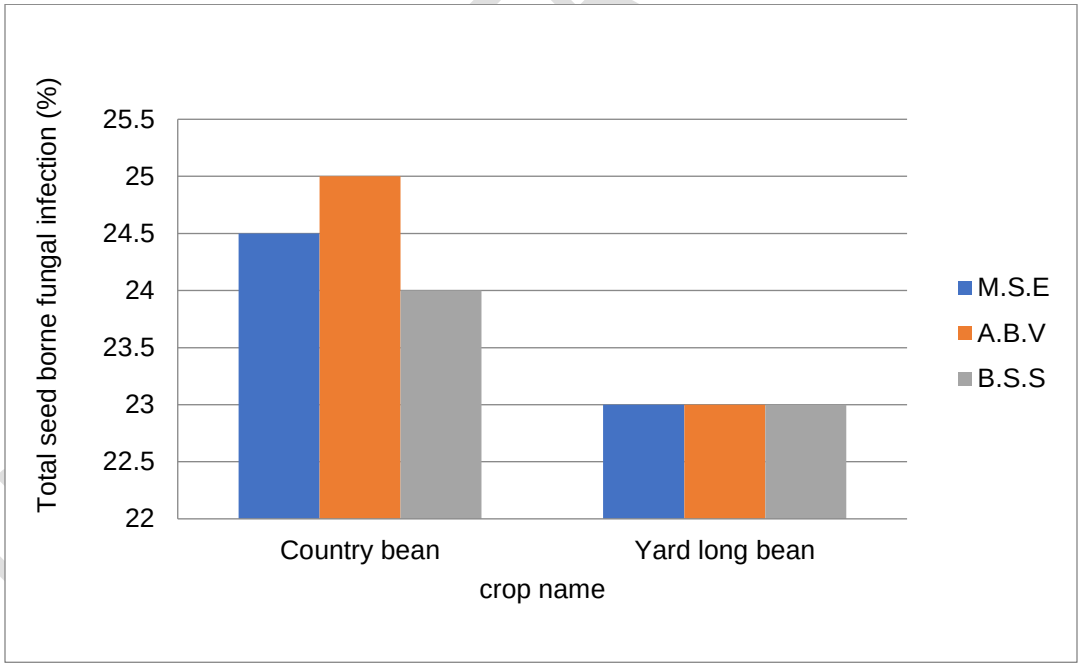

Figure 1. Total seed borne fungal infections (%) of podded vegetables of different seed sources

Here, M.S.E- Seed collected from Mithila Seed Enterprise, A.B.V- Seed collected from Alo Bij Vander, B.S.S- Seed collected from Bismillah Seed Store

The present study indicated that, in all cases, seeds from Alo Bij Vander exhibited the highest level of seed-borne fungal infection for country bean (25%). Bismillah Seed Store showed the lowest level of seed-borne fungal infection for both country bean and yard long beans. Seeds from Mithila Seed Enterprise exhibited a medium level of seed-borne fungal infection for country bean. For yard long beans, all seed sources showed similar results (Figure 1).

3.2. Seed health status of root vegetables

3.2.1. Radish (*Raphanus sativus*)

3.2.1.1. Health status of bottle gourd seed by inspection of dry seed

Wounded seeds were observed in seeds collected from Mithila Seed Enterprise, while both wounded and deformed seeds were found in seeds collected from Alo Bij Vander. Broken seeds were also observed in seeds collected from Bismillah Seed Store (Table 5). Bacterial ooze was noted in seeds collected from Mithila Seed Enterprise, cottony structures were found in seeds collected from Alo Bij Vander, and black dots were observed in seeds collected from Bismillah Seed Store (Table 5). For purity analysis, 40.0 grams of seeds from each sample were visually inspected. In the case of seeds from Mithila Seed Enterprise, 39.2 grams (98%) were pure seeds, 0.6 grams (1.5%) were inert matter, and 0.2 grams (0.5%) were other seeds. For seeds from Bismillah Seed Store, the pure seeds accounted for 39.4 grams (98.5%), inert matter was 0.4 grams (2.5%), and 0.2 grams (0.5%) were other seeds. Similarly, seeds from Alo Bij Vander contained 39.0 grams (97.5%) of pure seeds, 0.4 grams (1%) of inert matter, and 0.2 grams (0.5%) of other seeds (Table 5).

Table 5. Health status of radish seed by inspection of dry seed

Seed sources	Total weight (g)	Pure seeds (g)	Pure seeds (%)	Inert materials (g)	Inert materials (%)	Other seeds (g)	Other seeds (%)	Fruiting structures	Physical Abnormalities of seed
Mithila Seed Enterprise	40	39.2	98	0.6	1.5	0.2	0.5	Bacterial ooze	Wounded and shirked of seed
Alo Bij Vander	40	39.0	97.5	0.8	2	0.2	0.5	Cottony struck	Wounded and deformed of seeds
Bismillah Seed Store	40	39.4	98.5	0.4	1	0.2	0.5	Black dots	Broken seed

3.2.1.2 Prevalence of seed-borne fungi of radish identified by Blotter method

The incidence of *Rhizopus* spp. ranged from 3.5% to 4.5%. The highest incidence (4.5%) was observed in seeds collected from Alo Bij Vander, which was similar to the incidence in seeds from Mithila Seed Enterprise. The lowest incidence (3.5%) was observed in seeds collected from Bismillah Seed Store (Table 6). The incidence of *Aspergillus niger* ranged from 4.5% to 5.5%. The highest incidence (5.5%) was observed in seeds collected from Alo Bij Vander, which was similar to the seeds collected from Mithila Seed Enterprise. The lowest incidence (4.5%) was observed in seeds collected from Bismillah Seed Store. Among the samples, there was no significant difference observed for seed-borne infections of *Aspergillus flavus*, *Fusarium* sp., and *Chaetomium* spp.

Table 6. Prevalance of seed-borne fungi of radish identified by blotter method

Seed sources	Seed borne infection (%)					Total seed borne fungal infections (%)
	***Rhizopus* spp.**	***Aspergillus niger***	***Aspergillus flavus***	***Fusarium* sp.**	***Chaetomium* sp.**	
Mithila Seed Enterprise	4.0ab	5.0ab	9.5	4.5	5.0	28.00
Alo Bij Vander	4.5a	5.5a	9.5	4.5	5.0	29.00
Bismillah Seed Store	3.5b	4.5b	9.5	4.5	5.0	27.00
LSD 0.05	0.923	0.653	-	-	-	
Level of Significance	**	*	NS	NS	NS	
CV%	14.43	8.16	-	-	-	

*, **Significant at 5% and 1% level of significance respectively; NS = non- significant

Researchers worldwide have observed similar types of pathogen infestations in seeds. For example, studies on the major seed-borne fungi associated with common bean (*Phaseolus vulgaris* L.) seeds were conducted in several bean-growing regions of Ethiopia by [8]. The primary seed-borne fungi identified were *Ascochyta phaseolorum*, *Phaeoisariopsis griseola*, and *Colletotrichum lindemuthianum*. Contaminated seeds were identified as the main source of bean anthracnose infection in the field, as the disease only survived in infected seeds and not in the soil. For *Phaseolus vulgaris* seeds, fungal variability includes pathogens like *Alternaria*, *Colletotrichum*, and *Fusarium* species. These fungi can lead to seed decay, reduced germination, and plant diseases, affecting overall crop yield [9]. The genetic diversity of these fungi makes it difficult to develop universal control methods, necessitating ongoing research and development of new strategies. Seed treatments, crop rotation, and resistant varieties are some of the approaches used to manage fungal infections in common beans. Beans are also highly susceptible to seed-borne fungi, including *Colletotrichum lindemuthianum* (causing anthracnose), *Fusarium spp*., *Rhizoctonia solani*, and *Aspergillus niger*. The pathogenic variability. This variability necessitates regular monitoring and the development of resistant bean varieties.

Furthermore, Alves et al. [10] isolated *Colletotrichum gossypii* var. *cephalosporioides*, *Colletotrichum truncatum*, and *Colletotrichum lindemuthianum* from common bean seeds (*Phaseolus vulgaris* L.) using the water restriction technique. The blotter test results also revealed the presence of *Fusarium* spp., *C. gossypii* var. *cephalosporioides*, *C. truncatum*, and *C. lindemuthianum* on the surface of inoculated seeds. In *Vigna unguiculata* seeds, fungal variability is also a major concern, with species such as *Aspergillus*, *Fusarium*, and *Macrosphomina* being prevalent. These fungi can cause seed discoloration, reduced germination rates, and seedling blights. The diversity of fungal species and their ability to produce mycotoxins pose significant challenges for seed health management. Research has shown that seed treatments and proper storage conditions can help mitigate fungal infections, but the variability among fungal species requires tailored approaches for effective control [11]. The variability of fungi in *Raphanus sativus* seeds is significant, with common pathogens including *Alternaria, Aspergillus*, and *Fusarium* species. These fungi can cause seed rot, damping-off, and root diseases, impacting seed germination and plant health [12]. Studies have shown that seed treatment with fungicides can reduce fungal infection rates, but the effectiveness varies among different fungal species. The genetic diversity of these fungi contributes to their adaptability and resistance to control measures [13]. Understanding the variability of these fungi is crucial for developing effective seed treatment strategies and ensuring healthy radish crops. In the current investigation, similar seed-borne fungal infections were observed in podded vegetable seeds, including cabbage, Indian cabbage, spinach, Indian spinach, and red amaranth. Seeds from different seed shops in Mymensingh tested positive for various fungal species such as *Alternaria spp.*, *Curvularia* spp., *Fusarium* spp., *Aspergillus niger*, *Phoma* spp., *Penicillium* spp., and *Rhizopus* spp. [2].

Conclusion

Six different types of seed-borne fungi were identified from the seeds of three vegetable crops: *Rhizopus* spp., *Aspergillus niger*, *Aspergillus flavus, Fusarium* sp., *Chaetomium* sp., and *Alternaria* spp. Of these, six fungi were found in the seeds of pod vegetables, while only five were detected in the seeds of root vegetables, specifically radish. According to the results of the blotter test, the seeds collected from Alo Bij Vander

exhibited the highest frequency of seed-borne fungal infections, while those from Bismillah Seed Store had the lowest. Radish seeds showed the highest frequency of seed-borne fungi, whereas yard long beans had the lowest. Further studies with a broader range of seed samples from various markets in Dhaka are needed to fully understand the impact of different seed sources on seed health.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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