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Variation in Resistance to Fungal Attack among Tomato (*Solanumlycopersicum*) Fruits Varieties Sold in Gombe Metropolis, Nigeria

Sani Sale[a]*, Muhammad Auwal Sadiq[b], Halima Mohammed Abba[c], Muhammad Ahmad[d] and Usman Abubakar Yuguda[e]

[a,b,c,d,e]*Department of Biological Sciences, Gombe State University, P.M.B. 127, Gombe, Nigeria*

[a]*Email: sanisale20@yahoo.com,* [b]*Email: sadiqauwal65@gmail.com*

[c]*Email: halimamohammedabba77@gmail.com,* [d]*Email: Muhammadforall99@gmail.com,*

[e]*Email: yugudausman@gmail.com*

Abstract

Tomato is one of the major commercially cultivated fruits vegetable that is widely consumed both as fresh fruits and for making soup. Paradox to its importance and value, tomato spoils very fast after harvest due to its limited shelf life. This, in most cases, leads to huge loses both for farmers and marketers. Consequently, this research aimed at investigating the variation in resistance to fungal spoilage between local and improved varieties of tomatoes. A total of eighty (80) fresh tomato fruits of two varieties, improved (UTC) and local (Siriya), were bought from Gombe main market and allowed to deteriorate under room temperature and used in this study. A diseased portion of the infected tissue of each of the samples was cut and inoculated in petri dish containing Potato Dextrose Agar, and incubated at room temperature for 10 days. The growths were sub-cultured and viewed under mcroscope. The results showed that *Aspergillus niger*, *Candida albicans*, *Aspergillusfumigatus*, *Rhizopus stolonifer*,and *Fusarium oxysperum* were associated with tomato spoilage, with the frequencies of occurrence of 26, 6, 4, 2, and 4 in Siria; 13, 7, 2, 3 and 0 in UTC respectively. Pathogenicity test revealed that all fungi isolated were pathogenic and contributed to tomato spoilage. However, Siriya variety was observed to be susceptible to all the pathogens, whereas UTC showed some degree of resistance.This indicated that UTC might be better for farmers as well as marketers in terms of harvest and shelf life.

Keywords: Tomato; fungi; spoilage; variety; resistance.

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* Corresponding author.

1. Introduction

Tomato, *Solanumlycopersicum* L, is a cultivated member of a large and diverse genus *Solanum* of the derived *Asterid* family *Solanaceae* [1]. It have its origin in South America where it was growing in the wild. It was then taken to other part of the world by the explorers [2] as ornamental curiosities before its usability as edible plants was uncovered. After the discovery of its immense nutritional and medicinal importance [3], today tomato has become an important and popular horticultural and industrial commodity [4], ranking second in the global horticultural produce after potato [5].

Tomatoes are a good sources of ions, fibers and dietary supplements. They are rich in potassium, folate, vitamins A, C, and E [6]. They are superior source of vitamin A, second to carrots among the regularly consumed vegetables. Furthermore, tomatoes contain valuable phytochemicals such carotenoids, phytoene and phytofluene [7]. Studies have shown that these phytochemicals are effective in reducing prostate cancer [8] and lower risk for developing cardiovascular diseases [9,10].

There was increase in the global production of tomatoes in recent times largely due to introduction of high yielding and more desirable varieties of tomatoes through breeding activities; and also due to advent of mechanized agricultural process [5]. Today, countless varieties of tomatoes have been bred and are consumed all over the globe in different recipes. In Africa, the total tomato production was 17.938 million tons in 2012, with Egypt being the highest producer with 8.625 million tons followed by Nigeria with 1.56 million tons [11].

Tomato has the tendency of improving the lives of small scale rural farmers in most developing countries of the world. Besides its numerous health benefits, tomato can serve as a source of income for farmers as a result of its numerous uses. The tomato industry can increase the foreign exports earning of many African countries like Nigeria thereby contributing to GDP [12,13].

Despite the economic potentials of tomato, a lot of problems are associated with its production which mostly lead to loses [14]. Such problems include lack of irrigation system [12], pests and diseases [15], lack of postharvest handling practices and treatments that would prolong the otherwise short shelf life [16] among others. This could results to up to 50% losses of the entire harvest [17,18]. Losses accrued in tomato is mostly due to incidental spoilage of fruits in the value chains cause by myriad of pathogens such as fungi. High levels of sugars and nutrients element and low pH value of tomato make them particularly desirable to fungal decayed [19]. In addition to increase in losses, the occurrence of fungal spoilage may constitutes a potential health hazard to consumers due to production of mycotoxins by the fungi [20]. To reduce the problem of loses as well as health hazard due to fungal spoilage, there is need to grow tomato varieties that are resistant to fungal spoilage. Consequently, this research seek to assess the variation in resistance to fungal spoilage between commonly grown tomato varieties in Gombe metropolis.

2. Materials and Methods

2.1 Study area

The research was conducted in Biological Sciences laboratory, Gombe State University, Gombe State, Nigeria.

2.2 Sample collection

A total of eighty (80) fresh tomato fruits of two varieties, improved (UTC) and local (Siriya), were obtained from Gombe Main Market and transported to the laboratory for this studies.

2.3 Preparation of culture medium

Potato dextrose agar (PDA) was prepared using manufacturer's instruction and used for the isolation of fungi from the spoilt tomato fruits and for the preparation of pure cultures. Thirty-nine (39) grams of PDA powder was dissolved in 1000ml of distilled water in a beaker and placed in sterile conical flask covered with cotton wool and aluminium foil paper. It was then sterilized in autoclave at 121^0C for 15 minutes. The medium was cooled after autoclaving to 50^0C and then dispense aseptically into sterile petri dishes. Chloramphenicol (0.5%w/v) was added to the medium to inhibit growth of bacteria.

2.4 Isolation of fungi

To isolate the fungal species, the fruits were allowed to spoil under the shade at room temperature. The rotten part of the fruits was cut with sterile scissors into smaller portions. The cut portions were disinfected with 75% ethanol for 2 min, rinsed in three different changes of distilled water, and then each inoculated in PDA plates. Fifty percent (50%) lactic acid was added to support the growth of fungi at room temperature for 10 days [21].

To obtain pure isolates of fungi, colonies were picked with inoculating needle and place into fresh PDA plates [22].

2.5 Identification of fungal Isolates

To identify the fungal isolates, documented keys were used [23]. Macro-morphological characteristics (colony morphology, colour, shape and appearance) were observed under compound microscope at magnification of 10X and 40X and recorded. For micro-morphological characteristics, a drop of Lactophenol cotton blue stain was placed on a clean slide and, with the aid of inoculating needle, a small portion of the mycelium from the fungal cultures was collected and placed in the drop of the stain. The mycelium was spread very well on the slide and then covered with cover slip. This was allowed to stay for 15 seconds before observing under the microscope [24,25]. Conidia shape, hyphae colour, septation and pigmentation were observed and recorded.

2.6 Pathogenicity test

To find the specific effects of each fungal isolate, pathogenicity test was carried out as described by [26] and [27]. Clean mature healthy fruits were washed with distilled water and surface sterilized with 75% ethanol. A hole was made with a 3mm cork borer on each of the fruit. A colony of fungi isolate (from each pure culture) was inoculated into the hole and the point of inoculation was sealed with petroleum jelly to prevent

contamination [28]. Control fruits were wounded but not inoculated.

They were then placed in clean polyethylene bag (one fruit per bag) and moistened with wet balls of absorbent cotton wool to create a humid environment and incubated at room temperature for 4 days. The level of spoilage of each isolate across the two varieties was observed and recorded.

3. Results

Results of this study revealed five (5) species of fungi associated with tomato fruits spoilage. They include *Aspergillusniger*,*Candida albicans*, *Fusariumoxyspernums*, *Aspergillusfumigatus*and *Rhizopusstolonifer*as shown in Table below.

Table 1: Identification of fungi isolated from tomatoes

Fungal isolate	Macroscopic morphology	Microscopic morphology
Aspergillusniger	The surface of the colony is green while the reverse Side is black. It showed fast Growth	Conidial heads are large, globose, dark brown, becoming radiate and tending to split into several loose columns with age.
Candida albicans	Colonies white to cream-coloured smooth, glabrous yeast-like	Spherical to subspherical budding blastoconidia
Fusariuoxysperum	Colonies growing rapidly, whitish pink pigmentation	Aerial mycelium white, becoming purple, with mucor, ovoid to ellipsoidal in shape slightly cured and pointed at both end.
Aspergillusfumigatus	Colonies are granular, flat, often with radial grooves, yellow at first but quickly becoming bright to dark yellow-green with age	Conidal heads are typically columnar and uniseriate. Conidiophore stipes are short, smooth-walled and have conical-shaped terminal vesicles which support a single row of phialides on the upper.
Rhizopusstolonifer	Colonies are cottony white and are shows faster growth	Non-septate mycelium with branches sporangiospores

The above characteristics are based on macroscopic and microscopic examinations [24], which are used to identify isolates based on cultural and morphological characteristics respectively.

3.1 Variation in resistance to fungal attack between the two varieties

The results showed variation between the two tomato varieties with respect to fungal attack as shown in table 2 below.

Table 2: Variation in occurrence of fungal species on the two varieties of tomato

No	Fungi	Colony color	Frequency (%)	
			Siria	**UTC**
1	*Aspergillusniger*	Black brown	26 (61.9)	13 (52.0)
2	*Candida albicans*	Creamy milk	6 (14.2)	7 (28.0)
3	*Fusariumoxysperum*	Pink	4 (9.6)	**0 (0.0)**
4	*Aspergillusfumigatus*	Green	4 (9.6)	2 (8.0)
5	*Rhizopusstolonifer*	Cottony white	2(4.8)	3 (12.0)

From table 2, *Aspergillusniger*had the highest occurrence followed by *Candida albicans, Aspergillusfumigatus*and *Rhizopusstolonifer*, while *Fusariumoxysporum* had the least occurrence, and found only in Siria variety as presented in figure 1.

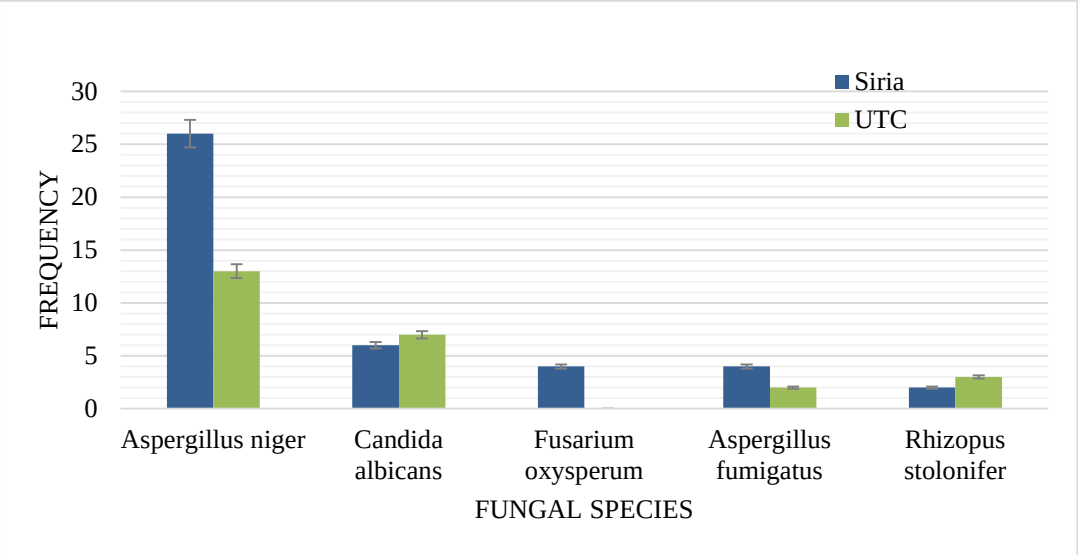

Figure 1: Frequency of occurrence of various fungal isolates

3.2 Pathogenicity test

To establish the real effect of the isolated fungal species, fresh tomato fruits of each variety were infected with each of the isolated fungi and the result is shown in table 3 and 4.

Table 3: Pathogenicity test of Siria variety

S/N	Pathogen	Colony	Diameter (mm)	Patten of spoilage
1	*Candida albicans*	Milk	52	Green watery
2	*Aspergillusniger*	Brown	Full	Green spot with white edges
3	*Aspergillusfumigatus*	Green	Full	Winkle, complete spoilage, black spot with white edges and watery
4	*Rhizopusstolonifer*	White	Full	Complete spoilage
5	*Fusariumoxysperum*	Pink	Full	Whitish-pink mycelia growth with sunken depression

Table 4: Pathogenicity test of UTC variety

S/N	Pathogen	Colony	Diameter (mm)	Patten of spoilage
1	*Candida albicans*	Milk	44	Watery and wrinkle
2	*Aspergillusniger*	Black	53	Sunken spot, black spot with white edges
3	*Aspergillusfumigatus*	Grey	35	Sunken spot
4	*Rhizopusstolonifer*	White	Full	Complete spoilage with white watery spot
5	*Fusariumoxysperum*	Pink	42	Pinkish-white mycelia growth

The results of pathogenicity test indicated that all the isolated fungal species were able to attack and spoil fresh and healthy tomato fruits after five days of incubation. The magnitude of spoilage of each isolate across the varieties is measured as the diameter of the rotten spot.

Rhizopusstolonifer was able to spoil both varieties, and with the exception of *Candida albicans*, all other isolates were able to attack and spoil Siria variety (Table 3). For UTC, different isolates indicated varying degrees of spoilage (Table 4). *Aspergillusniger* showed green spot with white edges, *Aspergillusfumigatus*showed narrow suken spot and *Fusariumoxysperum* showed white-pinkish mycelia growth in UTC variety. Meanwhile the control fruits showed no disease symptoms.

4. Discussion

The results indicated variation between the two tomato varieties with respect to fungal attack. Highest frequency of occurrence was recorded for *Aspergillusniger*. Similar results were reported by [29] and [30] with *Aspergillus* species. This may be due to ability of this species to break the defense mechanism of both the

tomato varieties. *Fusarium* species had the least total frequency and was totally absent in UTC variety. This, perhaps, is due to inability of *Fusarium* to properly attack and spoil tomato fruits. More so, UTC, being an improved variety, may have the mechanism to resist *Fusarium* attack.

The results of the pathogenicity tests showed that all the isolated fungi,exception *Candidaalbicans,* were pathogenic to Siria variety and were able to infect and spoil the entire fruit. Similar results were reported by [31]and [32] on other tomato varieties. The exception here is might be due to the fact that Candida is not naturally a tomato pathogen but can affect tomato to some extend if it lands on bruise or break spot on the fruits. With respect to UTC variety, only one of the identified fungal species (*Phizopusstolonifer*) was able to infect and completely spoil its fruits. All other pathogens were only able to establish themselves on a tiny spots on the fruits' body. This ability of UTC to resist the infection by most of the isolates placed it on a superior position than Siria variety.

4.1 Conclusion

Four (4) different fungal pathogens were isolated from both varieties, with the fifth one only found in local variety (Siria). These isolates have varying frequencies of occurrence across pathogens and tomato varieties. UTC variety proved to be superior over Siria as it showed tendencies to resist fungal pathogens attack.

4.2 Recommendations

From the findings of this research, UTC variety is recommended to farmers in Gombe metropolis because of its tendencies to have more shelf life. Furthermore, there is need for more research that would incorporate more local as well as improved varieties. This would provide broader base for selection in breeding programmes.

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