

Full Length Research Paper

Comparative Susceptibility of *Capsicum annum* and *Capsicum frutescens* to Post-Harvest Fungal Infections

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Experiment was carried out to compare the susceptibility of *Capsicum annum* and *Capsicum frutescens* on sale to fungal infection at Sharada and Rimi markets in Kano metropolitan area. A total of four fungal species were isolated from samples of *C. annum* and *C. frutescens* collected from the two markets. Out of the colonies isolated, the most abundant colony was *A. niger* (84, 39.25%). This was followed by *R. stolonifer* (71, 33.17%) and *A. fumigatus* (37, 17.28). The least occurring colony was *A. flavus* (22, 10.28). The difference between the four species was statistically significant at $P < 0.001$. On the basis of location, more colonies were isolated from samples collected from Sharada market (126, 58.87%) than Rimi market (88, 41.12%). The results indicate that hot or sweet features have no influence on the fungal infection of the sample from the two locations. More isolates were counted on Mondays (133, 62.1%) while 81 (37.9%) were counted on Thursdays. The differences between Mondays and Thursdays exposure was statistically significant at $P < 0.05$.

Key words: *Capsicum annum*, *Capsicum frutescens*, fungi, Rimi, Sharada.

INTRODUCTION

Members of the family *Solanacea*, *Capsicum annum* L. and *Capsicum frutescens* L., are species of genus *Capsicum* native to Southern North America and Northern South America (Norman, 1992; Williams et al., 1991; Alao, 2000; Jay et al., 2005). They are important as source of food as well as cash in Nigeria, particularly at the northern part of the country as in many tropical countries of the world (Alao, 2000; Yahaya, 2010; Ewekeye et al., 2013). *C. annum* and *C. frutescens* are

vegetables of great importance in human nutrition and grows over a wide variety of soil types with rain fall between 100 to 160 mm per annum. They are oxidizing specificity with rich source of vitamins (particularly vitamin C), poly phenols, chlorophylls, caratenoides, as well as various essential oils. David et al. (1985) and Jay et al. (2005) stated the nutritional values in ripe pepper as; protein (0.20 g/dry wt), fat (0.2 g/dry wt), carbohydrate (5.8 g/dry wt), calcium (0.7 g/dry wt), iron (5 mg/dry wt),

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thiamin (0.5 mg/dry wt), riboflavin (0.15 mg/dry wt), nicotinamide (2.3 mg/dry wt), ascorbic acid negligible and vitamin A variable.

Large quantities of *C. annuum* and *C. frutescens* are produced in Nigeria however, in 1987, Opadokun observed that practically all fresh vegetables grown in Nigeria are consumed in this country and production is seasonal resulting in a glut during the season and scarcity at off seasons. However, because of their soft texture they are easily bruised or wounded as a result of harvesting, and other post-harvest handling operation such as packaging, transportation and storage (Kuku et al., 1980; FAO, 1989; Williams et al., 1991).

Traditionally, unlike other fruits and vegetables fresh *C. annuum* and *C. frutescens* have not been considered as high risk food in terms of causing food-borne diseases or illness (Williams, 1987; Mare, 1999; Bukar et al., 2009). However, report by Hayatu (2000) and Yahaya (2005) shows that *C. annuum* and *C. frutescens* are susceptible to a number of fungal disease most of which require mechanical damage or weakening of the body tissue before they can penetrate. They reported that pathogens can enter into the fruits through severed tissue and natural opening. Damaged *C. annuum* and *C. frutescens* are usually mixed with undamaged ones in the market and are sometimes washed together which predisposes them to be attack by mould thus reducing their shelf life and resulting in wastage of production (Tindal, 1992; Hayatu, 2000; Yahaya, 2005; Yahaya, 2010).

Like in other parts of the world, large quantity of perishables such as *C. annuum* and *C. frutescens* are grown in Kano state which serves as a source of food and cash to many families (Alao, 2000; Yahaya, 2005; Sani and Alao, 2006). However, the quantity and quality of *C. annuum* and *C. frutescens* is greatly reduced due to fungal infection. However, there is no accurate data to clarify between *C. annuum* and *C. frutescens* which one is more susceptible to fungal infection. Therefore, the main aim of this study was to identify the fungal species and compare their susceptibility in *C. annuum* and *C. frutescens* so as to provide baseline information which will be valuable in control.

MATERIALS AND METHODS

Study site

Rimi market

It is located at municipal local government area of Kano state, Nigeria. It is one of the busiest vegetable markets within the ancient city of Kano state. There are no vegetables grown in Kano state that are not found at Rimi market. Despite being one of the largest markets in Kano state, there are no good storage facilities in the market. Some marketers store their vegetables on the floor of the stores, while others kept their vegetables packed in baskets. Marketers hardly used chemicals on their vegetables. They however washed them either with hot water or detergents, while others sort and grade their vegetables. About 9% of vegetables used in Kano metropolis are from Rimi market.

Sharada market

It is located at Gwale local government area of Kano state, Nigeria and is one of the largest vegetable markets in Kano state however, lacks good storage facilities. Some marketers stored their vegetables on the bare floor of the stores, while others kept their vegetables packed in baskets or sacks. Marketers hardly used chemicals on their vegetables. They however washed them either with hot water or detergents, while others sort and grade their vegetables. About 20% of vegetables used in Kano metropolis are from Sharada market. The two markets share similar feature of being the busiest and popular vegetable markets within the six metropolitan local government of Kano State, with produce at affordable rate for the consumers.

Experimental procedure

The methodology used in this study was similar to the one used by Yahaya (2005) and Yahuza and Yahaya (2016). The investigations lasted for a period of four months from September, 2014 to January, 2015. The procedure is described below.

Sample collection and handling

Five samples of *C. annuum* and *C. frutescens* each were obtained twice a week directly from Sharada and Rimi markets. The samples obtained were surface sterilized by immersion in 3% (v/v) sodium hypochlorite solution for 3 min. They were rinsed in three changes of running tap water and allowed to dry. Portions (2 mm) were cut with a sterilized scalpel. Cut pieces were placed on PDA and incubated at $25.7 \pm 2^\circ\text{C}$ for four days.

Colony count and subculture

Each week, growth of fungal organisms was monitored and the number of isolates that appeared was recorded. Each distinct species was sub cultured into fresh PDA.

Pathogenicity test

All fresh samples were separately washed in 10% (v/v) sodium hypochlorite solution and rinsed in three changes of running tap water and allowed to dry. A ruler was used to mark a 2 mm diameter circle on each sample; a sterilized needle was used to streaked fungal hyphae on marked portions. Controls were inoculated with sterile distil water. Materials were placed on the laboratory bench. Sterilized forceps were used to remove portions from the diseased areas on the fourth day and placed on freshly prepared PDA plates and incubated at $25.7 \pm 2^\circ\text{C}$ for four days. Fungal growth that appeared was recorded. Microscopic examination was carried out, for each examination; a streak of fungal mycelium was placed on a clean glass slide. One drop of cotton blue lactophenol was added and the cover slip placed. The slide was mounted on the microscope and observed at magnification of $\times 10$, $\times 40$ and $\times 100$. Morphological characteristics of fungi isolated were determined and identified using the method described by Dorothea et al. (1976) using colonial and morphological characteristics.

Statistical analysis

Data collected on fungal species was analysed using analysis of variance (ANOVA). This was achieved using statistical software

Table 1. Total number of colonies counted from *C. annuum* and *C. frutescens* collected from Sharada and Rimi market.

Location	<i>C. annuum</i>	<i>C. frutescens</i>	Total	Mean	% Abundance
Sharada	55	71	126	63	58.87
Rimi	39	49	88	44	41.12
TOTAL	94	120	214	107	100

Table 2. Total number of fungal colonies isolated from *C. annuum* and *C. frutescens* collected from Sharada and Rimi market.

Colonies	<i>C. annuum</i>	<i>C. frutescens</i>	Total	Mean	% Abundance
<i>A. niger</i>	38	46	84	42	39.25
<i>A. flavus</i>	09	13	22	11	10.28
<i>A. fumigatus</i>	14	23	37	18.5	17.28
<i>R. stolonifer</i>	33	38	71	35.5	33.17
Total	94	120	214	107	100

Table 3. Total number of fungal species counted on Mondays and Thursdays from *C. annuum* and *C. frutescens* collected from Sharada and Rimi markets.

Days	Sharada	Rimi	Total	Mean	% abundance
Monday	80	53	133	66.5	62.1
Thursday	46	35	81	40.5	37.9
Total	126	88	214	107	100

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RESULTS

A total of 214 were counted during the study at Rimi and Sharada markets. More colonies were counted from Sharada market (126, 58.87%), while 88 (41.12%) were counted from Rimi market (Table 1). The higher occurring species was *A. niger* with 84 colonies (39.25%). This was followed by *R. stolonifer*, 71 colonies (33.17%), and *A. fumigatus*, 37 colonies (17.28). The least occurring colony was *A. flavus* with 22 counts (10.28). Statistically, the differences between the four species were significant ($P < 0.001$) (Table 2).

Variation in the species isolated from *C. annuum* and *C. frutescens* collected from Sharada and Rimi markets

More species were isolated from *C. frutescens* (120, 56.07%) than *C. annuum* (94, 43.92%). *A. niger* was the highest occurring colony in both *C. frutescens* and *C. annuum*; 46 (21.49%) and 38 counts (17.75%),

respectively. The least occurring isolates in both *C. frutescens* and *C. annuum* was *A. flavus* with species count of 13 (6.07%) and nine (4.20%), respectively (Table 2).

Variation in isolate counted on Monday and Thursday in the two locations

Higher number of isolates were counted on Mondays, with 133 counts (62.1%) while 81 (37.90%) were counted on Thursdays. The differences between Mondays and Thursdays exposure was statistically significant at $P < 0.05$ (Table 3).

Variation in the species isolates on Monday and Thursday at Sharada and Rimi markets

The higher occurring species isolated on Monday and Thursday was *A. niger* with number of occurrence of 51 (23.03%) and 33 (15.42%) respectively while the least occurring colony isolated on both Monday and Thursday was *A. flavus* with 13 (6.07%) and nine (4.20%), respectively (Table 4).

Table 4. Fungal species isolated on Monday and Thursday from *C. annuum* and *C. frutescens* collected at Sharada and Rimi markets.

Days	<i>A. niger</i>	<i>R. stolonifer</i>	<i>A. fumigatus</i>	<i>A. flavus</i>	Total	Mean	%
Monday	51	40	22	13	127	63.5	59.34
Thursday	33	31	15	09	87	43.5	40.65
Total	84	71	37	22	214	107	100

Table 5. Total number of fungal species identifies from samples collected from Sharada and Rimi market.

Colonies	Sharada	%	Rimi	%	Total	Mean	% of abundance
<i>A. niger</i>	54	25.23	30	14.01	84	42	39.25
<i>A. fumigatus</i>	20	9.34	17	7.94	37	18.5	17.28
<i>A. flavus</i>	10	4.67	12	5.60	22	11	10.28
<i>R. stolonifer</i>	42	19.62	29	13.55	71	35.5	33.17
Total	126		88		214	107	100

Variation in the isolates counted from *C. annuum* and *C. frutescens* sampled from Sharada and Rimi markets

More counts of *A. niger* (54, 25.23%) were registered from Sharada market. The least occurring isolate at Sharada was *A. flavus* with 10 counts (4.67). At Rimi market *A. niger* was the highest occurring isolate with 30 counts (14.01 %), while *A. flavus* (14.01%) was the least occurring isolate (Table 5).

DISCUSSION

Almost all the *C. annuum* and *C. frutescens* samples collected from the two markets gave positive results for the presence of fungal species and each sample was contaminated with at least one of the known species of pathogenic fungi. The isolated fungi may have contaminated the *C. annuum* and *C. frutescens* either in the field or during postharvest handling operations. During the study, a total of 214 isolates were counted and recorded at Sharada and Rimi markets; out of this more isolates were counted at Sharada market (58.87%), while 41.12% were isolated at Rimi market. From the isolate counted during the study, four fungal species were identified that is, *A. niger*, *A. fumigatus*, *A. flavus*, *R. stolonifer*, while *A. niger* (84) was the highest occurring species.

The finding of this study could be related to the result of Hayatu (2000) and Yahaya (2005) who assessed fungal deterioration of some selected vegetables in some selected irrigation site of Kano State, Nigeria and found that 70% of losses in pepper were attributed to the activities of *A. niger*, *A. fumigatus* and *R. stolonifer*. The result of this study also support the finding of Yahaya and

Fatima (2009) who reported four fungal species associated with losses of sweet oranges in the two areas of study as *A. niger* (36.94%), *A. flavus* (17.83%), *Penicillium digitatum* (20.38%), and *Mucor* (24.84%).

The high number of isolates recorded from samples collected from Sharada market may be attributed to the nutrients effluent discharge in the surrounding household and industries around the market area, which infected the environment. Such contaminants may contain some effluents which might favour fungal growth as against the lower number of isolated counted from samples collected at Rimi market where the area is free from household and industrial effluents (Kuku et al., 1980; IAR, 1985; O'Neil et al., 1997).

In this study it is shown that more fungal species were counted on *C. frutescens* than in *C. annuum*. The high number of isolate counted from *C. frutescens* may be an indication that it is more susceptible to fungal infection. The higher isolates counted on Monday could be due to heavy activities with high influx of customers from different locations on the day for buying and selling. Statistical difference of $P > 0.05$ was obtained between the two markets.

It can be concluded that the four fungal species namely *A. niger*, *A. fumigatus*, and *A. flavus*, and *R. stolonifer* are the common post-harvest fungi associated with losses of *C. annuum* and *C. frutescens* on sale at the studied markets. The results obtained in this study indicate that more fungal isolates were counted on *C. frutescens* which is an indication that *C. frutescens* is more susceptible to fungal infection than *C. annuum*. At Rimi market area there is total absence of household and industrial effluents in the area surrounding the market and this might have accounted for the least colony count. Sharada site is the least suited for marketing of *C. annuum* and *C. frutescens* and other vegetables because

effluents from household and industries in the surrounding area were the source of infection. The effluents might contain toxic chemicals that on long time exposure could pose serious health hazards to the consumers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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