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Biodiversity of mycobiota associated with some rotted vegetables with special reference to their celluloytic and pectinolytic abilities

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Abstract: Fungi deteriorating vegetables are serious problem since they make their taste and odor unpalatable. Thus, the current work aimed to evaluate those fungi responsible for deteriorating vegetables and their enzyme-producing capabilities. A total of 45 species belonging to 19 genera were isolated on DRBC agar medium at 28°C, from carrot root (25 species, 13 genera), cucumber (26 & 13) and pepper (26 & 10), while, the lowest were observed on strawberry fruits (13 & 10). The most commonly deteriorating fungi were *Fusarium*, *Aspergillus*, *Alternaria*, *Cladosporium*, *Geotrichum* and *Rhizopus*, with *A. niger*, *A. flavus*, *A. alternata*, *F. solani* and *G. candidum* were the most common species. Among 83 isolates, related to 42 species tested for their ability to produce cellulase and pectinase enzymes, 79 (95.18%) and 75 (90.36%) had the ability to produce these enzymes respectively. The highest cellulase producers were isolates of *A. flavus* var. *columnaris*, *Exserohilum rostratum*, *Mucor circinelloides*, *M. hiemalis*, *M. racemosus*, *Penicillium chrysogenum* and *R. stolonifer*. From the pectinase producers, 15 isolates showed high enzyme production and these were related to *A. flavus*, *E. rostratum*, *F. dimerum*, *F. poae*, *F. proliferatum*, *F. sambucinum*, *F. solani*, *F. verticillioides*, *M. circinelloides*, *M. hiemalis*, *M. racemosus* and *R. stolonifer*. The remaining isolates were either moderate (58 and 45 isolates) or weak (12 and 15) producers for cellulase or pectinase respectively.

Key words: Carrot, cucumber, pepper, strawberry, vegetables, fungi, cellulase, pectinase.

Introduction

Vegetables play a vital role in human nutrition through supplying some necessary nutritional substances such as vitamins and essential minerals that can help in keeping a good and normal health and preventing diseases. Fungi cause spoilage for vegetables because they can grow on a great variety of substrates and a wide range of pH, water activities and temperatures (Dao and Dantigny 2011). The incidence of microorganisms in vegetables may reflect the sanitary quality of the processing steps and the microbiological conditions of the raw product at the time of processing (Adebayo-Tayo *et al*. 2012). Fungal deterioration is any change resulting from the activities of fungi which renders a product unsuitable for its intended use or reduces the economic value of the product. Also, fungi may change food colour, texture, taste and/or odor as a result of development of nitrogenous compounds, sulfides and organic acids. About 20-25% of annually produced vegetables are lost due to spoilage by pathogens during post-harvest handling (Dao and Dantigny 2011).

Carrot (*Daucus carota* L., Family: Apiaceae) is known to contain an important biologically active compound, carotenoid. *Aspergillus fumigatus*, *A. niger* and *Rhizopus stolonifer* and others had been isolated from carrot root (Adebayo-Tayo *et al*. 2012).

Cucumber (*Cucumis sativus* L., Family: Cucurbitaceae) is an important vegetable crop in Egypt, seed-borne pathogens cause low yield on cucumber crop due to damping-off, rot and wilt caused by *F. oxysporum* f. sp. *cucumerinum* (Martinez *et al*. 2003). *A. fumigatus*, *A. niger* and *R. stolonifer* were detected previously from cucumber fruits (Adebayo-Tayo *et al*. 2012). Also, Amande and Adebayo-Tayo (2012) isolated some species of *Aspergillus*, *Fusarium* and *Mucor* from cucumber in Ibadan, Oyo State in Nigeria.

Pepper (*Capsicum annuum* L., Family: Solanaceae) is suitable for the diets of the obese people and useful in the control of stomach and colon cancers, it is cholesterol-free, rich in vitamins, potassium and folic acid. *Colletothrichum capsici*, *C. gloeosporioides*, *C. coccodes*, *Aspergillus flavus* and *A. niger* were recorded previousely from pepper (Chigoziri and Ekefan 2013). Also, several fungi such as: *F. oxysporum*, *F. dimerum*, *F. equiseti*, *F. solani*, *Gliocladium roseum*, *Penicillium* spp., *Trichoderma* spp., *Mucor amphibiorum*, *M. racemosus*, *Rhizopus oligosporus* and *R. stolonifer* were responsible for spoilage of pepper (Udoh *et al.* 2015).

Strawberry (*Fragaria grnandiflora* Thuill, Family: Rosaceae) is one of the most commonly consumed berries worldwide (Hipol *et al*. 2014). It contains a large amount of phenolic compounds with antioxidant properties. Visible moulds have resulted in inedible strawberry fruits (Barth *et al*. 2009). It can be invaded by *Rhizoctonia solani*, *Phytophthora cactorum*, *Cladosporium* and *Penicillium* species (Pitt and Hocking 2009).

Infection of vegetables by fungi is initiated by production of cell wall-degrading enzymes to break down complex macromolecules including cellulose and pectin into smaller units to be taken up by the fungal cell for growth and assimilation. Cellulose is a linear

polymer of 8000–12000 glucose units linked by β-1,4-glycosidic bonds, it is a major component of plant biomass, and naturally degraded by cellulolytic fungi. This degradation is carried out via the synergic action of three cellulolytic enzymes: endo-β-D-glucanase, exo-β-D-glucanase and β-glucosidase. Cellulases are produced by numerous fungi such as species of *Aspergillus*, *Cladosporium*, *Fusarium*, *Geotrichum*, *Myrothecium*, *Paecilomyces*, *Penicillium*, *Trichoderma* and several others (Dedavid *et al.* 2008 and Moubasher *et al*. 2016).

Pectic substances are complex colloidal acid polysaccharides, with a backbone of galacturonic acid residues linked by α- (1-4) linkage. Pectin degrading enzymes weaken the plant cell wall and expose other polymers to be degraded by hemicellulases and cellulases. So, they are important virulence factors because they are considered the first cell wall degrading enzymes secreted by pathogens (Tomassini *et al*. 2009). Pectin-degrading enzymes are secreted by several fungi such as: *Fusarium oxysporum*, *Botrytis cinerea*, *Sclerotinia sclerotiorum*, *Aspergillus awamori*, *A. flavus*, *A. foetidus*, *A. japonicus*, *A. niger*, *A. oryzae*, *A. tubingensis* and *Rhizopus stolonifer* (Al-Hindi *et al.* 2011**)**.

The present work was designed to evaluate the mycological status of different vegetable fruits generally consumed in Sohag Governorate. Also, the ability of isolated fungi for cellulase and pectinase production was assessed.

Materials and Methods

Collection of samples

Eighty samples from spoiled carrot roots and cucumber, pepper and strawberry fruits (20 samples each) were randomly collected from different markets in Sohag City during winter 2014. Samples were kept separately inside clean bags, transferred to the laboratory and stored in a refrigerator at 4-5°C until fungal analysis.

Isolation and identification of fungi

The direct-plating technique described by Pitt and Hocking (2009) and dichloran rose-bengal chloramphenicol agar (DRBC) (King *et al*. 1979) were employed. Spoilage vegetables samples were cut approximately into 1 cm diam pieces, then surface sterilized with 1% NaOCl for 2 min and rinsed 4 times in sterilized distilled water. Four replicate-agar plates for each sample were inoculated each with four vegetable pieces. Plates were incubated at 28°C for 7 days and the developing fungi were counted (as colony forming units, CFUs per 16 segments for each sample), isolated and identified. Fungal identification was mainly based on their macro- and microscopic features based on keys of Raper and Fennell (1965), Booth (1971), Ellis (1971), Pitt (1979), Moubasher (1993), Leslie and Summerell (2006), Domsch *et al.* (2007), Pitt and Hocking (2009) and Ismail *et al*. (2015).

Screening of extracellular enzyme production

A total of 83 isolates belonging to 42 species of 16 genera isolated in the current work were assessed for their abilities to produce cellulase and pectinase enzymes.

Cellulase production was determined by the method of Eggins and Pugh (1962) on medium containing (g/l): cellulose, 10; $(NH_4)_2SO_4$, 0.5; L- asparagine, 0.5; KH_2PO_4, 1.0 ; KCL, 0.5; $MgSO_4.7H_2O$, 0.2; yeast extract, 0.5; and agar, 20. The pH was adjusted to 7 using acetate buffer. Three replicate-agar plates centrally inoculated were used for each isolate. The plates were incubated at 28°C for 5 days and the cultures were flooded with chloroiodide of zinc reagent. Clear zone around colony indicates hydrolysis of cellulose.

Pectinase production was tested on medium containing two main portions (Hankin *et al*. 1971).

Portion A: pectin, 5g; yeast extract, 1g; agar, 15g; distilled water, 500 ml (pH 7) and **Portion B:** mineral salts solution contained (g/l): $(NH_4)SO_4$, 2g; KH_2PO_4, 4g; Na_2HPO_4, 6g; $FeSO_4.7H_2O$, 0.2g; $CaCl_2$, 1.0g; H_3BO_4, 10 µg; $MnSO_4$, 10 µg; $ZnSO_4$, 70 µg; $CuSO_4$, 50 µg; MoO_3, 10 µg, pH 7. Portions A and B (500 ml each) were mixed after autoclaving and then poured into Petri-dishes. Three replicate-agar plates were used for each isolate. The plates were incubated at 28°C for 5 days then flooded with iodine solution. The diameter of clear zone around the colony was measured.

Results and Discussion

The mycological status of some rotted vegetables collected from Sohag City was evaluated on DRBC agar at 28ºC. The results revealed high incidence of deteriorating fungi in the analyzed samples. Also, there was no specific fungal species associated with these vegetables. A total of 45 species and one species variety belonging to 19 genera were isolated from the four vegetable types. In this respect, 32 fungal strains belonging to the genera *Aspergillus*, *Fusarium* and *Mucor* were isolated from the surface of some contaminated fruits, green beans, grapes, cucumber, banana and oranges (Amande and Adebayo-Tayo 2012).

Almost the same number of species was isolated from cucumber (26 species), pepper (26), carrot (25) but, strawberry registered the least number of species (13) (Table 1 and Figure 1). The total counts of fungi in all samples were also high in pepper (459 CFUs per 320 segments), cucumber (423/320), followed by carrot (382/320) and the lowest was recorded in strawberry (336/320) (Table 1 and Figure 2). These results are nearly similar to the findings of Udoh *et al*. (2015) on vegetables from Nigeria. The low fungal diversity associated with strawberry fruits may be attributed to the yeast or bacterial growth that produce antibiotics inhibiting fungal growth on strawberry (Essghaier *et al*. 2009), and interfering with the conidial germination and / or growth of *Botrytis cinerea* (Moline *et al*. 1999). In this respect, Kora *et al*. (2005) could isolate 27 isolates that caused various degrees of rot lesions on carrot root discs from commercial farms in Bradford Marsh, Ontario of Canada. Jamiołkowska (2009) could recover 512

fungal isolates representing 11 species contaminating hot pepper in Dublin, Poland.

The genera of high frequencies in three substrates (carrot, cucumber and pepper) were *Fusarium* and *Aspergillus*. They were detected in 60% and 80% of total samples from carrot, 70% and 75% from cucumber and 70 and 60% from pepper respectively. However, these two genera were isolated from only 10% and 25% of strawberry samples respectively (Table 1). *Alternaria* ranked second in its frequency from pepper, but third from carrot. Also, *Rhizopus* was isolated in high frequency from carrot (50% of total samples) and moderately from cucumber (45%), although it was isolated in low (20%) from pepper or rare (10%) frequency from strawberry. Kora *et al*. (2005) isolated species of *Alternaria*, *Aspergillus*, *Fusarium*, *Mucor*, *Penicillium* and *Rhizopus* as the most common on carrot from Ontario, Canada.

Of the previous genera, the most predominant species were A. *niger* (50%, 60% and 35% of carrot, cucumber and pepper samples respectively) and *R. stolonifer* (50%, 45% and 20% of the samples respectively). On the other hand, *A. niger* was recorded in only one strawberry sample and *R. stolonifer* in 2 strawberry samples. *A. alternata* was isolated moderately from carrot (40% of total samples), cucumber and pepper (30% each) and rarely from strawberry (10%). *A. flavus* and *A. tamarii* had moderate frequency on cucumber each representing 15% of total samples. In this respect, Amande and Adebayo-Tayo (2012) isolated these species from cucumber in Nigeria. *Mucor racemosus, A. flavus, A. niger, A. fumigatus, F. acuminatum, F. oxysporum, R. stolonifer* and other species were also associated with carrot from Enugu state, Nigeria (Udoh *et al*. 2015). It is worthy to mention that *R. stolonifer* was reported earlier from vegetables in the study of Akintobi *et al*. (2011). *Rhizopus* rot disease of carrot was prevalent in storage temperature above 10°C and dehydrated roots (Kora *et al*. 2005). The current results are in harmony with the findings of Adebayo-Tayo *et al*. (2012) and Amande and Adebayo-Tayo (2012), who isolated *A. niger* and *R. stolonifer* from spoiled cucumber in Uyo, Nigeria. *A. niger* is reported to cause black mold rot primarily on carrot roots (Kora *et al*. 2005).

Results in table (1) revealed also that only *Geotrichum candidum* (65% of total samples) and yeasts (60%) had high frequencies in strawberry samples, while they were isolated infrequently from carrot and pepper samples. *G. candidum* was detected in 20% of cucumber samples but, yeasts were missed in cucumber. In conformity with these results, Pitt and Hocking (2009) stated that yeasts are normal colonizers of strawberries being present at up to 10^5/g in macerates of mature berries and they can occur in tissues damaged by modified atmosphere storage. The high count and frequency of yeasts in strawberry is in harmony with the findings of Buhagiar and Barnett (1971).

Fusarium solani was detected in 40% of carrot and cucumber samples, but it was represented in 20% and 10% in pepper and strawberry samples respectively. *Fusarium* spp. cause dry rot and mainly attack carrot roots that are injured during harvest and handling (Kora *et al*. 2005).

The high count recovered from pepper samples was related to yeasts and *A. flavus* counts (Table 1). The fungi isolated in the current study were nearly similar to those isolated from cucumber in Nigeria (Akintobi *et al*. 2011, Adebayo-Tayo *et al*. 2012), hot pepper in Dublin, Poland (Jamiolkowska 2009), strawberry in Benguet, Philippines (Hipol *et al*. 2014).

All vegetables tested in the present work harbored *A. alternata, A. flavus, A. niger, Cladosporium sphaerospermum, F. solani, F. verticillioides, G. candidum* and *R. stolonifer*. Most of these fungi were reported as pathogens on vegetables, leading to rapid disintegration and decay (Akintobi *et al.* 2011, Adebayo-Tayo *et al*. 2012). Improper postharvest handling, hygiene and transport of vegetables might also lead to the contamination of these vegetables (Mgbakor *et al*. 2011).

Cellulase production

Eighty-three isolates related to 42 species +1 variety of 16 genera were tested for their potential to produce cellulase enzyme. Seventy-nine isolates were positive of which 9, 58 and 12 isolates were high, moderate and weak producers respectively. The high producers were *Exserohilum rostratum* and *Mucor racemosus* (2 isolates), *A. flavus* var. *columnaris*, *M. circinelloides*, *M. hiemalis*, *Penicillium chrysogenum* and *R. stolonifer* (1 isolate each) (Table 2).

Cellulase production was reported in numerous species (Romo-Sánchez *et al*. 2014). In the study of Adeleke *et al*. (2012) on 13 fungal isolates, only three were high producers and these were related to *Penicillium atrovenetum, A. flavus* and *A. oryzae*. Some strains of *A. niger, A. flavus* and *Trichoderma* sp. showed also high cellulolytic activity (Panda *et al*. 2012, Reddy *et al*. 2014 and Gupta *et al*. 2015).

Pectinase production

Out of 83 isolates screened, 75 had the ability to produce pectinase. Fifteen isolates showed high producing abilities, namely *F. solani*, *M. hiemalis* and *M. racemosus* (2 isolates each), *A. flavus*, *E. rostratum*, *F. dimerum*, *F. poae*, *F. proliferatum*, *F. sambucinum*, *F. verticillioides*, *M. circinelloides* and *R. stolonifer* (1 isolate each). The remaining positive isolates were either moderate (45 isolates) or weak (15) producers (Table 2).

Table 1. Total Counts (TC, calculated per 320 segments) and percentage frequency (F%) of fungi isolated from four types of vegetables on Dichloran Rose-Bengal Chloramphenicol agar medium (DRBC) at 28°C.

Fungal taxa	Carrot		Cucumber		Pepper		Strawberry	
	TC	F%	TC	F%	TC	F%	TC	F%
Acremonium strictum Gams	0	0	3	5	0	0	8	15
Alternaria Nees: Fries	40	50	37	30	102	60	2	10
A. alternata (Fries) Keissler	19	40	37	30	41	30	2	10
A. chlamydospora Mouchacca	9	15	0	0	13	15	0	0
A. tenuissima (Kunze: Fries) Wiltshire	12	20	0	0	48	40	0	0
Arthrobotrys sp.	0	0	0	0	0	0	12	15
Aspergillus P. Micheli ex Link	61	60	75	70	127	70	2	10
A. brasilensis Varga, Frisvad & Samson	9	10	0	0	6	10	0	0
A. flavus Link	9	20	7	15	53	55	1	5
A. flavus var. *columnaris* Raper & Fennell	0	0	0	0	6	15	0	0
A. japonicus Saito	0	0	0	0	6	5	0	0
A. niger van Tieghem	43	50	55	60	34	35	1	5
A. tamarii Kita	0	0	3	15	0	0	0	0
A. vadensis de Vries *et al.*	0	0	10	5	22	10	0	0
Botryodiplodia theobromae Patouillard	0	0	0	0	1	5	0	0
Chaetomium sp.	4	15	0	0	0	0	0	0
Cladosporium Link	11	30	36	45	45	30	1	5
C. cladosporioides (Fresenius) de Vries	4	10	4	10	6	10	0	0
C. sphaerospermum Penzig	7	20	32	40	39	20	1	5
Curvularia Boedijin	3	5	18	25	16	10	0	0
C. lunata (Wakker) Boedijn	3	5	14	15	16	10	0	0
C. ovoidae (Hiro & Watan.) Munt.-Cvetk.	0	0	4	15	0	0	0	0
Epicoccum nigrum Link	2	10	7	20	0	0	0	0
Exserohilum rostratum (Drechsler) Leonard & Suggs	0	0	16	20	0	0	0	0
Fusarium Link	147	80	128	75	33	60	10	25
F. dimerum Penzig	30	25	0	0	12	5	0	0
F. equiseti (Corda) Saccardo	0	0	2	5	0	0	0	0
F. heterosporum Nees : Fries	0	0	0	0	3	5	0	0
F. oxysporum Schlechtendal	16	15	28	30	3	10	0	0
F. poae (Peck) Wollenweber	0	0	4	5	0	0	0	0
F. proliferatum (Matsushima) Nirenberg	4	10	0	0	0	0	0	0
F. sambucinum Fuckel	12	10	34	20	0	0	0	0
F. solani (Martius) Saccardo	71	40	48	40	9	20	3	10
F. verticillioides (Saccardo) Nirenberg	14	25	12	10	6	25	7	15
Geotrichum candidum Link	62	40	31	20	44	30	150	65
Microdochium nivale (Fr.) Samuels & Hallett	0	0	0	0	0	0	9	15
Mucor Fresenius	9	25	0	0	0	0	7	25
M. circinelloides van Tieghem	0	0	0	0	0	0	1	5
M. hiemalis Wehmer	3	15	0	0	0	0	1	5
M. racemosus Fresenius	6	10	0	0	0	0	5	15
Neurospora crassa Shear & Dodge	0	0	2	5	0	0	0	0
Penicillium	8	25	22	40	16	35	0	0
P. brevicompactum Dierckx	6	15	0	0	0	0	0	0
P. chrysogenum Thom	2	10	5	15	0	0	0	0
P. corylophilum Dierckx	0	0	0	0	5	5	0	
P. crustosum Thom	0	0	5	10	2	5	0	0
P. duclauxii Delacriox	0	0	7	5	1	5	0	0
P. expansum Link	0	0	0	0	1	5	0	0
P. griseofulvum Dierckx	0	0	0	0	4	10	0	0

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Fungal taxa	Carrot		Cucumber		Pepper		Strawberry	
	TC	F%	TC	F%	TC	F%	TC	F%
P. madriti Smith	0	0	0	0	3	10	0	0
P. puberulum Bainier	0	0	5	15	0	0	0	0
Rhizocotonia solani Kühn	3	5	0	0	0	0	0	0
Rhizopus stolonifer (Ehrenberg) Vuillemin	25	50	42	45	12	20	3	10
Sterile mycelia (white)	0	0	4	5	0	0	4	5
Ulocladium Preuss	3	10	2	10	1	5	0	0
U. alternariae (Cooke) Simmons	3	10	2	10	0	0	0	0
U. botrytis Preuss	0	0	0	0	1	5	0	0
Yeasts	4	5	0	0	62	35	128	60
Total counts	382		423		459		336	
No. of genera (19)	13		13		10		10	
No. of species (46)	25		26		26 + 1		13	

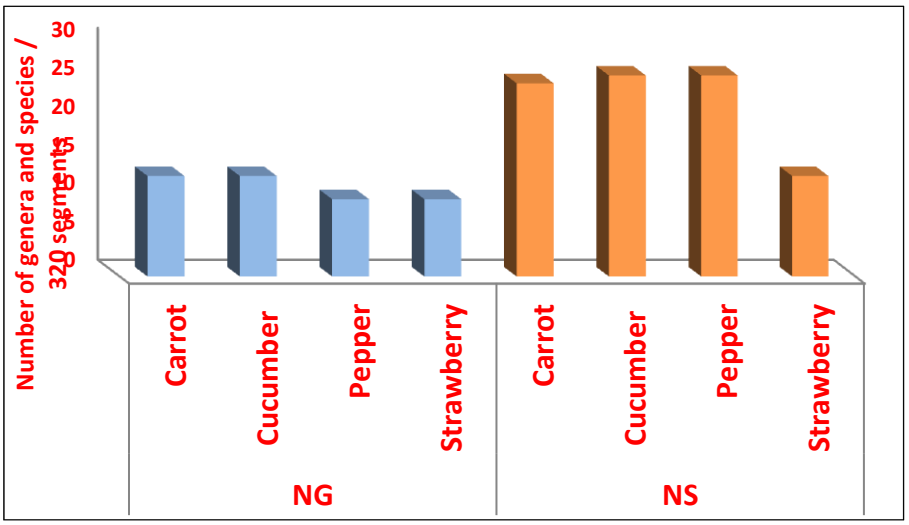

Figure 1: Number of genera (NG) and species (NS) of fungi isolated from carrot roots and fruits of cucumber, pepper and strawberry (per 320 segments) on DRBC agar medium.

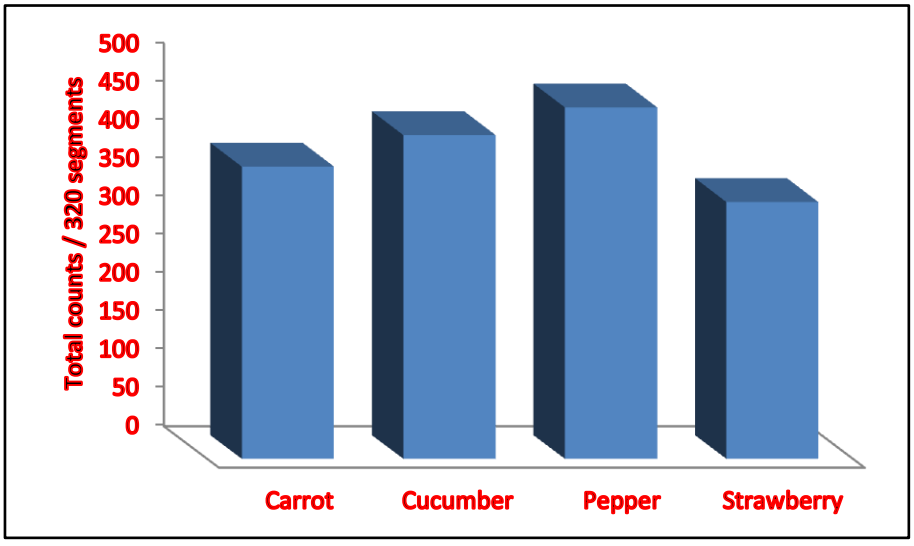

Figure 2: Total counts of fungi isolated from carrot roots and fruits of cucumber, pepper and strawberry (per 320 segments) on DRBC agar medium.

Table 2. Screening for cellulase and pectinase productivity of fungi isolated from carrot roots and cucumber, pepper and strawberry fruits (measured by diameter of clear zone in mm).

Fungal taxa	NTI	Cellulase			Pectinase		
		PI			PI		
		High	Moderate	Weak	High	Moderate	Weak
Acremonium strictum	2		1	1			
Alternaria alternata	2		2				2
A. chlamydospora	1		1				1
A. tenuissima	1		1			1	
Aspergillus brasiliensis	3		3			3	
A. flavus	4		4		1	1	1
A. flavus var. *columnaris*	3	1	2			1	2
A. japonicus	1		1			1	
A. niger	4		4			4	
A. tamarii	1		1			1	
A. vadensis	1		1			1	
Botryodiplodia theobromae	1		1			1	
Cladosporium cladosporioides	1		1				1
C. sphaerospermum	1		1				1
Curvularia lunata	4		1	3		3	1
C. ovoidea	1		1			1	
Epicoccum nigrum	1		1			1	
Exserohilum rostratum	2	2			1	1	
Fusarium dimerum	3		3		1	2	
F. oxysporum	2		2			2	
F. poae	2		1	1	1	1	
F. proliferatum	1		1		1		
F. sambucinum	4		3	1	1	3	
F. solani	7		3	3	2	4	
F. verticillioides	6		4	2	1	5	
Geotrichum candidum	1		1			1	
Microdochium nivale	1		1			1	
Mucor circinelloides	1	1			1		
M. hiemalis	2	1	1		2		
M. racemosus	2	2			2		
Penicillium brevicompactum	1		1			1	
P. chrysogenum	2	1	1			1	1
P. corylophilum	1		1				1
P. crustosum	2		2			1	1
P. duclauxii	2		1	1		2	
P. expansum	1		1				1
P. griseofulvum	1		1				1
P. madriti	1						
P. puberulum	1		1			1	
Rhizoctonia solani	2						
Rhizopus stolonifer	1	1			1		
Ulocladium alternariae	1		1				1
U. botrytis	1		1				
Total isolates	83	9	58	12	15	45	15

NTI = Number of tested isolates, PI = Positive isolates; High > 42 mm, moderate= 42-21 mm and weak < 21 mm

Species of *Aspergillus* and *Penicillium* are among the pectinolytic fungi reported earlier (Sukumaran *et al*. 2005 and Favela-Torres *et al.* 2006). These fungi and others (*Fusarium* and *Rhizopus*) showed high pectinolytic activities in the study of Fawole and Odunfa (1992). *Aspergillus niger, A. flavus, A. tamarii, A. terreus* and *A. parasiticus* were reported also to produce pectinase (Amande and Adebayo-Tayo 2012). In the current study and in harmony with the finding of Afifi (2003), all *Mucor* isolates tested were high producers. *A. flavus* and *A. niger* were moderate producers, while they showed high production in the

studies of Adeleke *et al*. (2012) and Panda *et al*. (2012). *G. candidum* was of moderate cellulase and pectinase production, but exhibited negative activity for the two enzymes in the study of Afifi (2003), and this discrepancy is an isolate difference effects.

Conclusion: The current study revealed that pepper had the highest incidence of fungi followed by cucumber. Vegetables may get spoiled by the associated fungi and their enzymes (cellulase and pectinase). The present results also indicate that the cellulolytic and pecinolytic capability is a common physiological attribute possessed by more than 90% of the test fungi. Isolates showing high or moderate cellulase and/or pectinase production could lead to complete hydrolysis of plant cell walls which may also lead to spoilage of vegetable. On the other hand, these enzymes play a role in beneficial biotechnological applications such as food industry, silage manufacture, treatment of turbidity and malclarification problems occurring in fruit juices and treatment of agricultural wastes (Afifi 2003 and Leeuwen *et al*. 2012).

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