
OCCURRENCE OF *FUSARIUM*, *ASPERGILLUS* AND *PENICILLIUM* SPECIES ON ONION (*Allium cepa*), ETHIOPIAN PEPPER (*Xylopiya aethiopicum*) AND WEST AFRICAN PEPPER (*Piper guineense*) SOLD AT ISHIAGU, EBONYI STATE

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ABSTRACT

This research work was carried out to compare the levels of *Fusarium*, *Aspergillus* and *Penicillium* spp occurrence on three common food spices; onion (*Allium cepa*), West African pepper (*Piper guineense*) and Ethiopian pepper (*Xylopiya aethiopicum*) sold at Ishiagu, Ebonyi State. The food spices were purchased from Ishiagu market and taken to laboratory for microbial analysis. Fifteen different samples were brought from the market for each food spice. Blotter technique for micro-floral assessment was used to determine microbial contamination and replicated three times. This was done in the pathology laboratory of Federal College of Agriculture, Ishiagu, Ebonyi State. The experiment was repeated after the initial work. The result revealed the presence of *Fusarium* spp, *Aspergillus flavus*, *Aspergillus niger* and *Penicillium* spp on the samples. *Fusarium* spp appeared on all the food spices, with highest occurrence on *Allium cepa*, but less on *X.aethiopicum*. *A.niger* had occurrence, on *A.cepa* and *P.guineense*, but absent on *X.aethiopicum*. *A.flavus* and *Penicillium* spp had their major occurrence on *P.guineense*. However *Penicillium* did not appear on *Allium cepa* and *X.aethiopicum*. The results also revealed varying degrees of rot and its severity on the food spices relative to levels of microbial occurrence on them. When food items are contaminated based on exposure to adverse environmental condition, they become unpalatable to human and animals and command low marketability.

INTRODUCTION

Spices are valued for their distinctive flavours, colours and aromas. Spices are among the most versatile and widely used ingredients in food preparation and processing throughout the world. As with many other agricultural products, spices may be exposed to a wide range of microbial contamination during pre- and post-harvest. Such contamination may occur during processing, storage, distribution, sale and/or use (Mckee, 2000). Although spices are present in foods in small amount, they are recognized as important carriers of microbial contamination mainly because of the conditions in which they were grown, harvested and processed. The tree common spices used are onion (*Allium cepa*), West African pepper (*Piper guineense*) and Ethiopian pepper (*Xylopiya aethiopicum*).

The onion (*Allium cepa* L.) also known as the bulb onion or common onion is a vegetable and is the most widely cultivated species of the genus *Allium* (Fritsh & Friesen 2002 & Eric 2010).

Bulbs from the onion family are thought to have been used as a food source for millennia. The onion is easily propagated, transported and stored.

Piper guineense is a West African species of piper; the spice derived from its dried fruit is known as West African pepper, Ashanti pepper, Benin pepper, false cubeb, guinea Cubeb, uziza pepper or

(ambiguously) “Guinea pepper”, and called locally Kale, Kukauabe, masoro, sasema and soro wisa. It is a close relative of cubeb pepper and a relative of black pepper and long papper

Like other members of the pepper family, West African peppers contain 5-8% of the chemical piperine which gives them their ‘heat’. They contain large amount of beta-caryophyllene which is being investigated as an anti-inflammatory agent. They also contain significant proportions (10%) of myristicin, elemicin, safrole and dillapiol. In terms of flavour, West African pepper is very similar to cubeb pepper but is much less bitter and has a fresher more herbaceous flavor. Though known in Europe during the middle Ages (it was a common spice in Rouen and Dieppe in 14th century France). These days, its use is marginal in west and central Africa. Research shows that Ashanti peppers have preservative and anti-oxidant properties (Kiin-Kabarri *et al* 2011).

Xylopiya aethiopicum, a West African “Pepper tree” with straight stem and smooth bark, it remains evergreen with a consistent aroma (Nnodim *et al* 2001). *Xylopiya aethiopicum* commonly known as “African guinea pepper” or “Ethiopian pepper is wide spread in tropical Africa, Zambia, Mozambique and Angola (Puri. *et al* 2001). In Nigeria, it is found all over the lowland rainforest and most fringe forest in the savanna zones of Nigeria. Negro pepper as it is also known has been used as a pepper substitute in

Europe and India (Sofowara 2005). The aromatic roots of the plant are used to arrest bleeding and owing to antiseptic properties, the aqueous concoction is usually administered after child birth (Burkhills 2002) it has also been reported to be an antioxidant (Amayaw *et al.*, 2003). Its anti-hypertensive and diuretic effects have also been reported (Somova *et al.* 2001).

Fungi are the predominant contaminants of spices (Kneifel and Berger 2004) but most such microbial populations are probably regarded as commensal residents on the plant that survived drying and storage. Soil and air is the main inoculum source for causing contamination in crude spices in field (Benerjee & Sarkar 2003). Other practices like handling, packaging and harvesting, cause additional contamination. Moreover, spices are collected in tropical areas by simple methods and are commonly exposed to many contaminants before being dry enough to prevent microbial growth (Bates and Bodnanek 2003; Benerjee & Sarkar 2003). The most frequent fungal contamination of spices are species from the genera *Aspergillus* and *Penicillium* (Silliker *et al.* 2002 & Dimic *et al.* 2008). Some species that belong to these genera are known as potential producers of different toxic substances such as aflatoxins, ochratoxins and sterigmatocystine, i.e. mycotoxins that exhibit toxic, mutagenic, teratogenic and carcinogenic effects in humans and animals (Frisvad *et al.* 2005 & Zinedine *et al.* 2006). Even products stored at low temperatures are vulnerable to some fungi (Durakovic *et al.* 2000). Fungal contamination of spices usually occurs when spices are not properly dried or when stored in a highly humid environment (Dimic *et al.* 2008). Ishiagu, the study area is an environment characterized by high temperature, humidity and rainfall. These spices are sold in their market to various consumers who use them in various forms. This therefore called for the research to determine the occurrence of fungal microbes on food spices sold in the study area. The objective of the study was to determine the levels of *Fusarium*, *Aspergillus* and *Penicillium* species in occurrence on onion (*Allium cepa*), West African pepper (*Piper guineense*) and Ethiopian pepper (*Xylopiya aethiopicica*). The objective equally tried to determine the rot level and its severity on these three selected food spices for examination. These spices are popular in the area, therefore require knowing their mycofloral status, to guide the consumers' health.

MATERIALS AND METHOD

The experiment was carried out in the pathology laboratory of Federal College of Agriculture, Ishiagu, Ivo LGA, Ebonyi State, Nigeria. Ishiagu lies within the latitude 05⁰ and 7⁰ North and longitude 7⁰ and 8⁰ east. It is in the derived savanna zone of south-eastern Nigeria. It has annual temperature of 27⁰C (minimum) and 33⁰C (maximum), with average

relative humidity of 88% and annual rainfall of 1600mm to 2000mm (Okoroafor *et al.*, 2018).

Experimental Materials: The tree common food spices: *Allium Cepa* (onion), *Piper guineense* (West African pepper) and *Xylopiya aethiopicica* (Ethiopian pepper) purchased from Ishiagu market, the study area, formed the experimental materials.

Physical Quality Determination: Assessment was made on their physical quality based on Percentage rots and Severity of rot (based on scoring) as observed in the market in addition to laboratory work. The rot severity scoring was based on five (5) point non-linear scale; 0=Non; 1=Minor; 3=Moderate; 5=High; 7=Very high (Nwawuisi *et al.*, 2012)

Laboratory Procedure: The method used was blotter method (2012) of assessing microbial occurrence which involved the use of Petri dishes lined with moistened cotton wool before white paper on top. The three food spices were surface-sterilized with 1% sodium hypochloride before plating. The sodium hypochloride solution was prepared by adding 10mls of it to 900ml of water. Cotton wool was soaked in the sodium hypochloride solution and was used to clean each of the petri dishes. The petri dishes were allowed to dry.

For each of the three common food spices: *Allium cepa* (onion), *Piper guineense* (West African pepper) and *Xylopiya aethiopicica* (Ethiopian pepper), they were collected from 15 retailers in the market. *A. cepa* (onion) was cut from the top to the bulb into 20 pieces and were collected using forceps and put into each petri dish underlined with moist cotton wool and paper in such a way that there was no contact among the onion cut. This gave 15 petri dishes for *A. cepa* (onion).

For *P. guineense* (West African pepper) samples, 20 seeds were placed in each petri dish under line with moist cotton wool and paper in such a way that there was no contact among the seeds. This equally gave 15 petri dishes

In Ethiopian pepper (*X. aethiopicica*), among the 15 samples, each sample was cut into 20 pieces and moisted. They were collected with forceps and put in each petri dish underlined with moist cotton wool and the paper in such a way that there was no contact among the samples. The same number of petridishes was maintained.

Each crop sample was in three replications, giving 45 petri dishes/crop. These gave a total number of 135 petri dishes used in the entire experiment. These three common food spices in the petri dishes were incubated at room temperature for 7 days. The experiment was repeated two times and observations made on fungal microbial occurrence.

Observation and Data Collection: After culturing for 4-7 days, the samples were examined and the fungi that appeared were identified based on their

mycelia colony, structure, colour and other attributes of the conidia in appearance.

Data collection were made at 4 and 7 days of incubation. This was done by closely observing the seeds under microscope and counting the numbers having the occurrence of the microbes. *Aspergillus species*, *Fusarium species* and *Penicillium species*. The number of seeds infested were expressed as percentage of the total seeds plated.

$$\frac{\text{number infested}}{\text{total number plated}} \times \frac{100}{1} = \text{percentage occurrence}$$

Data Analysis: Data analysis involved simple percentage frequency and standard error calculation at 5% probability level.

RESULT

The result of this work revealed varying degrees of occurrence of the tested fungal microbes on the examined three common food spices. The tested microbes differed in their occurrence on the various food spices. *Fusarium species* appeared in all the tested crops, while *Aspergillus flavus* did not occur in *Allium cepa* (onion). *Aspergillus niger* was not present on *Xylopi aethiopica* (Ethiopian pepper), while *Penicillium species* was present only in *Piper guineense* (West African pepper), but was absent in others.

Table 1 shows the occurrence of *Fusarium species* on the three food spices in the first experiment. *Allium cepa* had the highest *Fusarium species* occurrence of 43.70%, followed by *Piper guineense* with 15.78%, while *Xylopi aethiopica* had 3.67%. Such level of *Fusarium* could be detrimental to the product as well as human health if there is no caution to dealers. The same trend was observed in the second experiment where *Fusarium* occurrence (Table 2) on the three main food spices shows that *Allium cepa* still maintained the highest mean 45.30%, with *Piper guineense* having 27.30%, while *Xylopi aethiopica* had 7.78%. This second experiment corresponding to the first experiment, therefore, shows that *Fusarium spp* occurred in all the three food spices. Table 3 shows the occurrence of *Aspergillus flavus* on the spices; in the first experiment, *Piper guineense* had the highest mean (40.00%) with standard error of 10.34. while *Xylopi aethiopica* had 4.00%. There was no presence of *A. flavus* on *Allium cepa*.

On the other hand, Table 4 shows the results of *Aspergillus flavus* occurrence on three food spices during the second experiment. The result of the 1st test agreed with this 2nd test on level of occurrence of *A. flavus* and the spice it occurred most. *Piper guineense* had the highest mean (40.00%), *X. aethiopica* had 13.78%, while *A. cepa* did not have the microbe in occurrence. This situation on *A. cepa* is not accidental because *A. flavus* occurs most on oil crops which *A. cepa* does not belong.

Table 5 showed the occurrence of *Aspergillus niger* on the three common spices in the first experiment. *Allium cepa* had the highest *Aspergillus niger* occurrence which is 83.30%, *P. guineense* had 10.45%. The microbe was virtually absent on *X. aethiopica*, showing that it has the ability to resist the attack, proving its antifungal nature.

Table 6 shows the same trend of occurrence of *Aspergillus niger* on the three common food spices as observed on the first experiment. *Allium cepa* had 79.00%, *Piper guineense* had 22.70% while *Xylopi aethiopica* had non.

On the occurrence of *Penicillium species* on the three common food spices (Table 7), the result revealed that *Piper guineense* had the highest level of *Penicillium species* occurrence (15.00%), while the microbe did not occur on *X. aethiopica* and *Allium cepa*. The result of the 1st test equally agreed with the 2nd in *Penicillium* occurrence, where *Piper guineense* had the highest *Penicillium* occurrence while *Xylopi aethiopica* and *Allium cepa* did not show its occurrence (Table 8).

Tables 9 and 10 showed percentage rot and its severity respectively on the three spices. *Allium cepa* had the highest rot of 27.00% with severity of 5.40%, while *P. guineense* had rot of 15.00% with severity of 3.00%.

DISCUSSION

The occurrence of *Fusarium spp* on the various food spices is an indication of food contamination, as some of the products could be consumed raw. Mass casualties occurred in the soviet union in the 1930s and 1940s when *Fusarium* – contaminated wheat flour was baked into bread, causing alimentary toxic aleukia with a 60% mortality rate (WHO 1999; Drug policy alliance 2006). *X.aethiopica* had the least frequency, which shows that it can be used as an antifungal and antibacterial; hence could be formulated in creams and ointments for the treatment of superficial infections and capsules for the treatment of gastrointestinal tract infections (David and Ojo, 2010).

This study proved that fungi can break down crop produce and become significant health hazard to humans and animals. Losses of crops due to fungal disease or food spoilage can have a large impact on human food supplies and local economies (keller *et al*; 2005; Van Egmond *et al*; 2007).

Research had shown that *Fusarium oxysporum* causes rotting of the bulbs (basal rot) and yellowing of the leaves of daffodils. Some species may cause a range of opportunistic infections in humans. In human, with normal immune systems, fusarial infections may occur in the nails (onychomycosis) and in the cornea (*mycotic keratitis*) (Walsh, 1996).

This situation of non occurrence of *A. flavus* on *A. cepa* is not accidental because *A. flavus* occurs most on oil crops which *A. cepa* does not belong.

Aspergillus flavus is also an opportunistic human and animal pathogen, causing aspergillosis in immune compromised individuals (Amaike *et al* 2011).

Some strains of *Aspergillus niger* produce a potent mycotoxin called ochratoxins A; a human carcinogen found in grains and wine products (Samson *et al*; 2004; Schuster *et al*; 2002). Its occurrence on *A. cepa* is an indication of risk to the produce and human.

This experiment shows *Piper guineense* can be contaminated by *Penicillium species*. The high occurrence of *Penicillium specie* on *P. guineense* may be as the result of pre-and post-harvest contamination which pose a threat to food safety due to liberation of toxic secondary metabolites e.g aflatoxins (Bankole *et al* 2006).

Moreover, past findings (Keller *et al*, 2005) explained that moulds from spices may reduce the quality of the food and creates potential risk for human health with the production of toxic metabolites called mycotoxins.

The absence of *Aspergillus niger* on *Xylopi aethiopica* shows that *Xylopi aethiopica* cannot be affected by the fungus (*Aspergillus niger*), and cannot produce mycotoxins. *Xylopi aethiopica* can serve as antifungal, which are used in treating asthma when steeped in palm wine, stomach-aches and rheumatism (Burkill, 2002).. *Xylopi acid* had also demonstrated activity against the fungus *Candida albicans*. The plant contains high amounts of copper, manganese, and zinc. *Xylopi aethiopica* fruit extracts show activity as an antimicrobial against gram positive and negative bacteria (Iwu, 1993). *Allium cepa* had the highest *Aspergillus niger* occurrence. This is one of the noted major pathogens of the crop in agro-field.

This non occurrence of *Penicillium species* shows that the two spices *Xylopi aethiopica* and *Allium cepa* are routinely used in homeopathic medicine (David and Ojo, 2010). *Allium cepa* as well as garlic, when consumed, it protects against stomach and colorectal cancers (David and Ojo, 2010).

It was observed that *X. aethiopicas* had reduced rot percentage and severity (1.67). The high rot level observed on *A. cepa* and *P. guineense* could be attributed to poor handling and storage, paving way for mycroflora inversion/activities on the spices (Keller *et al*, 2005). The less rot level and severity observed on *X. aethiopicas* equally confirmed its antifungal properties as well as being medicinal to humans (David and Ojo 2010). It should be noted that rot levels and severity increased with increasing level of microbial occurrence as observed on the various spices.

The experiment revealed the various degrees of the tested fungal microbes in occurrence on the three common food spices; onion (*Allium cepa*), West African pepper (*Piper guineense*) and Ethiopian pepper (*Xylopi aethiopica*), sold in Ishiagu. *Fusarium spp* occurrence was observed on the three food spices though less on *X. aethiopica*, while *A. cepa* had the highest occurrence. *Aspergillus flavus* occurrence was only significant on *P. guineense*, but absent on *A. cepa*.

Fusarium spp with the highest occurrence is associated with aspergillases which is an agent of cornal otomycotic and nasorbital infection. *Penicillium species* was absent on *Xylopi aethiopica* and *Allium cepa*, but present on *Piper guineense*.

Microbe occurrence in the three common food spices can also cause mycotoxins to man and animals. The high level of colour changes, blemishes, rot and its severity makes the food spices unpalatable for human consumption as it can cause both cancer and kidney, liver and lungs diseases which are initiated by fumonisins produced by such disease pathogens. When plant products are exposed to adverse condition, microbial inversion occurs, leading to deterioration. Consumption of such deteriorated produce constitutes health risk.

CONCLUSION

The three food spices sold at Ishiagu, especially, *Allium Cepa* and *Piper guineense* had high level of fungal contamination thereby reducing their quality. The research had proved that these food spices with high fungal contamination and low quality have low market acceptance. However, *X. aethiopica* appeared to be antifungal, leading to less or no microbial effect on it.

RECOMMENDATION

Based on the result of this study, the following recommendations were made:

1. People should avoid improper handling of food spices and storage conditions which favours fungi growth and their activities.
2. People should know that *Fusarium spp* is the major fungal pathogen associated with food spices sold in Ishiagu.
3. Food spices should not be stored under conditions of relatively high humidity and high ambient temperature which favours the growth and activities of fungal contamination.
4. They should avoid improper handling of food spices during harvest to avoid pre-disposing the produce to fungal attack.

Table 1: Level of *Fusarium spp* occurrence on three food spices at Ishiagu in first experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	1.67	48.30	15.00	21.66
2	0.00	63.30	10.00	24.43
3	5.00	31.70	16.70	17.80
4	1.67	25.00	16.70	14.46
5	3.30	26.70	11.70	13.9
6	1.67	53.30	6.70	20.56
7	11.67	48.30	13.30	24.42
8	0.00	36.70	15.00	17.23
9	5.00	48.30	8.30	20.53
10	5.00	26.70	5.00	12.23
11	6.67	36.70	41.70	28.36
12	3.30	43.30	23.30	23.30
13	0.00	65.00	33.30	32.77
14	3.30	81.7	11.70	32.23
15	6.67	20.00	8.30	11.66
Total	55.00	655.00	236.7	315.54
Mean	3.67	43.70	15.78	21.04
SE \pm	0.95	11.29	4.08	5.44

Table 2 : Levels of *Fusarium spp* occurrence in three food spices in second experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	11.70	48.30	18.30	26.10
2	13.30	25.00	20.00	19.43
3	3.33	90.00	26.70	40.01
4	5.00	41.70	41.70	29.47
5	1.67	23.30	35.00	19.99
6	5.00	86.70	30.00	40.57
7	6.67	30.00	46.70	27.79
8	8.33	51.70	31.70	30.58
9	11.67	55.00	31.70	32.79
10	13.30	23.30	18.30	18.30
11	6.67	48.30	36.70	30.56
12	15.00	65.00	28.30	36.10
13	5.00	21.70	15.00	13.90
14	11.67	40.00	15.00	22.22
15	3.33	41.70	15.00	20.01
Total	116.67	679.70	410.00	407.82
Mean	7.78	45.30	27.30	27.19
SE \pm	2.01	11.71	7.05	7.03

Table 3: occurrence of *Aspergillus flavus* on the three common food spices in the first experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	6.67	0.00	15.00	7.22
2	1.67	0.00	11.70	4.46
3	1.67	0.00	23.30	8.32
4	3.30	0.00	36.70	13.33
5	5.00	0.00	38.30	14.43
6	5.00	0.00	18.30	7.77
7	6.67	0.00	53.30	19.99
8	6.67	0.00	60.00	22.22
9	1.67	0.00	43.30	14.99
10	1.67	0.00	31.70	11.12
11	1.67	0.00	70.00	23.89
12	10.00	0.00	41.70	17.23
13	5.00	0.00	61.70	22.23
14	0.00	0.00	41.70	13.9
15	3.30	0.00	53.30	18.87
Total	60.00	0.00	600.00	219.97

Mean	4.00	0.00	40.00	14.66
SE±	1.03	0.00	10.34	3.79

Table 4: Level of *Aspergillus flavus* occurrences on the three food spices in second experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	6.70	0.00	30.00	12.23
2	16.70	0.00	38.30	18.33
3	8.30	0.00	56.70	21.67
4	3.30	0.00	45.00	16.10
5	16.70	0.00	50.00	22.23
6	13.30	0.00	30.00	14.43
7	30.00	0.00	50.00	26.67
8	8.30	0.00	55.00	21.10
9	6.70	0.00	28.30	11.67
10	15.00	0.00	40.00	18.33
11	21.70	0.00	40.00	20.57
12	13.30	0.00	48.30	20.53
13	6.70	0.00	31.70	12.80
14	20.00	0.00	36.70	18.90
15	18.30	0.00	20.00	12.77
Total	206.70	0.00	600.00	268.33
Mean	13.78	0.00	40.00	17.89
SE±	3.56	0.00	10.34	4.62

Table 5: Levels of occurrence of *Aspergillus niger* on the three food spices on the first experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	0.00	90.00	5.00	31.67
2	0.00	80.00	1.70	27.23
3	0.00	65.00	11.70	25.57
4	0.00	88.30	1.70	30.00
5	0.00	86.70	10.00	32.23
6	0.00	96.70	6.70	34.50
7	0.00	83.30	3.30	28.87
8	0.00	71.70	20.00	30.57
9	0.00	83.30	13.30	32.20
10	0.00	55.00	0.00	18.33
11	0.00	78.30	8.30	28.87
12	0.00	83.30	13.30	32.20
13	0.00	93.30	11.70	35.00
14	0.00	95.00	30.00	41.67
15	0.00	100.00	20.00	40.00
Total	0.00	1250	156.7	468.91
Mean	0.00	83.30	10.45	31.26
SE±	0.00	21.52	2.70	8.08

Table 6: level of *Aspergillus niger* occurrence on the three food spices in second experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	0.00	75.00	10.00	28.33
2	0.00	70.00	15.00	28.33
3	0.00	86.70	18.30	35.00
4	0.00	100.00	18.30	39.43
5	0.00	90.00	30.00	40.00
6	0.00	55.00	33.30	29.43
7	0.00	78.30	26.70	35.00
8	0.00	95.00	28.30	41.10
9	0.00	61.70	13.30	25.00
10	0.00	80.00	20.00	33.33
11	0.00	86.70	28.30	38.33
12	0.00	100.00	31.70	43.90
13	0.00	78.30	30.00	36.10

14	0.00	60.00	25.00	28.33
15	0.00	68.30	11.70	26.67
Total	0.00	1185.00	340.00	508.28
Mean	0.00	79.00	22.70	33.89
SE±	0.00	20.41	5.87	8.76

Table 7: Level of *Penicillium spp* occurrence on the three food spices in first experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	0.00	0.00	28.30	9.40
2	0.00	0.00	15.00	5.00
3	0.00	0.00	21.70	7.23
4	0.00	0.00	10.00	3.33
5	0.00	0.00	13.30	4.43
6	0.00	0.00	10.00	3.33
7	0.00	0.00	6.70	2.23
8	0.00	0.00	21.70	7.23
9	0.00	0.00	23.30	7.80
10	0.00	0.00	15.00	5.00
11	0.00	0.00	15.00	5.00
12	0.00	0.00	20.00	6.67
13	0.00	0.00	15.00	5.00
14	0.00	0.00	3.30	1.10
15	0.00	0.00	6.70	2.23
Total	0.00	0.00	225.00	69.98
Mean	0.00	0.00	15.00	4.67
SE±	0.00	0.00	3.88	1.21

Table 8: level of *Penicillium spp* occurrence on the three food spices in second experiment

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	0.00	0.00	20.00	6.67
2	0.00	0.00	18.30	6.10
3	0.00	0.00	18.30	6.10
4	0.00	0.00	15.00	5.00
5	0.00	0.00	11.70	3.90
6	0.00	0.00	6.70	2.23
7	0.00	0.00	8.30	2.77
8	0.00	0.00	10.00	3.33
9	0.00	0.00	13.30	4.43
10	0.00	0.00	10.00	3.33
11	0.00	0.00	16.70	5.57
12	0.00	0.00	11.70	3.90
13	0.00	0.00	20.00	6.67
14	0.00	0.00	18.30	6.10
15	0.00	0.00	10.00	3.33
Total	0	1185.00	208.30	69.43
Mean	0.00	79.00	13.89	4.63
SE±	0.00	20.41	3.59	1.20

Table 9: Levels of rot percentage on the three food spices

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	10.00	15.00	15.00	9.40
2	10.00	15.00	15.00	5.00
3	10.00	15.00	15.00	7.23
4	10.00	25.00	15.00	3.33
5	10.00	35.00	15.00	4.43
6	10.00	35.00	15.00	3.33
7	10.00	35.00	15.00	2.23
8	10.00	35.00	15.00	7.23
9	10.00	35.00	15.00	7.80

10	10.00	25.00	15.00	5.00
11	15.00	25.00	15.00	5.00
12	15.00	25.00	15.00	6.67
13	15.00	25.00	15.00	5.00
14	15.00	25.00	15.00	1.10
15	15.00	35.00	15.00	2.23
Total	175.00	405.00	225.00	268.27
Mean	11.67	27.00	15.00	17.88
SE±	3.02	6.98	3.88	4.62

Table 10: The Rot severity on the three food spices

Retailers	<i>X. aethiopica</i>	<i>A. cepa</i>	<i>P. guineense</i>	Mean (\bar{X})
1	1.00	3.00	3.00	2.33
2	1.00	3.00	3.00	2.33
3	1.00	3.00	3.00	2.33
4	1.00	5.00	3.00	3.00
5	1.00	7.00	3.00	3.67
6	1.00	7.00	3.00	3.67
7	1.00	7.00	3.00	3.67
8	1.00	7.00	3.00	3.67
9	1.00	7.00	3.00	3.67
10	1.00	5.00	3.00	3.00
11	3.00	5.00	3.00	3.67
12	3.00	5.00	3.00	3.67
13	3.00	5.00	3.00	3.67
14	3.00	5.00	3.00	3.67
15	3.00	7.00	3.00	4.33
Total	25.00	81.00	45.00	50.35
Mean	1.67	5.40	3.00	3.36
SE±	0.43	1.40	0.78	0.87

Severity Code: 0=Non; 1=Minor; 3=Moderate; 5=High; 7=Very high

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