Influence of storage time on biodeterioration, aflatoxin contamination and food values of onion (*Allium cepa*)

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Abstract: Investigations were conducted on the onions (*Allium cepa*) stored for 1, 3 , 9 and 12months respectively. The parameters studied include the proximate analysis and shelf life evaluation of the spice, mineral elements compositions, level of fungal and aflatoxin contamination on fresh and stored onion bulbs. *Aspergillus* and *Fusarium specis* were detected in all the samples while *Penicillum sp* was found in the 1 year old onion bulb sample. Proximate analysis showed variation in their nutrient contents. The moisture content, dry matter, ascorbic acid, starch, glucose, amino acid, protein and mineral nutrients were of significant values in all the samples. The results also showed that the aflatoxin level in the 1st , 3rd and 9th months were statistically insignificant($P>0.05$), while those of 12 month old samples were relatively high.

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1.Introduction

Onion (*Allium cepa*) is an important plant of nutritional and medicinal values (Babatunde *et al,*2001;Jilani *et al*,2004). Both leaves and the bulb are used in the preparation of delicious dished among the Yoruba people of south Western Nigeria. There are several ethnic groups in Nigeria. These groups include Hausa,Igbo,Yoruba,Nupe,Itshekiri,Tiv,Urobo, Fulani and many others. Among these people, onion is an essential component of different varieties of meal and soups (Jonathan and olowolafe, 2001).It usually adds values, aroma, taste and nutritional qualities to different arrays of fresh and cooked Nigeria foods. Onion bulb is a biennial herb with over 600 species distributed world-wide. Onion has superficial root system, spherical fruit, long, linear and hollow leaves, and very short flattened stem at the base, which increases in diameter as it grows (Sullivan *et al*, 2001). All parts of onion produce a strong odour when crushed. A bulb is formed, by the thickening of the base leaves when the plant reaches a critical stage (Babatunde *et al,*2004).

Onion is high in food value, moderate in protein content, rich in calcium and riboflavin (Jilani *et al*,2004). Nutritional composition of onions may depend on type of varieties, developmental stage and period of storage. Fully developed onion bulb usually contain 85.0-88.6% moisture, 1.2-2.0 % protein, 0.1-0.3% fat, 0.6-1.0% fibre, 0.4-0.7% mineral elements and 10.2- 12.1% carbohydrates(Grubben and Denton, 2004). Its mineral and vitamin contents are calcium, iron, phosphorus, carotene, thiamine, riboflavin, niacin and vitamin C. *Allium cepa* is high in energy and water content. They are low in calories, and have a generous amount of vitamin B6, B1, and folic acid (Sullivan *et al*, 2001).

Allium cepa has been used as an ingredient in various dishes for thousands of years by many cultures around the world. World onion production is steadily increasing so that onion is now the second most important horticultural crop after tomatoes (Bankole *et al*,2004). There are many varieties of onion; red, yellow, white, and green, with different flavour, from very strong to mildly sweet. Onions can be

eaten raw, cooked, fried, dried or roasted. They are commonly used to flavour dips, salads, soups, spreads, stir-fry and other dishes (NIHORT, 1986 and Jilanil *et al*., 2004).

Onion and other *Allium* vegetables are characterized by their rich content of thiosulfinates, sulphides, sulfoxides, and other odoriferous sulphur compounds. The cysteine sulfoxides are primarily responsible for the onion flavour and produce the eye-irritating compounds that induce lacrimation(Bankole *et al*,2004). The thiosulfinates exhibit antimicrobial properties. Onion is effective against many bacteria including *Bacillus subtilis*, *Salmonella*, and *E.* coli. Onion is not as potent as garlic since the sulphur compounds in onion are only about one-quarter the level found in garlic (Jackson and Groopman, 1999). The scales of onion contain catechol and protocatechuic acid. The odour in onion is due to organic sulphur compounds and is produced only when the tissues are cut or injured by enzyme action on a water soluble amino acid (Scott, 2007). The highly pungent onion bulbs have been recommended for revitalization of the brain as well as increasing potency in male reproductive organs (Babatunde *et al*.,2004)

Onions contain chemicals which help fight the free radicals in our bodies. Free radicals cause disease and destruction to cells which are linked to at least 60 diseases. Onions increase circulation, lower blood pressure, prevent blood clotting and useful in treatment of common heart disease (Grubben and Denton, 2004;Scott, 2007).Storage of onion bulbs in a warm condition where relative humidity is high can cause decay of onion bulb (Sullivan *et al*., 2001; Babatunde *et al*., 2004; Dantata and Machunga, 2007).

Extended periods of wet conditions in the four to six weeks prior to harvest will promote the storage rots caused by *Aspergillus* and *Penicillium* spp., especially in the tropics.

Major storage diseases of onions and other food include; black mould caused by *Aspergillus* spp which produced sooty black masses under surface scales, neck rot of *Botrytis* spp showing dusty grey appearance and rot in neck of bulb, *Fusarium* spp causing Fusarium rot which formed white fluffy growth with soft rot at base or neck of onion and blue green mould caused by *Penicillium* spp showing dusty green masses under surface scales (Jackson and Groopman, 1999).

2. Materials and methods

2.1Collection and preparation of the sample

A total of 24 onion bulbs were collected from the National Horticultural Research Institute Idi- ishin, Ibadan Oyo state. They were divided into four groups of 6 onions each. Two onions each from the samples were collected , cut into minute bits and dried for 7days, after which they were pulverised. The pulverised samples were used for the determination of the mineral elements and food composition.

2.2Determination of minerals in the sample

Mineral content determined include calcium, potassium, magnesium, sodium, iron, copper, zinc, phosphorus(AOAC,1990).

2.3 Microbiological analysis

The microbiological analysis was carried out in the laboratory using the four samples (1, 3, 9 and 12 months) of onions from which cultures were prepared by direct plate method.

Ten grams of synthesized Potato Dextrose Agar was diluted in 250ml of water. The mixture was heated in a Gallenkamp water bath till the powder dissolves completely. This was then dispensed into 500ml conical flasks. The mouth of the conical flasks was plugged with cotton wool and wrapped up with aluminium foil. The flasks were then sterilized at 1.05kg/cm^2 (121^{o}C) for 15 minutes in an autoclave. After the autoclave had cooled and pressure is at zero, it was opened and the flasks were removed and kept in a Gallenhamp water bath at controlled temperature of 45°C. The cooled agar was dispensed in 15 ml amounts into sterile glass petri dishes. The part of the sample was cut and surface sterilized in diluted ethanol after which the samples were plated on the prepared media and incubated for 3 to 5 days. Sub-culturing was done to obtain pure cultures. Fungi isolates were identified using morphological characteristics, spore formation

and biochemical reactions (Jonathan and Olowolafe,2011;Fadahunsi *et al*,2011).

2.4Pathogenicity test

To ascertain that the organisms isolated caused the disease on the onions collected, pathogenicity test was conducted using Koch's postulate as described by Markson *et al*., (2005). This was done by re-inoculating healthy onion samples with the microorganisms previously isolated from diseased onion samples. The establishment of the disease and disease symptoms on the onion and the affirmation of the organisms re-isolated from diseased experimental onion as being identical to the original specific causative agent confirmed the pathogenicity of the isolated fungi species on the *Allium cepa* bulb.

2.5 Proximate Analysis

This test included moisture content, protein, starch, glucose, amino acid, Ascorbic acid and
dry matter and it was carried out using AOAC (Association Official Analytical Chemist) method (1990).

2.5Aflatoxin detection

Aflatoxin detection were determined according to the method of Gnononfin et al(2008).

2.6.Shelf life stability Test

The storage stability study carried out on the *Allium cepa* samples showed that it took some time before spoilage organisms began to invade the samples. This was confirmed through the appearance , change in colour and odour. This study was carried out at room temperature and increased storage resulted in decline in quality and quantity.

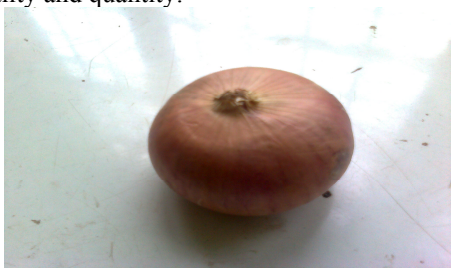

Plate 1: An *Allium cepa* bulb

Plate 2: *Allium cepa* stored for 1 month

Plate 3: *Allium cepa* stored for 3 months

Plate 4: *Allium cepa* stored for 9 months

Plate 5: *Allium cepa* stored for 1 year

3. Results and Discussion

The results of food compositions of *Allium cepa* bulb at different duration of storage was represented on Table 1.Percentage of moisture content ranged from 20.0 to 23.0% within the 12 months of storage. Moisture was found to be less in one month old sample compared with twelve months old samples. This might be due to high relative humidity of the environment where these onions were stored (Jonathan and Esho, 2010).The % dry matter in 1,3,9 and 12 months were 80.0,78.1,77.5 and 77.0 respectively. The % increase in dry matter is not unexpected since these values represent the trend observed in other stored food materials reported by other authors (Jonathan and Olowolafe; Manzi *et al*,1999;Babatunde *et al*,2004).

Amino acids concentration observed during the period of storage (Table1) were found to be statistically similar (P>0.05).These showed that these compounds were relatively stable at 1, 3,9 and 12 months respectively. The glucose contents in the onion bulbs were found to be reducing with period of storage. This reduction may be due to the fact that this monosaccharide is used for metabolism during storage (Jonathan and Fasidi, 2003).The level of protein in the stored samples were unexpectedly low (Table 1). This may be linked to the type of onion used, physical nature of the land where it was planted and various environmental factors. Ascorbic acid in stored onion bulb was observed to be high. This shows that this spice is rich in vitamin C. This result is similar to the report of other researchers that other vegetables such as garllic ,Telfaria occidentalis and mushrooms are rich source of vitamins (Grubben and Denton , 2004;Aina *et al*,2012;Jonathan *et al*,2012a).

Mineral element analysis of onions showed that potassium, phosphorus, calcium, magnesium, iron and sodium were present in appreciable quantities in onion while manganese, copper and zinc were present at very low level. This result showed that onion is very rich in mineral nutrients. The mineral element composition obtained for onion bulb in this study is similar to the results of the mineral nutrients recorded for other vegetables(Jonathan *et al*,2012b; Grubben and Denton ,2004).).

It was also found that *Aspergillus spp and Fusarium sp* were the dominant organisms in all the samples of onion analyzed, while *Penicillium sp* was found only in the one year old sample (Tables 3 and 4). This shows that *Aspergillus spp*, *Fusarium sp* and *Penicillum spp* are the typical organisms that are associated with onion spoilage. It was also found out that the duration of storage and age of the onions could aid infection and dominance of particular fungus. It was obvious that the occurrence of these organisms may be as a result of moisture because when kept in a dry environment, the rate of infection was greatly reduced. This was also observed by Fadahunsi *et al*,(2011).

The aflatoxin level in the 1, 3 and 9 months onion samples were infinitesimal so there was no significant values, while the aflatoxin detected for the one year old samples was very high (5.0-5.2) microgram/ kilogram. According to the FAO/WHO (1990) and (1992), aflatoxin level in any food material meant for consumption must not be more than 4 microgram/ kilogram for Nigerians, while NAFDAC (National Agency for Food Drug Administration and Control) recommends 3.5 microgram/kilograms for Nigeria. Scientists and chemists put the bench mark of aflatoxin contamination at about 3 microgram / kilogram.

The results also showed that the stored onion samples of 1, 3 and 9 months were safe for consumption while that of one year should not be encouraged because of its level of aflatoxin. Similar observation were reported by Bankole *et al*,2002(for melon seeds) and Jonathan and Esho,2010 (for Pleurotus mushroom) that were stored values on the same column followed by the same letter(s) are not significantly different by Duncan's Multiple Range Test ($p > 0.05$). Values are means of 3 replicates.

This was done for two different samples of onions at the same time.

Table 1: Proximate compositions of onion bulb during storage

Sample	Moisture content (%)	Dry matter (%)	Ascorbic acids (mg/100)	Amino acids (mg/100)	Protein (mg/100)	Glucose (g/100)	Starch (g/100)
A	20.0d	80.0a	13.51d	0.027a	1.10b	4.45c	8.42d
B	22.0c	78.0b	81.08a	0.027a	1.07c	5.10a	8.70c
C	22.5b	77.5c	54.05b	0.024a	1.14a	5.02b	8.79b
D	23.0a	77.0d	40.54c	0.027a	1.00d	5.00b	9.34a
Mean	21.875	78.125	47.275	0.026	1.080	5.093	0.813
Std. dev	1.315	1.315	28.131	0.002	0.060	0.563	0.385
Std.Error	0.658	0.658	14.066	0.0008	0.030	0.282	0.193

Values on the same column followed by the same letter(s) are not significantly different by Duncan's Multiple Range Test ($P > 0.05$). Values are means of 3 replicates.Key:A=1 month B=3 months C=9 months D=1 year (12months)

Table 2: Mineral element compositions of onion bulb during storage

Sample	Ca	Mg	K	Na	P	Mn	Fe	Cu	Zn
	(ug/1000g)								
A	23.5a	3.4a	146a	2.3b	33.0c	0.23a	2.31c	0.11a	0.09a
B	21.0c	3.1c	146a	2.4a	32.8d	0.24a	2.14d	0.10b	0.08a
C	23.7a	3.4a	146a	2.3b	33.5a	0.23a	2.39a	0.10b	0.09a
D	22.9b	3.3b	145b	2.2c	33.4b	0.27a	2.34b	0.12a	0.07a

Values on the same column followed by the same letter(s) are not significantly different by Duncan's Multiple Range Test ($p > 0.05$). Values are means

Table 3: Colonial and microscopic characteristics of fungal isolates

Organism	Colonial characteristics	Microscopic characteristics
1	Widely spread black colonies and spore head. Round spores appearance	Presence of septate hypha growing in ring which also has spore-like that are tiny brown
2	Grey powder like colonial Appearance	Spores are rod-like in shape. Hyphae are highly branched at the tip and
3	White fluffy growth like Cushion	Presence of septate hyphae

Table 4: Name of Organisms and their sources

Organism	Name	Source
1	*Aspergillus niger*	All samples
2	*Penicillium sp*	A year old sample
3	*Fusarium sp*	All samples

Table 5: Aflatoxin Level in Microgram/ gram

Onion sample	Months							
	1		3		9	12		
1	0	0	0	0	0	1.2a	5.0a	5.2a
2	0	0	0	0	0	1.5b	5.1b	5.2a

CONCLUSIONS

Harvested commodities from farm should be kept in the shade to minimize high relative humidity which could be a predisposing factor to the presence of bio-deteriorating fungi. The harvested commodities should be sorted, carefully packed in order to avoid bruises for the entrance of spoilage microorganisms.

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