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Advances in Biotechnology Research Vol. 1(1), pp. 1-9, October 2014
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Full Length Research Paper

Physicochemical profile and microflora associated with the spoilage of soursop fruits (*Annona muricata*)

Accepted 18 September, 2014

Abstract

An investigation was conducted on the microflora associated with the pulp of fresh and rotten fruits of *Annona muricata*. Microflora was more in the rotten fruits than in the fresh fruits. *Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Proteus* sp., *Klebsiella* sp., *Rhizopus* sp., *Fusarium* sp., *Candida* sp., *Mucor* sp. and *Aspergillus niger* were the microorganisms isolated from the rotten fruits while *S. aureus, Micrococcus* sp., *P. aeruginosa, Aspergillus niger, Candida* sp. and *Penicillium* sp. were isolated from fresh fruit. *Rhizopus* sp was the most dominant mycoflora in the rotten fruit having a percentage mean occurrence of 37% while *P. aeruginosa, S. aureus and Proteus* sp., were the most dominant bacteria in the rotten fruit with a percentage occurrence of 23.1%. Proximate composition and physicochemical analysis were carried out on the pulp of the rotten and fresh fruit. The results showed that the pulp of the fresh and rotten fruit contained an approximate mean value of 72.9 and 80.7% moisture, 11.8 and 10.5% ash, 0.84 and 0.76% titratable acidity, 4.01 and 2.89% crude fiber, 1.55 and 0.24% lipid, 1.43 and 0.42% protein, 8.47 and 5.25% carbohydrate and pH of 4.57 and 6.63 respectively. Different microorganisms, specifically bacteria and fungi occur within the rotten and apparently fresh fruits of *A. muricata* and these microbes can have health implication on humans and affect the value of the fruits in the food industry.

Key words: *Annona muricata*, microflora, mycoflora, proximate composition, physicochemical analysis.

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INTRODUCTION

Loss in nutritional value of fruits is brought about by contamination by different microorganisms either before harvest; pre-harvest deterioration or after harvest; post-harvest deterioration (Amusa et al., 2003). In other words, the most frequent reason for quality deterioration of food products is as a result of microbial activity and this often results in food molding, fermentation, and change in acidity (Gow-Chin and Asin-Yan, 1996). More often than not, the tissue of normal healthy fruits is generally without experimental evidence considered to be sterile although occurrences of microorganisms in different parts of fresh fruits have been reported by some workers (Okigbo, 2001). The fruit surface may consist of pathogenic epiphytic microbes, which may belong to subjects of microbial world, which include the bacteria, yeast, molds, and viruses (Hanklin and Lacy, 1992). The general bacteria association with the fruit outer surfaces includes both the gram positive as well as the gram negative bacteria spanning over varied morphological structures such as bacillary rods to spherical coccoid cells. The predominant gram negative bacteria include the genus belonging to family *Pseudomonadaceae*, genus *Pseudomonas* and *Xanthomonas*, family *Enterobacteriaceae*, genus *Flavobacterium*; gram negative rods belonging to family *Bacilaceae*, genus *Bacillus* and *Lactobacillus*; the coccoid bacterial; genera include the members of family *Micrococcaceae*; genus *Micrococcus*, family *Staphylococcaceae*; genus *Staphylococcus*, family *Streptococcaceae*; *Streptococcus equines*, *Streptococcus salviarus*, *Streptococcus faecalis*, *Streptococcus mitis* and *Sarcinae* (Lindow et al., 1998). The presence of these microorganisms has been shown to occur at any stage from standing crop through to harvest handling operation until they reach the consumer (Singh et al., 1990; Okigbo, 2009).

The non-stringent or unsafe practice during handling and packaging of fresh produce can inoculate the surface of the fruits with human and plant pathogens. Thus, the surface flora of fresh products reflects the environmental flora where the produces are grown, quality of irrigation water, use of partially processed comport or manure, conditions of harvesting and processing equipment etc.

The bacterial flora may range from common bacteria often isolated from soil, water and vegetation such as

Bacillus sp., *Enterobacter* spp., *Klebsiella* spp., *Ralmella aquatilis* and *Serratia* spp., which are not considered to be of hygienic importance, to potentially pathogenic bacteria including the *Shigella*, *Salmonella*, *Escherichia coli*, *Bacillus cereus*, *Listeria monocytogenes* and *Campylobacter* spp. that inhabit animal and human intestine. The gram positive cocci such as toxinogenic *Staphylococcus aureus* can be inoculated on the fruit surfaces during distribution and handling (Johannessen et al., 2002). These organisms which are natural inhabitant of human skin could be pathogenic on the fruit thereby leading to spoilage and could result into food borne diseases when ingested. The spoilage molds that are associated with fruit like certain strain of *Aspergillus*, *Mucor*, *Rhizopus* etc., produce mycotoxins that have bad impacts on the different part of the fruits resulting into spoilage.

In these fruits, fungal contamination is reported to be the most prevalent microflora and also their most important pathogens, without neglecting the fact that bacterial contamination is also an important source of the fruit spoilage. Therefore, the occurrence of bacteria and fungi as the prevalent organisms in fruits is of primary importance in this study as some of these microflora have the potential to produce toxins which are secondary metabolites of organisms that are toxic and/or carcinogenic in some cases (Tseng et al., 1995; Okigbo, 2009). For example, many infertility cases and other infection have been traced to be caused by some microflora, although their toxicity depends on the species and level of exposure (Osuide, 1999).

Furthermore, nutrient depletion, quality loss, and damage of physiological structures before consumption or converting into secondary products is as a result of the toxins produced by these microflora (McDonald et al., 2006).

Soursop (Plate 1) is known locally has guanabana, graviola, prickly custard apple, guyabano, sirsak and has the scientific name of *Annona muricata*. It belongs to the family Annonaceae and indigenous to tropical North and South America. It is one of the exotic fruits prized for its very pleasant, sub-acid, aromatic and juicy flesh which consists of edible white pulp and a core of Indigestible black seeds (Lutchmedial et al., 2004). The fruit is a fleshy syncarp, formed by the fusion of numerous ripened ovaries and the receptacle. The family Annonaceae comprises about 80 genera and 850 species occurring in the tropics but with relics of earlier distributions remaining in some temperate regions (Dupriez and De Leener, 1989).

A. muricata alkaloids have also been reported to have anti-inflammatory and anti-microbial properties (Kumar and Tandon, 1979; Okwulehie and Alfred, 2009). However, it is highly susceptible to spoilage, softens very rapidly during ripening, and becomes mushy and difficult to consume. It is sold in local markets and is rejected at market because of external injuries or uneven shape and size (Abbo et al., 2006). It produces large heart-shaped edible fruit of various sizes, average fruit weight is about 0.5 kg. It is yellow green in color with white flesh (National Academy of Science, 1978; Okigbo, 2009). Soursop has many therapeutic properties; the juice is diuretic while the other parts have antibacterial, anticancerous, astringent, sedative, and other properties (Asprey and Thornton, 1995).

The number of edible tropical fruits is legion and thousands of them are used locally. Several tropical fruits have already been exploited. While edible fruits occur in a vast number of families, they are particularly important in Anacardiaceae, Annonaceae, Myrtaceae, Rutaceae, Sapotaceae and Sapindaceae (Ifeoma et al., 2004).

Soursop, like other tropical fruits, serves as a potential source of raw materials for fruit products such as juice, beverages, wine, jellies, jam puree, power fruit bars, and flakes (Abbo et al., 2006). The economic and nutritional importance of fruits to Nigerians cannot be overemphasized (Aluko, 1989; Okigbo, 2009). It is a major source of income for many farmers who cultivate them for fresh produce markets. It also provides a source of nutrients and play important role in the diet of many people living in the tropics by raising its nutritional value through the provision of essential minerals and vitamins and addition of flavors, colors and variety to the diet and equally by contributing to the proteins and calories contents of the diet (Okigbo, 2001). For instance, the food value per 100 g edible portion of soursop contains 29.6 mg of ascorbic acid, 11 mg of trytophan, 11.00 g of protein, 14.63 g of carbohydrates, and a lot of sugar (Amusa et al., 2003). Hence, the fruit is nutritionally high in carbohydrates, particularly fructose, and contains significant amounts of vitamin C, vitamin B1, and vitamin B2 (Amusa et al., 2003). However, adverse physical and biochemical changes in these fruits tissues can lower acceptability and nutritional value (Vyaya and Karana, 1981; Okigbo, 2009). However, the production of fruit crops in Nigeria is seasonal, thus, there is a need to preserve and store them from time of harvest through the period of scarcity, for the purpose of retaining them as foods and articles of trade (Osuide, 1999).

The fruit of *A. muricata* plays many important roles in the diet of many in several parts of the tropics including Nigeria. However, the numerous uses and the potentialities of these fruits are reduced by the high rate of its deterioration both on the tree top and in storage. This information aroused the interest of the researchers in investigating the deteriorative agents involved in the deterioration of the fruits in order to recommend appropriate control measures to reduce the susceptibility of the fruit to microbial spoilage. Information on the microflora associated with the spoilage of soursop (*A. muricata*) fruit is scanty and occurrence in the rotten fruits of the plant has not been documented in this part of the world. This work, therefore investigates the different microflora associated with the spoilage of soursop fruits (*A. muricata*), coupled with a detailed information on the

physicochemical profile of the fruits (*A. muricat*a).

MATERIALS AND METHODS

Sources of materials

Fresh healthy fruits of various sizes were collected from soursop trees in the Department of Botany, Obafemi Awolowo University, Osun State, Nigeria. The plant was authenticated in Botany Department of the University. These fruits were refrigerated until required for analysis whereas those for rotten fruits analysis were packaged in polyethylene bags and taken to the laboratory where they were kept until needed.

Isolation, characterization and identification of fungi from the pulp of fruit

Determination and isolation of fungal pathogens from the pulp

Two fresh fruits were thoroughly washed with sterile water after which the surface of the skins was sterilized with 70% ethanol. With the aid of sterile forceps and sterile gloves worn, the fruits were hand peeled; small strips of each of the pulp of the two fruits were obtained aseptically and plated. Pulps from each fruit were plated separately in two different Petri dishes (three strips to a plate) in the already prepared media (Sabourand dextrose agar [SDA] incorporated with streptomycin). This was also done to the pulp of the rotten fruits.

Determination of percentage occurrence of the fungal isolates

This was done to determine the incidence of occurrence of the different fungal isolates. The frequency of occurrence of the pathogens from the pulp, of the soursop fruit was determined. The total number of each isolate in the pulp sample was obtained against the total number of all the isolates in the sample screened. The mean value of this gives the percentage of occurrence as the following equation shows:

% of occurrence = X/N × 100; where X = total number of each isolate in the sample and N = total number of all the isolates in the sample.

Identification of isolated fungi

The identification of the isolated fungi was done both macroscopically and microscopically. The gross morphology of the fungal growth on plates was studied including their colors. Small portions of the fungal pure culture were teased and mounted in lactophenol in cotton blue dye on a clean slide and covered with a clean cover slip and observed under the microscope. The identities of the fungi were certified using cultural method as well as comparing them with confirmed representative identified by means of keys (Booth, 1977; Okigbo 2009). The incidence of occurrence of each fungus was calculated using a formula (Buroughs, 1971; Okigbo, 2009).

Isolation and Identification of bacteria from pulp of the fruit

Pour plate method was employed for the determination of bacteria load of the sample using different solid media. Ten folds serial dilutions of the sample were made and 10^5 dilution of the sample from both fresh and rotten fruit was plated out on Nutrient agar, MacConkey, Mannitol Salt Agar. These plates were then incubated for 24 h at 37°C. After incubation, observed colonies was counted and then isolated. The bacterial isolates after obtaining pure culture was further subjected to gram staining reactions to aid in identification after which they were examined for carbohydrate production of indole from tryptophan, citrate utilization, catalase production coagulase and oxidase test. The bacterial isolates were also identified by comparing their characteristics with those of known taxa, as described by Jolt et al. (1994), Oyeleke and Manga (2008).

Physicochemical analysis of the fruit

The moisture, crude protein, lipid, ash, crude fiber, titratable acidity (g citric acid/100 g), pH and the carbohydrate content of the pulp of the fruit were obtained using standard methods (Lowry et al., 1951; AOAC, 2009). All analyses were done in duplicates.

Statistical analysis

Data were subjected to Student's t-test to determine the significance of difference between the mean values of the physicochemical parameters involving both the rotten and fresh fruits. Significance was defined at $p<0.05$.

RESULTS

Isolation and identification of fungi

The fungi isolated from the pulp of both fresh and rotten soursop fruits showed that lesser species of fungi were isolated from the fresh fruit than the rotten fruit (Figure 1). These included: *A. niger (Plate 3)*, *Candida* sp., and *Penicillium* sp., while the isolated fungi from rotten fruit included *A. niger*, *Mucor* sp., *Fusarium* sp., *Candida* sp., and *Rhizopus* sp. The incidence of *Penicillium* sp., was highest in the fresh fruit with 50% occurrence while the incidence of *Rhizopus* sp., was highest in the rotten fruit with 37% occurrence (Figure 2). *Rhizopus* sp., *Mucor* sp., and *Fusarium* sp., occurred only in the rotten fruit while *Penicillium* occurred only in the fresh fruit. *A. niger* and *Candida* sp., occurred in both the rotten and fresh fruit. The morphological characterization of the isolated fungi from the fresh and rotten pulp of soursop fruits is shown in Table 1.

Isolation and identification of bacteria

The bacteria isolated from the pulp of both fresh and rotten soursop fruits also showed that lesser species of bacteria were isolated from the fresh fruit than the rotten fruit (Table 2). These included: *S. aureus, Micrococcus* sp., *P. aeruginosa* while the isolated bacteria from rotten fruit included *P. aeruginosa, E. coli* (Plate 4), *Proteus* sp., *Klebsiella* sp. and *S. aureus*. The incidence of *S. aureus* was highest in the fresh fruit with 42.9% occurrence while the incidence of *P. aeruginosa, S. aureus* and *Proteus* sp., was highest in the rotten fruit with 23.1% occurrence (Table 3). *Klebsiella* sp., *E.coli and Proteus* sp., occurred only in the rotten fruit while

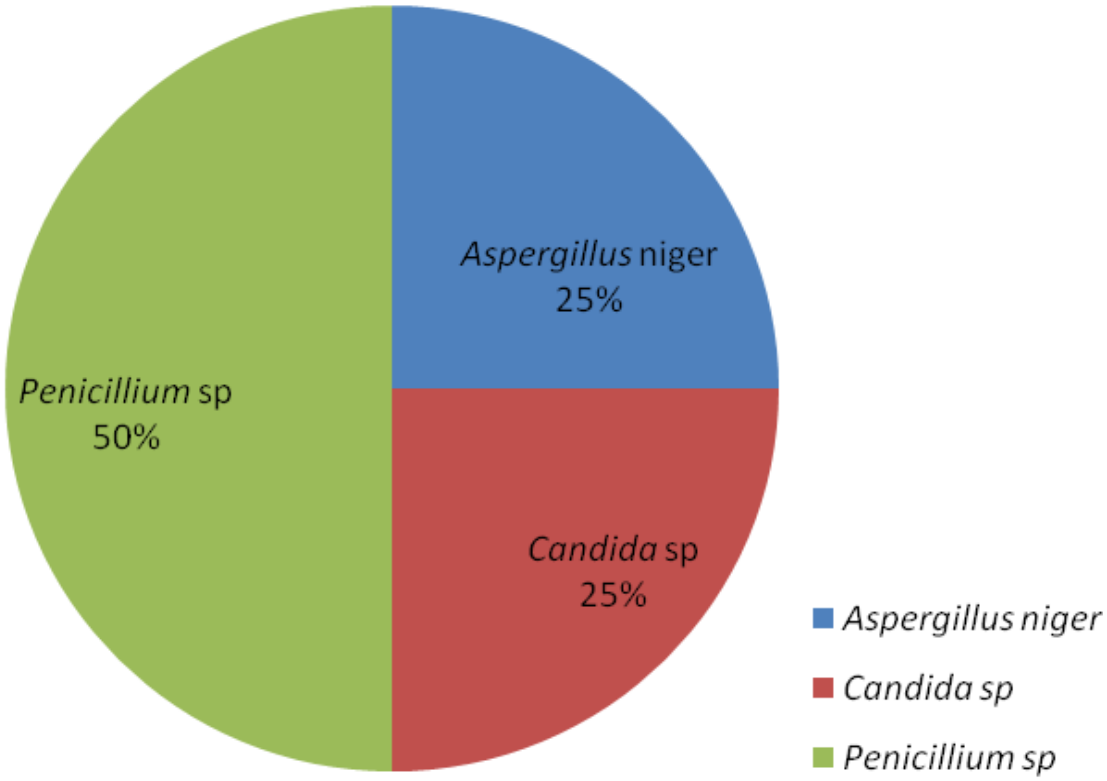


Figure 1. Mean percentage occurrence of fungi in the pulp of the fresh fruit of *Annona muricata.*

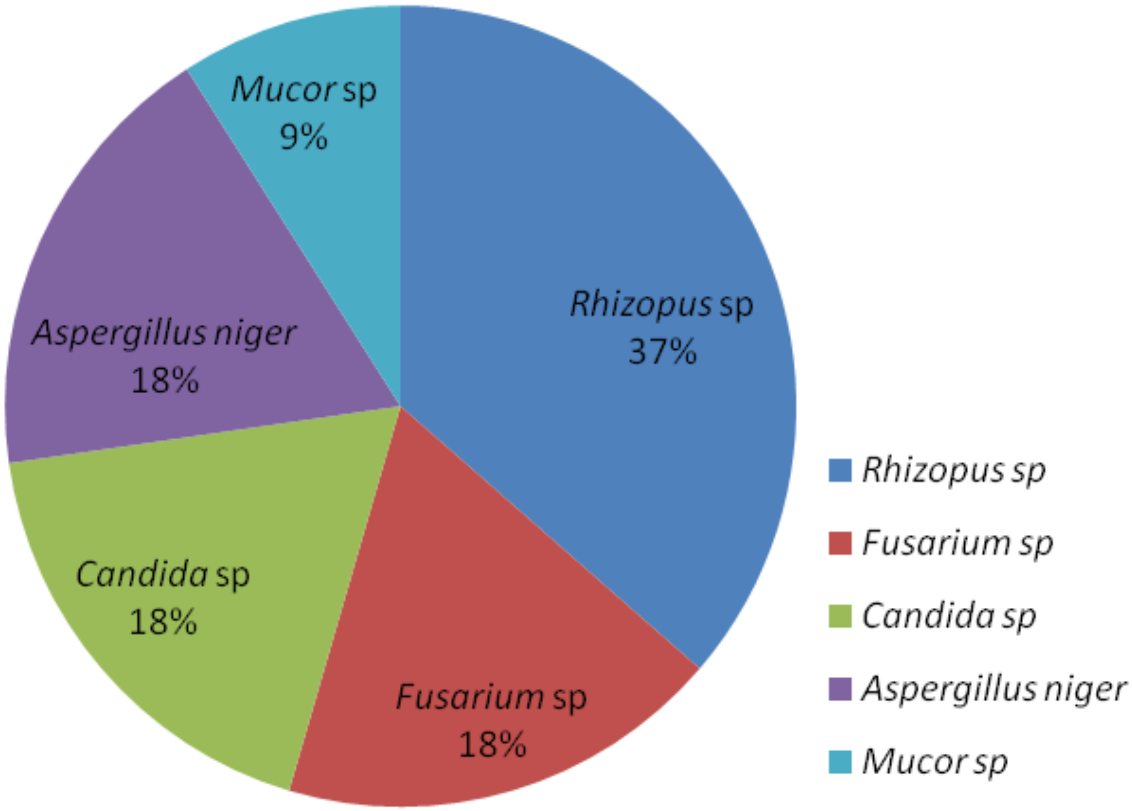


Figure 2. Mean percentage occurrence of fungi in the pulp of the rotten fruit of *Annona muricata.*

Table 1. Morphological characteristics of fungi isolated from fresh and rotten pulp of *Annona muricata.*

Colonial morphology	Microscopic	Fungi identified	Source of isolation
Effuse black colonies	Simple septate and conidia	*Aspergillus niger*	Fresh and rotten fruit
White smooth glabrous and yeast like colonies	Spherical budding yeast-like cells	*Candida* sp.	Fresh and rotten fruit
Powdery white colonies	Presence of a round conidia with a small hyphae	*Penicillium* sp.	Fresh fruit
Woolly whitish colonies	Presence of a broad non-septate hyphae	*Mucor* sp.	Rotten fruit
Pale white colonies with a cottony aerial mycelium	Presence of macroconidia	*Fusarium sp.*	Rotten fruit
Gray white mycelium with dark spot	Presence of hyphae, straight unbranched and bore opposite rhizoids	*Rhizopus sp.*	Rotten fruit

Table 2. Mean percentage occurrence of bacteria in the pulp of the fresh fruit of *Annona muricata.*

Bacteria	No.(%)
Staphlococcus aureus	42.9
Micrococcus sp.	28.6
Pseudomonas aeruginosa	28.6
Total	100.0

Table 3. Mean percentage occurrence of bacteria in the pulp of the rotten fruit of *Annona muricata.*

Bacteria	No. (%)
Pseudomonas aeruginosa	23.1
Staphylococcus aureus	23.1
Escherichia coli	15.4
Proteus sp.	23.1
Klebsiella sp.	15.4
Total	100.0

Micrococcus sp., occurred only in the fresh fruit. *P. aeruginosa* and *S. aureus* occurred in both the rotten and fresh fruit. Bacteria have the highest frequency of occurrence on both the rotten and fresh fruits. Thus, they are the most predominant organism in the fruit (Figure 3).

Physicochemical quality of rotten and fresh soursop fruit

The physicochemical composition of the fruits is shown in Tables 4. There is no significant difference between the mean values of the various physicochemical parameters determined in both the rotten and fresh fruit ($p>0.05$).

The pH of the two fresh fruit samples was 4.58 and 4.56 respectively and that of the rotten fruit samples was 6.68 and 6.57. The values of other parameters are indicated (Table 4). Generally; there is a depletion of nutrient in the rotten fruit with respect to a reduction in some of the values of their proximate parameters as compared with the fresh fruits.

There are changes across the values of the physicochemical parameters involving both the rotten and fresh fruits (Figure 4).

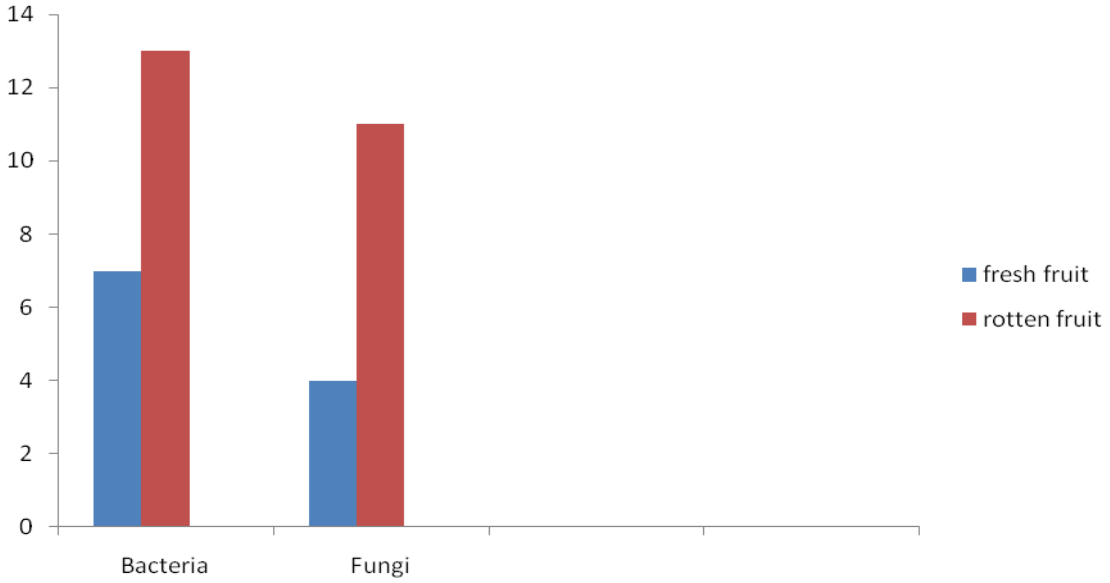


Figure 3. Frequency of occurrence of microflora isolated from fresh and rotten soursop fruit.

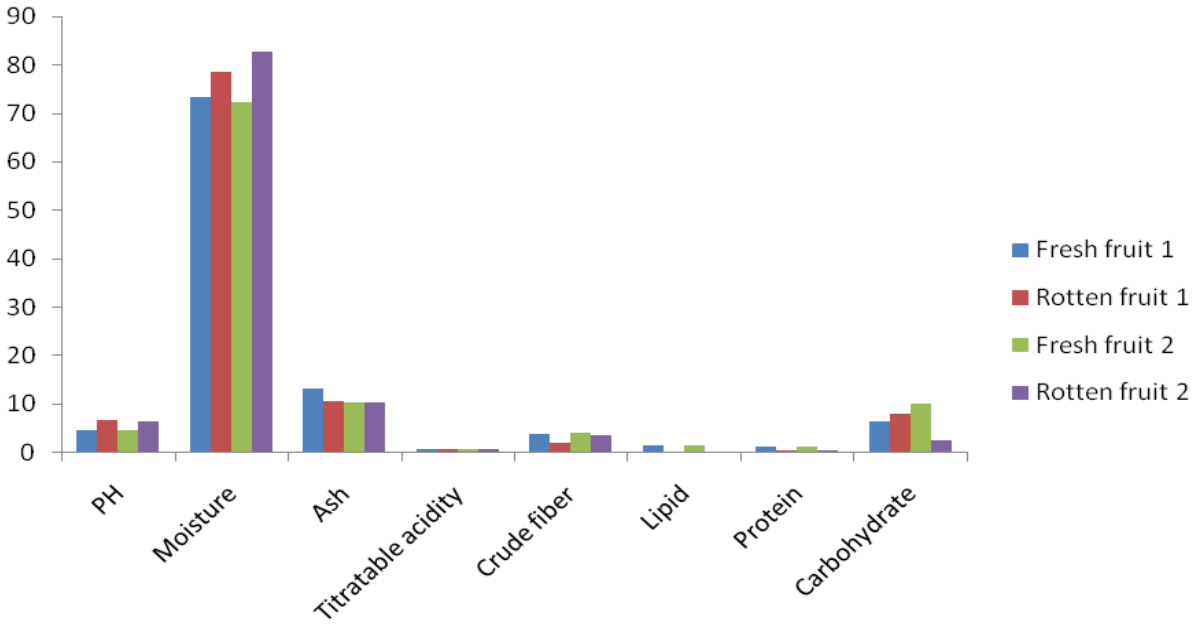


Figure 4. The changes in the various physicochemical parameters between the rotten and fresh fruit samples.

Table 4. The approximate physicochemical composition of soursop fruit.

Sample	pH	M	A	TA	C/F	L	P	C
Fresh (1)	4.57	73.3	13.3	0.82	3.85	1.58	1.42	6.55
Rotten (1)	6.68	78.6	10.7	0.77	2.08	0.26	0.40	7.96
t =0.3935 (p>0.05)								
Fresh (2)	4.56	72.4	10.3	0.85	4.17	1.52	1.43	10.18
Rotten (2)	6.57	82.8	10.3	0.75	3.70	0.22	0.43	2.55
t =0.4479 (p>0.05)								

M = Moisture, A = Ash, TA = Titratable acidity, C/F = Crude Fiber, L = Lipid, P = Protein, C = Carbohydrate.

DISCUSSION

Microorganisms have been reported to cause extensive deterioration of fruits and vegetables (Rezende et al., 2009). Some of these microorganisms cause rotting, discoloration or fermentation of the fruits which affect their preservation.

This research revealed that both the rotten and fresh fruit of soursop (*A. muricata)* possess appreciable number of microflora in the pulp. The Microflora isolated and observed coincides with other reports (Amusa et al., 2003). There were more bacteria and fungi isolated from the rotten fruit (Figure 3). This could be due to the fermentation processes taking place in the rotten fruit which favored bacterial and fungal growth. It could also be as a result of the moisture content of the fruit as well as the difference in the nutritional composition of the fruits (Abbo et al., 2006).

It has been reported that moisture impacts effectively on microbial growth, thus the rotten fruits with more moisture levels have more number of microorganisms (Buroughs and Saver, 1971; Okigbo, 2009). This work indicated that bacteria are the most predominant organisms of the fruits as it occurred more numerously than fungi on both the fresh and rotten samples. However, this is contrary to an earlier report that fungi are the most prevalent microorganisms (Tseng et al., 1995; Okigbo, 2009).

This variation could be as a result of the differences in the sources of sample collections and most importantly could be due to the limitation of the earlier research conducted that was basically focused on the mycoflora of the fruit only.

This work equally agreed with previous findings that some of the isolated microflora could be responsible for inducing spoilage in the fresh fruit (Amusa et al., 2003). *Rhizopus* sp. and *Fusarium* sp. which were not isolated from the fresh fruit (Table 1) but were more predominant in the rotten fruit could induce spoilage due to the fact that they have a high percentage of occurrences. *Proteus* sp., *Escherichia coli,* and *Klebsiella* sp. could also induce spoilage in the fresh fruit as these organisms were isolated from the rotten fruit and are often associated with spoilage of food items. The microflora of the soursop fresh fruit according to this research are; *S. aureus, Micrococcus* sp., *P. auriginosa, A. niger* (Plate 3)*, Candida* sp. and *Penicillium* while that of the rotten fruit are; *P. auriginosa, S. aureus, E. coli* (Plate 4)*, Proteus* sp., *Klebsiella* sp., *Rhizopus sp., Fusarium* sp., *Candida* sp., *Mucor* sp. and *A. niger*. A close observations of the fruit microflora showed that many of them were the same as those isolated from black plum (Okigbo, 2001). However, any of these microorganisms could become pathogenic to the fruit when conditions are unfavourable.

Furthermore, when the rotten and fresh soursop fruits were physically and chemically analyzed to determine its nutritional composition, there was increase in the value of the ash content, titratable acidity, crude fiber, lipid content, protein content and carbohydrate content of the fresh fruits while there was a reduction in the afore-mentioned parameters as regards the rotten fruit (Table 4), thus, giving an indication of nutrient depletion as a result of the intense microbial activities in the rotten fruit. These findings tailed with earlier report (Okigbo, 2009).

However, the moisture content and the pH of the rotten fruit were higher than the fresh fruit. The high pH value which is slightly acidic could be as a result of the impacts of moisture on the fruit thus bringing about the effectiveness of microbial growth that changes the acidic nature of the fruit to a slightly acidic state so as to favour their growth.

Generally, the moisture content of the pulp of soursop fruit has shown in this research indicated that the fruit has very high moisture content (72.9%).

This compares favourably to earlier findings on the biochemical analysis of the pulp of soursop fruit (Ifeoma et al., 2004) where the moisture content of the fruit pulp was found to be (75%). However, this is contrary to earlier findings of the moisture content of the pulp of *Vitex doniana* that was known to have a moisture content of (18.6%) (Okigbo, 2001), the reason for this variation could be attributed to the differences in the biological make-up of the fruits.

The protein content of the soursop fruit pulp (1.43%) has shown in this research is lower than that reported in a similar finding for ripe soursop fruit juice (2.9%) (Ifeoma et al., 2004), this variation could also be as a result of the freshness and non-ripeness of the fruit used for this research. However, the protein content of the soursop fruit has been found to be higher than that reported for African bush mango juice (0.52%), and *V. doniana* (0.8%) (Onimawo, 2002), reasons could be attributed to the variations in the fruits used and the differences in their botanical make-up.

The ash content of the fresh soursop fruit pulp shown in this finding is 11.8%. However, this is contrary to the early findings of the ash content of the seed of soursop fruits (Onimawo, 2002) with an ash content of 13.6%. This variation could be as a result of the seed make-up of the fruit which is quite different from the pulp. The ash content is however higher than that reported for African bush mango which was 0.5% (Okigbo, 2001).

The pH value of 4.57 for the pulp of the soursop fruit indicates that it is slightly acidic, similar to earlier findings on the mycoflora of the soursop fruit where the pH of the fruit was shown to be 4.5 (Okigbo, 2009). This is also similar to the pH value reported for the pulp of *V. doniana* with a pH of 4.53 (Okigbo, 2001). Conclusively, the crude fibre, protein, carbohydrate, lipid, titratable acidity and ash content decreased in the rotten fruit when compared to the fresh soursop fruit as earlier mentioned. This shows that microbial activity affect the physical and chemical composition of the soursop fruit thereby causing nutrient depletion.

CONCLUSION

With the number of isolated microorganisms from the pulp of the fresh and rotten soursop fruits, it can be concluded that different microorganisms occur within both the rotten and apparently fresh healthy fruits of *A. muricata* and that some of these microbial isolates have the potential to induce rot on fresh fruits which might have a remarkable effect on the value of the fruit especially in the food industry as well as on human health.

The physicochemical analysis conducted on the fruits has however shown that the fruit is a good source of nutrient and could be used for many industrial applications.

However, as part of recommendation to reduce the susceptibility of the fruit to microbial spoilage and to ensure its effectiveness in different applications, the following measures should be taken:

(i) There should be prompt removal of over-ripe fruits under the *A. muricata* trees (Plate 2) to reduce inoculum levels of the pathogenic microorganisms.
(ii) Careful handling is also recommended to ensure minimal damage of the fruit.
(iii) In respect to the maximization of the potentialities of the fruit in many industrial applications, the utilization of soursop pulp for wine production is therefore recommended due to its favourable physicochemical characteristics.

ACKNOWLEDGEMENTS

The researchers wish to express their sincere gratitude to the Head of Department, Biosciences and Biotechnology, College of Pure and Applied Sciences, Kwara State University, Malete: Dr. S.K. Babatunde for prompt assistance and contribution to the success of the research. We also acknowledge the Microbiology Technologists for their timely assistance.

REFERENCES

Abbo ES, Olurin T, Odeyemi G (2006). Studies on the storage stability of soursop (*Annona muricata* L.) juice. Afr. J. Biotechnol. 5(19): 1808-1812

Aluko RE (1989). Biochemical properties of some tomato fruit cultivars grown in northern Nigeria. Nig. J. Bot. 2:157–164.

Amusa NA, Ashaye OA, Oladapo MO (2003). Pre-harvest deteriorations of soursop (*Annona muricata*) at Ibadan South Western Nigeria and its effect on nutrient composition. Afr. J. Biotechnol., 2(1):23–25.

AOAC (2009). Official Methods of Analysis of the Association of Official Analytical Chemists. Washington, DC.

Asprey GF, Thornton P (1995). Medicinal plants of Jamaica. J. West Indian Med. Plants. 4:69–92.

Booth CH (1977). *Fusarium*: Laboratory guide to the identification of major species. Kew, UK: Commonwealth Mycological Institute; 1977.

Buroughs R, Saver DB (1971). Growth of fungi in Sorghum grains stored at high moisture contents. Phytopathology., 61:767–772.

Dupriez H, De Leener P (1989). African gardens and orchards: growing vegetables and Fruits. 1st ed. Macmillan Publishers Ltd. London and Basingstoke: 286-287.

Gow-Chin Y, Asin-Yan L (1996). Microbial, enzymatic and chemical changes during storage of fresh and process orange juice. J. Food Sci., 57:1187–1197.

Hanklin L, Lacy GH (1992). Pectinolytic microrganisms in C Vanderzant, DF Splittstoesser(eds) compendium of methods for the microbiological examination of foods. J. Am. Public Health Assoc., Washington, 176-183.

Ifeoma B, Josephine O, Timothy E, Charles O (2004). The biochemical analysis of soursop (*Annona muricata*) and sweetsop (*A.squamosa*) and their potential use as oral rehydration therapy. J. Food Agric. Environ., **2**(1): 39-43.

Johannessen GS, Loncarevie S, Krush H (2002). Bacteriological analysis of fresh produce in Norway. Int. J. Food Microbiol., 77: 199-204

Jolt JG, Krieg NR, Sneath HA, Stanley JT, Williams ST (1994). Bergey's manual of systematic bacteriology, 9th edition. Williams & Wilkins Co. Baltimore, Maryland: 786

Kumar S, Tandon MP (1979). Post Infection changes in organic acid contents of *karaunda* fruits. J. Indian Phytopathol., 32: 134-135.

Lindow S.E, Desurmont C, Elkins R, McGourty G, Clark E, Brandl MT (1998). Occurrence of indole-3-acetic acid –producing bacteria on pear trees and their association with fruit russet. J. Phytopathol., 88: 1149-1157.

Lowry OH, Rosebrough NJ, Farr AL, Randall RJ (1951). Protein measurement with the folin phenol reagents. J. Biol. Chem. 193:265-275.

Lutchmedial M, Ramlal R, Badrie N (2004). Nutritional and sensory quality of stirred soursop (*Annona muricata*) yoghurt. Int. J. Food Sci. Nutr., 55:407–414.

McDonald J.K, Caffin N.A, Sommano S, Cocksedge R (2006). Effect of Postharvest Handling on Selected Native Food Plants. Barton, Australia: RIRDC No: 06/021

National Academy of Science (1978). Under exploited tropical plant with promising economic value. Washington, DC.

Okigbo RN (2001). Mycoflora within black plum (*Vitex doniana*) Sweet fruit., 56:85–92.

Okigbo RN (2009). Mycoflora and production of wine from fruit of soursops. Int. J. Wine Res., 1: 1-9

Okwulehie IC, Alfred, NK, (2009). Fungi associated with deterioration of sour-sop (*Anona muricata*. Linn) fruits in Abia State, Nigeria. Afr. J. Microbiol. Res. Vol. **4**(3): 143- 146

Onimawo IA (2002). Proximate composition and selected physicochemical properties of the seed, and pulp of soursop fruits. J. Plants Foods Human Nutr., 57:165-171

Osuide GE (1999). Post-harvest losses implication for food quality and safety. Proceedings of 23rd Annual Conference of Nigeria Institute of Food Science and Technology, Abuja, Nigeria. 270-272.

Oyeleke SB, Manga SB (2008). Essentials of Laboratory Practicals in Microbiology. Tobest publisher, Minna, Nigeria. 36-75.

Rezende ABC, De Castro MF, Porto E, Uchima CA, Benato E, Penteado AL (2009). Occurrence of *salmonella* spp. In persimmon fruits (*Diospyrus kaki*)., J. Food Quality Control 20: 1025-1029.

Singh P, Tanbson E, Buangusuwon D (1990). Aflatoxin in maize in Thailand. Proc ACJAR. 36:187–193. (*Phaseolus vulgaris*) produced in Taiwan and in Ontario, Canada. 36:229–234.

Tseng TC, Tu JC, Tzean SS (1995). Mycoflora and mycotoxins in dry bean (*Phaseolus vulgaris*) produced in Taiwan and in Ontario, Canada. Bot Bull Acad Sin., 36:229–234.

Vyaya KP, Karana D (1981). Determination of Cowpea seeds in storage by *Aspergillus flavus*. J. Indian Phytopathol., 34:222–223.

How to cite this article:
Ajiboye AE, Ajuwon IB, Adedayo MR (2014). Physicochemical profile and microflora associated with the spoilage of soursop fruits (Annona muricata). Adv. Biotechnol. Res. Vol. 1(1): 1-9.

APPENDIX



Plate 1. Soursop fruit.



Plate 2. Soursop fruits on the tree.

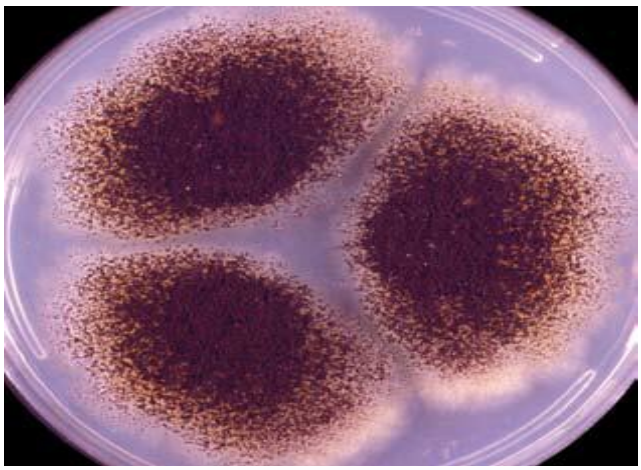


Plate 3. Culture morphology of *A. niger.*



Plate 4. Culture morphology of *E. coli.*

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