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THE NUTRITIONAL QUALITY AND MICROORGNISMS ASSOCIATED WITH THE SPOILAGE OF *Dacryodes edulis* FRUITS IN EZIOBODO, OWERRI WEST LOCAL GOVERNMENT AREA, IMO STATE, NIGERIA.

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ABSTRACT

The African pear tree (*Dacryodes edulis*) is a tropical *oleiferous* fruit tree that possesses enormous potential in Africa. *Dacryodes edulis* fruit is popular in the diets of many Africans. It can be eaten raw, roasted or boiled in hot water and is eaten alone or used in garnishing cooked or roasted maize. It could also be used as butter to eat bread. The nutritional quality and microorganisms associated with the spoilage of *Dacryodes edulis* fruit (African Pear) was investigated. *Dacryodes edulis* fruit samples were obtained from Eziobodo Community farm and Eziobodo market in Owerri West L.G.A, Imo state, Nigeria. Bacteria and fungi species were isolated and characterized from the fruit. The organisms isolated were bacteria; *Bacillus* sp, *Erwinia* sp, *Xanthomonas* sp, *Pseudomonas* sp, *Staphylococcus* sp, *Escherichia coli*, *Lactobacillus* sp. Fungi; Alternaria sp, *Trichoderna* sp, *Geotrichum* sp, *Aspergillus* sp, *Fusarium* sp, *Cladosporium* sp *and*

Sacchromyces sp. The nutritional quality of the fruit was determined using standard methods. Observation shows that the most prevalent bacteria and fungi species isolated from both farm and market samples were *Bacillus* sp (36% and 86%) and *Aspergillus* sp (14% and 43%). The least prevalent are *Lactobacillus* sp (2%) and *Geotrichum sp* (3%) for farm samples and *Xanthomonas* sp (12%) and *Saccharomyces sp* (21%) for market samples. Moisture contents increased from 12.3 to 18.2 for 0 to 7th day, while crude fibre, ash content and fat contents decreased from 13.1 to 8.5, 2.81 to 1.49 and 53.21 to 38.31 within 0 to 7th day respectively. Spoilage microbes not only reduced the nutritional quality of the fruits, but pose public health challenge to the populace. Thus proper washing of the fruits should be ensured before consumption.

Keywords: *Dacryodes edulis*, nutritional quality.

1. INTRODUCTION

Dacryodes edulis (African Pear) is an important fruit in tropical Africa. The tree is common in the region and belongs to the family Burseracec, this family are mainly shrubs and trees with resinous aromatic gum on their bark. The fruit has a central core with fleshy edible layers as epicarp and mesocap. It is found in the rain forest zone of Africa ranging from Serria Leone, Ghana, Nigeria, Equatorial Guinea, Cameroun and other such areas [1] [2]. It is called by different names among the Nigerian tribes, Ube (Igbo), Eben (Efik) and Elemi (Yoruba). The tree of *Dacryodes edulis* var. edulis has stout and the fruit is larger, the tree has an ascending branches. *Dacryodes edulis* var. parvicarpa has smaller fruit and slender, drooping branches. African pear fruit is important because of its nutritional value as a major and cheap source of protein, fat, carbohydrates, vitamins and minerals. The fruit contains 6.39% protein, 33.50% fat, 47.7% carbohydrates, 10.67% crude fibre and 9.0% moisture. It is rich in Vitamin C, which can protect the body cells from oxygen-related damage caused by free radicals; this is because it has antioxidant properties. Phosphorus (692.55-698.40mg/100g), potassium (540.81-553.15mg/100g), calcium (347.50-

354.6mg/100g), magnesium (280.15-287.65mg/100g) and sodium (162.50-170.0mg/100g) are the most abundant mineral element in the fruit pulp [3]. Because *Dacryodes edulis* have high nutrients composition, they are highly susceptible to invasion by specific microorganisms. To initiate fruit spoilage, microorganisms penetrate the intact cuticle of fruits through wounds and natural openings on the surface of fruits. Spoilage of the fruit has been attributed to some group of microorganisms, which include *Botryodiplodia, theobromae, Rhizopusstolonifer, Aspergillus niger* and *Erwinia sp* [4]. These soft rot microorganisms have been noted as *deteriogens* of *Dacryodes edulis* fruits. However, spoilage microbes not only reduce the nutritional quality of the fruit, but pose public health challenge to the populace. Thus proper washing of the fruit should be ensured before consumption. However *Dacryodes edulis* can be eaten raw, cooked in warm salt water or roasted [5]. Cooked flesh of the fruit has a texture similar to butter. The pulp contains 48% oil, a plantation can produce 7-8 tons of oil per hectare. The kernel can be used as fodder for sheep or goats. The flowers are useful in apiculture. Shade tolerant traditional crops, such as *Xanthosomas agittifolium* and taro can be co-cultivated with *D edulis* [6]. This study was carried out to evaluate the nutritional quality and microorganisms associated with the spoliage of *Dacryodes edulis* fruits.

2 MATERALS AND METHODS.

Sample Collection

Dacryodes edulis fruits were collected from farms (from trees directly, clean catch) in Eziobodo community farm and Eziobodo market Owerri west L.G.A, Imo state and immediately taken to the laboratory for analysis. Only mature deep/dark blue healthy fruits were used in the research.

Spoilage potentials of the isolated micro organisms

Storage of Samples

The samples were stored in sealed glass containers at room temperature (28 ± 2^0C). Samples were collected at 24 h interval for a period of one week. Samples were collected at 24 h interval for the microbiological and chemical analysis of the samples.

Microbiological Analysis

The mesocarps of *Dacryodes edulis* were cut aseptically using sterile forceps and Scalpels.

Five grams (5g) aseptically weighed into conical flasks containing 50 ml peptone water. The contents were transferred into a sterile mortar and homogenized into a watery paste [7]. Ten (10) fold serial dilutions of the samples were prepared by weighing out 10 ml of the pulp and suspended into 90 ml of sterile saline to form the stock. Using a sterile pipette, one milliliter (1.0 ml) of the solution was serially diluted in sterile saline solution up to 10^{-10}. Thereafter an aliquote (0.1 ml) of the dilutors 10^{-2} and 10^{-3} were plated out in triplicates on nutrient agar and Sabouraud dextrose agar (SDA) supplemented with 50 µg/mg. The plates were incubated for 24 h at the temperature of 37^0C for the nutrient agar plates (bacteria count) and 28 ± 2^oC for 72-120 h for SDA (fungi count). Microbial counts of the fruit pulp samples were reported as cfu/g.

Purification of isolates

The bacteria and fungi isolates were subcultured in nutrient agar and SDA, after 24 h and 72-120 h incubation respectively. The isolates were subcultured severally to get a pure culture of the isolates. The purified isolates were transferred into a nutrient agar slant and SDA slant and stored in a refrigerator at a temperature of 4^0C for identification and further test.

Identification of the isolates

The pure cultures of bacterial isolates were obtained by picking distinct colonies from countable plates and streaking on nutrient agar. They were identified based on morphological, microscopy and biochemical charactertics according to [8] [9]. Fungal isolates were characterized based on their morphology and microscopic characteristics based on [10].

Chemical analysis of *Dacryodes edulis* pulp

The matured ripe fruits were washed thoroughly in running tap water and rinsed three times with distilled water. The fruit was split open with a clean sharp knife, deseeded and the pulp separated for analyses on proximate, mineral composition and anti-nutrient contents.

Proximate Analysis

Moisture content was determined by the method off [11] [12]. Ash content, crude fat/oil and crude fiber were determined using the method by [13]. Crude protein (Nx6.25) was determined by the Kjedahl method [13]. The carbohydrate content of the fruit was obtained by inference through the formula stated by [14] as follows: Carbohydrate % = 100 – (Protein % + fat % + moisture content % + Ash % + Crude fibre %).

3. RESULT

Table 1, shows the percentage occurrence of bacteria and fungi isolates from *Dacryodes edulis* fruits from both farm and market. For bacteria, *Bacillus* sp., had the highest percentage occurrence in the farm with 36 %, while *Aspergillus* sp had the highest occurrence for fungi with 14 %. *Lactobacillus* had the lowest percentage of 2 % among the bacteria isolated, while for fungi, *Geotrichum* sp., had the lowest percentage occurrence with 3 %. *Staphylococcus* sp., *Escherichia coli*, and *Saccharomyces* sp. were not isolated from the *Dacryodes edulis* from the farm**.** *Bacillus* sp., also had the highest percentage of occurrence in the market with 86 %, while *Aspergillus* sp had the highest occurrence for fungi with 43 %. The lowest percentage was

recorded by *Xanthomonas* sp., (12 %), while for fungi, *Saccharomyces sp* had percentage occurrence of 21%. *Lactobacillus* was not isolated from the *Dacryodes edulis* from the market.

Table 1: Percentage occurrence of bacterial and fungal isolates from *Dacryodes edulis* fruits from farm and market

Organism	Farm (%)	Market (%)
Bacteria		
Bacillus sp.	36	86
Erwinia sp.	7	24
Xanthomonas sp.	5	12
Pseudomonas sp.	3	36
Staphylococcus sp.	-	40
Escherichia coli	-	27
Lactobacillus sp.	2	
Fungi		
Alternaria sp.	9	26
Trichoderna sp.	11	36
Geotrichum sp.	3	28
Aspergillus sp.	14	43
Fusarium sp.	12	36
Cladosporium sp.	10	29
Saccharomyces sp.	-	21

Table 2 shows the variation in nutritional contents and microbial loads with storage time. Moisture contents increased from 12.3 to 18.2 for 0 to 7th day, while crude fibre, ash content and

fat contents decreased from 13.1 to 8.5, 2.81 to 1.49 and 53.21 to 38.31 within 0 to 7th day respectively. The highest bacterial count was recorded on the 4th day with 2.7 x 10 ^{4} CFU/ml, the lowest count was recorded on at the zero hour (1.0 x 10 CFU/ml). The lowest fungi was recorded at the zero hour with 1.3 x 10 ^{1} CFU/ml, while the highest fungal count was recorded on the 7.1 x10 ^{4} CFU/ml. Table 3 shows the spoilage potentials of the isolated microorganisms. *Erwinia* sp., *Pseudomonas* sp., *Altennaria* sp., *Geotrichum* sp., *Clodosporium* sp. and *Rhizopus* sp. showed their spoilage potential on the 2nd day. *Staphylococcus* sp. and *Escherichia coli* showed their spoilage potential on the 4th day. Non of the microorganisms isolated showed spoilage potential on the 1st day. All the fungi species isolated showed their spoilage potential on the 3rd day.

Table 2: Variations in nutritional contents and microbial loads with storage time

							Microbial count (CFU/ml)	
Days	**MC**	**CF**	**ASC**	**CP**	**CHOc**	**FAT**	**Bacterial count**	**Fungi count**
0	12.3+0.03[a]	13.1+0.03[a]	2.81+0.05[a]	4.41+0.04[d]	13.13+0.02[a]	53.21+0.23[a]	1.0 x 10	1.3 x 10[1]
1	12.3+0.03[a]	13.1+0.03[a]	2.80+0.05[a]	4.46+0.04[a]	13.10+0.02[a]	53.19+0.21[a]	1.2 x 10[1]	2.2 x 10[1]
2	13.9+0.63[a]	11.4+0.42[b]	2.61+0.11[a]	5.82+0.06[b]	12.41+0.21[a]	51.31+0.41[a]	1.5 x 10[2]	2.1 x 10[3]
3	14.8+0.72[b]	10.2+0.62[b]	2.22+0.15[b]	7.93+0.09[c]	10.32+0.42[b]	49.38+0.44[b]	2.1 x 10[4]	4.7 x 10[3]
4	16.1+1.03[c]	9.8+0.91[c]	2.13+0.26[b]	7.03+0.08[c]	8.91+0.62[c]	42.11+0.31[c]	2.7 x 10[4]	1.3 x 10[4]
5	17.4+1.08[c]	9.1+1.10[d]	1.81+0.39[c]	4.74+0.11[d]	7.11+0.94[d]	40.31+0.54[d]	1.3 x 10[4]	3.1 x 10[4]
6	18.2+1.10[d]	8.7+1.34[e]	1.62+0.41[c]	4.61+0.14[d]	7.02+0.91[d]	39.21+0.51[a]	1.2 x 10[4]	2.1 x 10[4]
7	18.0+1.10[d]	8.5+34[e]	1.40+0.91[d]	4.02+0.20[e]	6.99+0.96[d]	38.31+0.81[d]	1.2 x 10[3]	7.1 x10[4]

* Figures followed by the same alphabets are not significantly different

* Figures followed by the different alphabets are significantly different

MC = Moisture content, CF = Crude fibre, ASC = Ash content, CP = Crude protein, CHOc = Carbohydrate content, Fat = Fat/oil content, CFu/ml= Colony Forming unit per mililitre.

Table 3: Spoilage potentials of the isolated microorganisms

Organism	No of days for spoilage signs to appear						
Bacteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
_ *Bacillus* sp.	-	-	X	X	X	X	X
_ *Erwinia* sp.	-	X	X	X	X	X	X
_ *Xanthomonas* sp.	-	-	X	X	X	X	X
_ *Pseudomonas* sp.	-	X	X	X	X	X	X
_ *Staphylococcus* sp.	-	-	-	X	X	X	X
_ *Escherichia coli*	-	-	-	X	X	X	X
_ *Lactobacillus* sp.	-	-	X	X	X	X	X
_ **Fungi**							
_ *Altennaria* sp.	-	X	X	X	X	X	X
_ *Geotrichum* sp.	-	X	X	X	X	X	X
_ *Aspergillus* sp.	-	-	X	X	X	X	X
_ *Fusarium* sp.	-	-	X	X	X	X	X
_ *Clodosporium* sp.	-	X	X	X	X	X	X

Saccaromyces sp.	-	-	X	X	X	X	X
Penicillum sp.	-	-	X	X	X	X	X
Rhizopus sp.	-	X	X	X	X	X	X

X = Spoilage signs observed
- =No sign of spoilage

DISCUSSION

The assessment of microbial spoilage of *Dacryodes edulis* (African pear) fruits showed the presence of seven bacteria (*Bacillus* sp., *Erwinia* sp., *Xanthomonas* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Escherichia coli* and *Lactobacillus* sp.) and eight fungi species (*Altennaria* sp, *Geotrichum* sp., *Aspergillus* sp., *Fusarium* sp., *Clodosporium* sp., *Saccaromyces* sp., *Penicillum* sp. and *Rhizopus* sp.). *Penicillium* sp., *Aspergillus* sp., *Escherichia coli* and *Staphylococcus aureus* were also isolated from *Dacryodes edulis* by [15]. The result obtained in this study is in agreement with [16], who also isolated mould; *Rhizopus stolonifer, Penicillium expansum* and bacteria; *Erwinia carotovora, Pseudomonas, fluorecens* and *Bacillus subtilis.* Generally, more of the fungi caused spoilage of African pear than bacteria, [17] and [18] reported that African pear has acidic mesocarp.

The fruit carbohydrates, proteins, fibre and fats/oil served as nutrient for the various organisms. Continuous metabolism of these nutritional components caused the decrease in their quantity. However, the initial increase in protein content experienced in the first two days is similar to the observation of [19] who observed a similar crude protein increase in African oil bean (Ugba). Fermentation of the fruit caused the release of some solid protein materials thereby making them available for assessment. However, when the micro-organisms continued to utilize them for growth, the protein content began to decrease as there were no more replacements.

Further observation showed that moisture content of the fruits increased till the end of the experiment. This is similar to the observation of [19] working on African oil been

seed. Fermentation caused the breakdown of solid plant materials with consequent release of liquid components [20]. The microbial spoilage of *Dacryodes edulis* also included the fermentation of the fruits hence the increase in the moisture content. Generally, the microbial spoilage of the fruits caused decreased nutritional value.

Omogbai *et al.*[21] reported that some fruits are not very good sources of fats and are usually recommended as part of weight reducing diets. The fat content of *Dacryodes edulis* fruit pulp was in the range 53.21-38.31 %. This is in agreement with [16], who recorded the value of fat content as 30.55-35.60 %. The value of the fat content higher compared to other fruits such as apple with 0.4 %, guava 0.4 %, banana 0.39 % and pawpaw with traces of oil. The high lipid content in the fruit pulp is significant for this fruit. Apart from the fact it contains linoleic acid, an important polyunsaturated fatty acid in human food which can prevent cardiovascular disorder, the oil is also rich in oleic acid which has oxidative stability important as frying oil [22]. Thus oils from this fruit can be exploited commercially as a source of edible and industrial fat which will in turn reduce dependence on the popular vegetable oils [16].

CONCLUSION

African pear fruit is important because of its nutritional value as a major and cheap source of protein, fat, carbohydrates, vitamins and minerals. It is evident that mature fruits including *D.edulis* fruit are highly susceptible to invasion by specific microorganisms because of their high nutrients composition. And micro organisms penetrate the intact of fruits through wounds and natural openings on the surface of fruits to initiate spoilage.

More so, spoilage of the fruits has been attributed to some group of microorganisms, which include; *Bacillus* sp., *Erwinia* sp., *Xanthomonas* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Escherichia coli, Lactobacillus* sp., *Altennaria* sp, *Geotrichum* sp., *Aspergillus* sp., *Fusarium* sp., *Clodosporium* sp., *Saccaromyces* sp., *Penicillum* sp. and *Rhizopus* sp. These microorganisms have been noted as deteriogens of *Dacryodes edulis* fruits. However, spoilage microbes not only reduce the nutritional quality of the fruit, but pose a public health challenge to the populace.

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