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Nutritional composition and fungal spoilage of African pear (*Dacryodes edulis*) fruits sold in Port Harcourt Metropolis, Nigeria

Authors:
Chukunda FA[1] and Offor U Stephen[2]

Institution:
1. Department of Forestry and Environment, Faculty of Agriculture, Rivers State University of Science and Technology, Rivers State, Nigeria.

2. Department of Agricultrual Sciences, Ignatus Ajuru University of Education, Port Harcourt, Nigeria.

ABSTRACT:

The nutritional composition and fungal spoilage of *Dacryodes edulis* fruits were carried out in the Department of Forestry/ Environment Laboratory using standard procedures. The experiment was laid out in a Completely Randomized Design (CRD) with six treatments and three replicates. The fungal pathogens isolated from the rotted fruits were *Aspergillus niger, Aspergillus flavus, Rhizopus stolonifer*, *Fusarium pallidoroseum*, *Botryodiplodia theobromae* and *Colletotrichum gloeosporioides.* The predominant spoilage causing fungi were *Colletotrichum gloeosporioides* (60%) and *Aspergillus niger* (52%). Proximate analysis revealed that the affected fruits had significantly reduced ($P<0.05$) quality when compared to the uninfected fruits in terms of carbohydrate content, protein, oil content, moisture, crude fibre and Ash content. This work holds promise on the importance of the nutritional properties of the fruits in screening for rot tolerance and storage stability.

Keywords:

Fungal spoilage, fungal pathogens, nutritional composition, rot tolerance, storage stability

Corresponding author:
Chukunda FA

Email Id:
onyifank2002@yahoo.com

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INTRODUCTION

The contribution of fruits and vegetables in human nutrition cannot be neglected but is limited due to the presence of fungal attack which make some essential nutrients unavailable for human nutrition. There is a geometric increase in demand for fruits/ vegetables in Nigeria (Ikhuoria *et al.,* 2007; Oyolu, 1980).

The production and commercialization of African Pear has been on the increase in the past few years and transactions are now known to cut across some national and international boundaries (Awono *et al.,* 2002). The fruit is rich in lipids infact investigations into the nutritional composition of the fruit has focused on the oil content (Omote *et al.,* 1987; Kinkela *et al.,* 1993). Kapseu *et al.* (1996) studied on the lipid and fatty acid content of the fruit. Gadet *et al.* (2005) and Lam *et al.* (1987) reported that the oil composition of the fruits depend on the fruit origin and ripening conditions as well as the variety. However, *Dacryodes edulis* is consumed in Nigeria as raw, roasted or boiled in hot water and is eaten alone or used in the garnishing of fresh maize (Arisa *et al.,* 2008; Lam, 1985).

Despite the increased consumption of *D. edulis* fruits in Nigeria, particularly in the Port Harcourt Metropolis, the fruits have faced huge waste due to lack of proper post harvest preservation. Microorganisms penetrate the intact cuticle of the fruits through natural openings or wound during harvest (Nwufo *et al.,* 1989). Microbial deterioration of the fruits have paved a way for the investigation of nutritional and fungal spoilage of *Dacryodes edulis* and thus the current research was done.

MATERIALS AND METHODS

Sources of fruits

Samples of *Dacryodes edulis* fruits were obtained from three markets in Port Harcourt Metropolis Rivers State, Nigeria (Fruit market at D-line, Ahoada market and Mile III markets). The fruits are transferred in sterile plastic containers to the laboratory for analysis.

Chemical analysis

The matured ripe fruits were thoroughly washed in running tap water and thereafter rinsed with sterile distilled water. The fruits were split open using a sterile knife, deseeded and the pulp was separated for proximate nutritional analysis.

Proximate Composition Analysis

Proximate nutrient compositions were determined using the method followed by Onwuka (2005). The moisture content of the pulp was determined by drying to constant weight at 60^{o}C in a vacuum oven (Onwuka, 2005). Protein content was determined by the estimation of total Nitrogen using Kjeldahl method (AOAC, 2004), while the percentage ash content was determined by ignition in a muffle furnace for 4 hours at 525^{o}C as described by Pearson (1976) and Osbome and Vooght (1978). The vegetable fibre content was estimated from the loss in weight of the crucible and its content on ignition. The fats/ oil contained in the pulp was extracted using petroleum ether (60-80^{o}C) in a soxhlet extractor as described by AOAC (2004). The percentage oil content, was estimated using the expression.

$$\text{Oil content (\%)} = \frac{\text{Weight of the oil extracted}}{\text{Weight of the sample}} \times 100$$

Carbohydrate of the sample was determined when the sum of the percentages of moisture, ash, crude protein, either extracts and crude fibre were subtracted from 100.

Microbiologial analysis

The pulp or mesocarps of *D. edulis* were cut aseptically using sterile forceps and scalpels and plated in the sterile petri dishes containing Potato Dextrose Agar (PDA) medium. Plates were incubated at room temperature 28 ± 2^{o}C for 4-7 days as described by

Table 1: Percentage frequency of fungal occurrence in infected fruits of African pear *(Dacryodes edulis)*

Fungal Isolates	% Frequency
Botryodiplodia theobromae	40.00
Rhizopus stolonifer	36.00
Colletotrichum gloeosporioides	60.00
Fusarium pallidoroseum	48.00
Aspergillus niger	52.00
Aspergillus flavus	48.00
LSD (P≥0.05)	**0.024**

(Ckukunda *et al.,* 2013). Fungal Isolates were characterized and identified based on their macroscopic appearance on culture medium, microscopic morphology and type of asexual spores produced **(**Banett *et al.,*1972; CMI, 2010; Samson *et al.,* 1995**).**

Data Analysis

Data were analysed using Statistical Analysis System (1999) software where ANOVA (Analysis of Varance) was carried out with a probability level of 5% (LSD, P≥0.05).

RESULTS AND DISCUSSION

The percentage of fungal occurrence in a spoiled fruit pulp sample of *Dacryodes edulis* is shown in Table 1. The fungi isolated from the spoiled samples include *Aspergillus niger, Aspergillus flavus, Rhizopus stolonifer, Fusarium pallidoroseum, Botryodiplodia theobromae, Colletotrichum gloeosporioides.* The findings from this study is in agreement with (Nwufo *et al.,*1989) who had earlier reported four soft rot micro-orgamisms; *Botryodiplodia theobromae, Aspergillus niger, Rhizopus stolonifer* and *Erwinia* Sp as deteriogens of *D. edulis.* The changes in the nutrient of *D. edulis* fruits infected with fungal rot isolates are shown in Table 2. The results indicated that there was a significant increase (P≥0.05) in protein when infected with *R. stolonifer* (35.8%) compared to the uninfected (30.8%) followed by *C. gloeosporioides* (31.2%).

Moisture level also increased when infected with *R. stolonifer* (29.4%) followed by *F. pallidoroseum* (20.6%) and *C. gloeosporioides* (20.3%). Ash content increased significantly when infected with *R. stolonifer* (15.4%). Conversely, carbohydrate content reduced significantly (P≥0.05) when infected with *A. niger* than the uninfected (6.5%) and fibre content was significantly reduced by *A. niger* (10.6%) followed by *B. theobromae* (10.9%). Chukunda (2014) observed that *Fusarium pallidoroseum* and *R. stolonifer* isolated from *D. edulis* fruits produced spores, which are found in soil and aerial parts of the fruit trees. These spores when in contact with harvested fruits caused spoilage. On the other hand,

Table 2: Nutritional changes in *D. edulis* fruits infected by fungi

	Biochemical Composition (%w/w)					
Fungal isolates	**Carbohydrate**	**Moisture**	**Proteins**	**Extracted oil**	**Ash**	**Fibre**
Aspergillus niger	6.5	12.7	16.6	25.6	10.2	10.6
Aspergillus flavus	28.7	15.6	19.5	27.9	14.6	12.5
Rhizopus stolonifer	28.5	29.4	35.8	49.2	15.4	15.2
Fusarium pallidoroseum	20.7	20.6	30.4	38.5	12.8	14.5
Botryodiplodia theobromae	18.8	19.4	25.6	32.4	10.5	10.9
Colletotrichum gloeosporioides	15.3	20.3	31.2	30.8	11.7	16.5
Control (Uninfected)	43.5	13.8	30.8	45.6	10.5	12.5
LSD (P£0.05)	**0.013**	**0.018**	**0.022**	**0.019**	**0.010**	**0.012**

A. niger and *A. flavus* are known for their lipolytic abilities, since they facilitate the breakdown of fats/ oil by lipase enzyme into free fatty acid and glycerol consequently increasing spoilage of the fruit. Similarly Liao *et al.* (1993), Omogbai *et al.* (2010) and Chukunda (2014) observed that most fungal hydrolyze pectin of fruits giving rise to a soft mushy appearance or consistency of the fruits amounting to huge wastage.

The nutritional contribution of *D. edulis* fruits in Nigeria cannot be over emphasized. The knowledge of the nutritional changes of *D. edulis* fruits due to fungal infection is not only of primary importance to consumers but to prospective industrialists who rely on it for other use. It is reported that depletion or reduction in carbohydrate due to fungal infection is probably due to hydrolysis of carbohydrate to glucose which is used as a source of carbon and energy for microbial growth carbohydrate content decrease. Fortunately, the high value of carbohydrate in the uninfected fruits of *D. edulis* can be used for compounding animal feeds. These findings are in agreement with Ikhuoria *et al.* (2007) and Abighor *et al.* (1997).

This further suggests that more energy could be derived from consuming *D. edulis.* The moisture content of every fruit determines the stability and quality of the fruits as reported by Onwuka (2005). Similarly, Uraih (1990) reported that moisture content of food is a measure of stability and susceptibility to microbial contamination. This implies that plants with lower moisture content may have relatively longer shelf-life than those with high moisture. This present research agrees with the findings of Uraih (1990).

The protein content of the fruit pulp of *D. edulis* shown to be of high value (16-6-35.8%) which will make significant contribution to diet in ameliorating protein malnutrition. The decrease in the value of protein is due to its breakdown to nitrogen which favours the growth of fungal isolates of *D. edulis* as supported by Onifade *et al.* (2004), Frazier *et al.* (1998) and Kays (1991). They reported that the decrease in protein may be attributable to the physiological and metabolic activities of the cells of the fruit pulp. This is in consonance with the present findings.

According to Ibanga (2009), higher values of crude fibre and ash content may be considered suitable for compounding animal meals. In the present study the crude fibre and ash content were fairly high and this will enhance the quality of the extracted oil.

CONCLUSION

This work indicates that the fresh fruits of *Dacryodes edulis* are among the fruits that will solve the food scarcity in Nigeria if handled with care. Therefore, losses due to post-harvest spoilage or pathological decay should be avoided through proper processing/storage before consumption to avoid opportunistic infections on the harvested fruits. However, the rapid occurrence (proliferation) of fungi within the first five days of storage (incubation) at room temperature shows that adequate nutrients were available to support the fungal growth. Therefore, the increase or decrease in fungal occurrence is probably due to the phenomenon of exhaustion of nutrients for the sustainability of fungi in fruits during spoilage. Also, the richness of carbohydrates, crude fibre, ash and oil in *D. edulis* will continue to promote it as a dietary contribution in Nigeria and a source of oil for various industrial uses.

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