Effects of Fungi Flora of *Artocarpus Altilis* on the Nutrient Components

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Abstract
Studies were conducted on the effects of fungi flora of Artocarpus altilis on the nutrient composition of the fruits in the Department of Plant Science and Biotechnology and the Food Science and Technology Laboratory respectively in the Rivers State University. Fungal isolates from rotted fruits of A. altilis were inoculated into healthy and mature A. altilis fruits and allowed for a period of seven days at room temperature at the end of which the samples were analysed to check their effects on the nutrient status of the fruits in comparison with the control. It was observed that combined treatments had the highest moisture value (80.15±0.00) while the least was found in the control (70.00±0.00). Ash value was highest in control (1.30±0.00) and least in Aspergillus (0.50±0.00). Fibre, however had the highest value in control (1.60±0.00) and least in Penicillium (0.50±0.00). Lipid content was highest in Rhizopus treated sample (1.05±0.05) and least in control (0.40±0.00). Carbohydrate value was highest in control (24.40±0.10) and lowest in combined treatments (14.120±0.10). The protein content recorded highest value in Rhizopus treated samples (8.35±0.05) and least in control (2.24±0.06).
The various fungal isolates also showed varying effects on the mineral compositions of the fruits of A. altilis. Calcium value was highest in Penicillium treated samples (22.0±0.00) and the least in Aspergillus treated samples (21.03±0.06). Iron had the highest value in control (0.54±0.01) and least in Rhizopus treated samples (0.10±0.01). Phosphorus recorded the highest value of (31.73±0.06) in control and least value (1.00±0.00) in the combined fungal treatments. Potassium value was highest in control (300.0±0.00) and least in Rhizopus treated sample (21.10±0.10). Sodium value was highest in control (28.40±0.00) and least in Penicillium treated sample (2.40±0.00). Magnesium value was highest in control (25.01±0.11) and least in combined fungal treatments (2.30±0.10).

Keyword: *Fungi, Artocarpus altilis and Nutrient components.*

Introduction

Breadfruit (*Artocarpus altilis*) belongs to the mulberry family moraceae. According to Adepeju *et al*., 2011, it is native to Malaysia and countries of the South Pacific and the Caribbean. It serves as staple in the diet and is covered by the International Treaty on Plant Genetic Resources for food and Agriculture (Ragone, 2007). African countries where breadfruits are found include Senegal, Guinea-Bissau, Cameroun, Sierra Leone, Liberia and Ghana. It is widely cultivated to appreciable extent in South-West States of Nigeria. Present level of breadfruit production in the South-Western Nigeria has been estimated to about 10 million tonnes dry weight per year with potentials for exceeding 100million tonnes every year (Akanbi *et al*., 2009). Breadfruit is also known to be a traditional starch rich crop. The genus *Artocarpus* (Moraceae) comprises of approximately 50 species and is widely distributed in tropical and subtropical regions. The generic name of the species comes from the Greek words 'artos' (bread) and 'karpos' (fruit) and the fruits eaten are commonly called

breadfruit (Jones, 2011). Synonyms of *Artocarpus altilis* are *Artocarpus communis* and *Artocarpus incises* (Orwa *et al*., 2014).

According to NTBG, 2009, the tree has a great productive ability with an average sized tree producing 400 to 600 fruits per year. Singh, 2009 and Elevitch and Wilkinson (2003) reported that bread fruit yields in terms of food are superior to other starchy staples such as cassava, yam, potato and white rice. The mature fruit is a good source of carbohydrate (84%) with starch constituting more than 60% of the total carbohydrate (Oladunjoye *et al*., 2010).It produces fruit twice a year, from March to June and from July to September with some fruiting throughout the year. Breadfruit is highly nutritious, cheap and readily available in overwhelming abundance during its season, it has found limited applications in the food industries (Omobuwajo, 2003).

Materials and Methods

Sample Collection and Preparation

Artocarpus altilis were obtained from Igwuruta in Rivers State of Nigeria. Freshly harvested matured unripe and ripe fruits were washed with clean water and transported to the laboratory for physicochemical composition analysis. Decaying and rotted *A. altilis* were also washed and packaged with sterile polyethene bags and transported in cool boxes to the laboratory where they were analysed for the presence of microorganisms. The decaying and rotted breadfruit were rinsed in distilled water and sterilized with 70% ethanol and cut open with a sterile knife. The cells of the rotted parts were disrupted using sterile mortar and pestle and 1.0g of each sample was added to separate 9.0mls of diluent and serial dilutions of each sample was made (Chuku, 2007).

Mycological studies

Preparation of mycological medium

Sterilization of conical flask, slides, Petri dishes and all the equipment needed for the experiment was carried out in the laboratory. The glass wares were sterilized in the oven at 120^{o}C for an hour after washing with soap, while other equipment were surface sterilized with 70% ethanol to reduce microbial contamination (Agrios, 2005). Inoculating loops and scalpels were sterilized by dipping for 20 seconds in 70% ethanol and heated to red hot. The mycological medium used was Sabouraud Dextrose Agar prepared in a conical flask using the standard method. The mouth of the flask was plugged with non-absorbent cotton wool and wrapped with aluminium foil. The conical flask containing the mycological medium was autoclaved at 121^{o} C and pressure of 1.1kg cm-3 for 15 minutes. The molten agar was allowed to cool to about 40^{o} C and dispensed into Petri dishes at 15mls per plate and allowed to further cool and solidify.

Isolation of fungi from *Artocarpus altilis*

One gram of *Artocarpus altilis* sample showing visible signs of spoilage by moulds was inoculated onto Sabouraud Dextrose Agar in Petri dishes onto which ampicillin was added to hinder the growth of bacteria in triplicate. The inoculated plates were incubated for 5 days at ambient temperature of 25^{o} C ± 3^{o} C (Baudoni, 1988, Chuku, 2009, Samson *et al*, 1981). The entire set up was observed for 7 days to ensure full grown organisms. Pure cultures of isolates were obtained after a series of isolations**.**

Identification of fungal organisms from *Artocarpus altilis*

Microscopic examination of fungal isolates was carried out by the needle mount method (Cheesebrough, 2000). The fungal spores were properly teased apart to ensure proper

visibility. The well spread spores were stained with cotton blue in lacto phenol and examined microscopically using both the low and high power objective. The fungi were identified based on their spore and colonial morphology, mycelia structure and other associated structures using the keys of (Samson *et al*, 1981, Olds, 1983, Barnett and Hunter, 1972).

Pathogenicity studies

Pathogenicity studies was carried out on *Artocarpus altilis* to check if the fungi isolated from *Artocarpus altilis* were capable of causing spoilage of the freshly harvested fruits. The method of (Agrios, 2005, and Trigiano, 2004) was basically followed. The fungal isolates were introduced into *Artocarpus altilis* and observed for seven days. The set up was monitored regularly for growth.

Determination of nutrient components of *Artocarpus altilis* treated with the various test fungi.

The treated fruit samples of *Artocarpus altilis* were sent to the Food Science and Technology Laboratory for the determination of nutrient composition. The methods of AOAC (2005) was used for the analysis.

Results and Discussion

The results of effect of different fungi on the proximate and mineral compositions of *A. altilis* are shown in tables 1 and 2 respectively.

Table 1: The effect of different fungi on the proximate composition of *A. altilis*

Treatments with different fungi	Proximate composition (%)					
	Moisture	Ash	Fibre	Lipid	CHO	Protein
A. altilis (Aspergillus)	75.20±0.00^{a}	0.50±0.00^{a}	1.00±0.00^{b}	0.65±0.01^{b}	16.50±0.10^{c}	6.15±0.01^{c}
A. altilis (Penicillium)	76.32±0.03^{b}	1.00±0.00^{a}	0.50±0.00^{a}	0.75±0.01^{c}	15.60±0.10^{b}	5.80±0.00^{b}
A. altilis (Rhizopus)	70.50±0.10^{c}	1.10±0.00^{a}	1.50±0.10^{d}	1.05±0.05^{d}	17.50±0.10^{d}	8.35±0.05^{d}
*A. altilis (*combined*)*	80.15±0.00^{d}	1.00±0.00^{a}	1.12±0.00^{c}	0.50±0.00^{a}	14.20±0.10^{a}	4.01±0.01^{a}
Control	70.0±0.00	1.30±0.00	1.60±0.00	0.40±0.00	24.40±0.10	2.23±0.06

Figures followed by the same alphabets are not significantly different (p≤0.05)
Legend:
CHO= Carbohydrate

Table 2: The effect of Different fungi on the mineral content of *A. atilis*

Treatments with different fungi	Mineral composition					
	Ca	Fe	P	K	Na	Mg
A. altilis (*Aspergillus*)	21.03±0.06[a]	0.32±0.01[b]	1.20±0.00[a]	30.2±0.10[d]	2.80±0.00[a]	2.50±0.10[b]
A. altilis (*Penicillium*)	22.0±0.00[c]	0.35±0.01[c]	1.40±0.00[a]	22.50±0.00[b]	2.40±0.00[a]	2.50±0.10[b]
A. altilis (*Rhizopus*)	21.50±0.10[b]	0.10±0.01[a]	1.70±0.00[a]	21.10±0.10[a]	18.40±0.00[a]	16.50±0.10[c]
A. altilis (Combined)	21.50±0.10[b]	0.45±0.00[d]	1.00±0.00[a]	24.00±0.00[c]	2.50±0.00[a]	2.30±0.10[a]
Control	21.47±0.06	0.54±0.01	31.73±0.06	300.0±0.00	28.40±0.00	25.01±0.11

Figures followed by the same alphabets are not significantly different (p≤0.05)
Legend:
Ca= calcium; Fe= Iron; P= Phosphorus; K=Potassium; Na= Sodium and Mg= Magnesium.

The effect of different fungi on the proximate composition of *A. altilis*

The moisture content of *A. altilis* with *Rhizopus* is 70.50 ± 0.10 which did not vary with the control. This implies that the presence of *Rhizopus spp* did not affect the moisture content of the fruit. More so, *A. altilis* inoculated with *Aspergillus niger* and *Pencillium spp* were 75.20 ± 0.00 and 76.32 ± 0.10. This implies that the presence of both fungi in the fruit increased the moisture content an indication of spoilage enhancement (Chuku, 2009). And if the moisture content is increased, it can lead to fast deterioration of the fruit causing economic loss or value depreciation. *A. altilis* inoculated with *Aspergiluus spp, Penicillium spp* and *Rhizopus spp* showed great increase in the moisture content been (80.15 ± 0.00). This means that these organisms are able to cause cell proliferation and rapid deterioration of the fruit.

The ash content ranged from 0.50 ± 0.00 in *A. altilis* inoculated with *Aspergillus niger,* 1.00 + 0.00 in *A. altilis* inoculated with *Penicillium spp* and *A. altilis* with the combination of the three fungi. While *A. altilis* inoculated with *Rhizopus* had 1.10 ± 0.00 ash content. There is no significant difference in the ash content of *A. altilis* inoculated with the three fungi and the control.

The fibre content of *A. altilis* inoculated with *Rhizopus* is 1.50 ± 0.10 which did not differ significantly from the control 1.6 ± 0.00, while *A. altilis* inoculated with the combination of the three fungi is 1.12 ± 0.00 which slightly differed from the control whereas *A. altilis* inoculated with *Peniicllium* and *Aspergillus spp* is 0.50 ± 0.00 and 1.00 ± 0.00 respectively. This showed that the presence of *Penicillium* and *Aspergillus spp* can greatly affect the fibre content of the fruit thereby reducing the nutritional quality. The lipid content of *A. altilis* inoculated with combination of the three fungi did not differ significantly with the control whereas *A. altilis* inoculated with *Aspergillus spp* and *Pencillium spp* had 0.65 ± 0.01 and 0.75 ± 0.01 and increased slightly while *A. altilis* inoculated with *Rhizopus spp* had 1.05 ± 0.05. This shows that the presence of *Aspergillus, Penicillium and Rhizopus spp* can increase the lipid content of *A. altilis*.

The carbohydrate content of *A. altilis* with the combination of the three fungi, *Penicillum, Aspergillus* and *Rhizopus spp* are 14.20 ± 0.10, 15.60 ± 0.10, 16.50 ±0.10 and 17.50 ±0.10 respectively. This shows that these fungi feed on carbohydrate and their presence can greatly reduce the carbohydrate content. For example *A. altilis* with the combination of the three fungi was 14.20±0.10 showing that the different fungi organisms compete for the food in

order to survive.(Chuku and Barber, 2013).

The protein content of *A. altilis* with the combination of the three fungi, *Penicillium, Aspergillus* and *Rhizopus spp* are 4.01 ± 0.01, 5.80 ± 0.05, 6.15±0.01 and 8.35 ± 0.05 respectively. This signified that the presence of these organisms increased the protein content of the fruit which could be due to their secretions of some enzymes which in turn increased the protein content (Chuku *et al.,* 2004)

The effect of the different fungi on the mineral composition of *A. altilis*

The presence of *Aspergillus spp* in *A. altilis* did not affect the Calcium content of the fruit which recorded 21.03 ± 0.06 while *A. altilis* inoculated with *Rhizopus* and *A. altilis* with the combination of the three fungi had 21.50 ± 0.10 which slightly increased the calcium content. However, *A. altilis* inoculated with *Penicillium spp* increased the calcium content to 22.0 ± 0.00.

The iron content of *A. altilis* inoculated with *Rhizopus, Aspergillus, Penicillum* and combination of the three fungi were 0.10 ± 0.01, 0.32 ± 0.01, 0.35 ± 0.01 and 0.45 ± 0.00 respectively. This showed that the presence of these fungi greatly reduced the iron content and the nutritional quality. This work is in line with the previous work on the effects of Rhizopus stolonifer on the biochemical composition of tomatoes (Lycopersicone esculenta, Mill) (Chuku and Emelike, 2013).

The Phosphorus content of *A. altilis* inoculated with *Aspergillus, Penicillum, Rhizopus* and combination of the three fungi were 1.20 ± 0.00, 1.40 ± 0.00, 1.70 ± 0.00 and 1.00 ± 0.00 respectively. There is no significant difference in the Phosphorus content of the different fungi on *A. altilis* but the fungi greatly reduced the phosphorus content of the fruit compared to the control. The Potassium content of *A. altilis* inoculated with *Rhizopus, Penicillum,* combination of the three fungi and *Aspergillus spp* were 21.10 ± 0.10, 22.50 ± 0.00, 24.00 ± 0.00 and 30.2 ± 0.10 respectively. There was a significant difference between the Potassium content of *A. altilis* inoculated with the different fungi. These fungi greatly reduced the potassium content of the fruit when compared to the control.

The sodium content of *A. altilis* inoculated with *Penicillum,* combination of the three fungi, *Aspergillus* and *Rhizopus spp* were 2.40 ± 0.00, 2.50 ± 0.00, 2.80 ± 0.00 and 18.40 ± 0.00 respectively. There was no significance difference except for *A. altilis* inoculated with *Rhizopus spp*. This is to show that the presence of these fungi in the fruit did not have any negative effect but their accumulation can also reduce the sodium content of the body.
The Magnesium content of *A. altilis* with the combination of the three fungi was 2.30 ± 0.10 while that of *Aspergillus* and *Penicillium spp* recorded 2.50 ± 0.10 which differed greatly. The presence of these fungi decreased the Magnesium content of the fruit (Chuku *et al*; 2007, Chuku and Emelike, 2013)

Conclusion

In general, the various fungal organisms affected the nutrient composition of *A. altilis* differently. The outstanding observation was that while some fungus increased some nutrients components, others reduced them.

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