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Fungi Associated with Post-Harvest Diseases of Different Species of Ripe Paw Paw (Carica Papaya)

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Abstract- ***The aim of this work is to determine the fungi associated with post-harvest diseases of different species of ripe paw paw (Carica papaya). In this study, the fungi associated with post-harvest diseases of different species of ripe paw paw, the result shows the total heterotrophic count of fungi isolated from ripe paw paw shows the fungal count ranges from 1.6×10^5 to 5.0×10^5cfu/g. The frequency of occurrences of fungi associated with ripe paw paw showed that of the three fungi species isolated from samples, Rhizopus sp. 6(40%) is the most predominant followed by Penicillium sp. 5(33.3%) and Aspergillus spp. 4(26.7%). It is advisable that ripe paw paw should be disposed instead of being consumed since its consumption could be detrimental to health. In addition, food handlers on our market should handle food product with care by practicing proper hygiene in the market environment, by using clean water to wash food products to avoid contamination by micro-organisms present in the water.***

I. INTRODUCTION

Papaya (*Carica papaya L.*) is cultivated in tropical and subtropical regions of all over the world (Baiyewu *et al.,* 2019). Due to its high nutritional values it is major and economically important fruit crop of India. It also widely used in pharmaceuticals, nutraceuticals, cosmetics and beverage industries (Aravind *et al.*, 2020). After harvesting, during storage and transportation these fruits are subjected to several biotic and abiotic stresses, which plays a pivotal role in association of different pathogens and establishment of diseases over papaya fruits. Among these, the fungal pathogens cause several diseases to papaya fruits for example *Rhizopus* rot, *Aspergillus* rot, *Penicillium* rot (Sharma, 2018), *Fusarium* rot, *Alternaria* rot and *Anthracnose* (Singh *et al*., 2021). Fungal infection affected on quality and quantity of the fruits, which decreases the market value of fruits and ultimately hampers its economy (Singh *et al.,* 2021). Considering these things, present attempt has been emphasizing on study of post-harvest fungal pathogens, fungal diseases, their incidence and economic loss of papaya fruits. Pawpaw has several uses which include: its ripe fruits eaten as food and also used in the production of smoothies and juices. The medicinal properties are found in the leaves and latex of the raw fruits which contains papain or papayotin majorly used in tenderizing meat and when fermented becomes an important product in the pharmaceutical industry. The latex is used in treating fever, stomach aches, beriberi and also as an anthelmintic (Tasiwal, 2008). Therefore the aim of this study is to determine the fungi associated with post-harvest diseases of different species of ripe paw paw (*Carica papaya*).

II. LITERATURE REVIEW

Pawpaw is a fast-growing herbaceous, soft wooded perennial tree-like plant in the Caricaceae family that lives for about 5-10 years (Gadgile, 2019). Pawpaw plant is grown across all tropical countries such as Nigeria and many sub-tropical regions of the world (Singh *et al.,* 2021). In some countries an unrelated plant native to North America Asiminia triloba (*Annonaceae*), is also called pawpaw. In Nigeria pawpaw trees are grown throughout the year, its fresh and ripe fruits are available all year round with its peak period towards the end of the raining season.

Phytochemical and Nutritional Composition

Oludemokun, (2021) reported that 100 g edible portion of fresh and ripe pawpaw fruits contains approximately: 88% - water, 10% - sugar, 0.5% - protein, 0.1% - fat, 0.1% - acids, 0.6% - ash and 0.7% - fibre. Pawpaw is a powerhouse of vitamin A, E, pantothenic acid, folate as well as vitamin C, it also contains magnesium, potassium, calcium and dietary fibre. The latex contains the enzymes papain that effectively treats trauma, allergies and sports injuries and chymopapain as well. Both papain and chymopapain contains protein – digesting and milk clotting properties. The vitamin A and C content of one medium papaya fruit (approx 350 g edible portion) exceed the dietary reference minimum intake established for adults by the US Food and Nutrition Board and much higher than paw paw or oranges. Papaya fruit is marked as a power house of

many minerals and vitamins necessary for wellbeing. The extracts from an unripe *C. papaya* fruit may contain a little of terpenoids, alkaloids, flavonoids, glycosides, saponins and steroids (Allen, 2021).

Nutritional Comparism of Pawpaw

Pawpaw fruits are very nutritious. They are high in vitamin C, magnesium, iron, copper, and manganese. They are a good source of potassium and several essential amino acids, and they also contain significant amounts of riboflavin, niacin, calcium, phosphorus, and zinc. Pawpaw contains these nutrients in amounts that are generally about the same as or greater than those found in bananas, apples, or oranges. In comparison with banana, apple, and orange, pawpaw has a higher protein and fat content. Banana exceeds pawpaw in food energy and carbohydrate content. There is little difference among these fruits in dietary fiber content. Pawpaw is most similar to banana in overall composition. Apple is especially low in protein, orange is low in fat, and both are lower than pawpaw or banana in food energy (Singh *et al*., 2021).

Pawpaw has three times as much vitamin C as apple, twice as much as banana, and one third as much as orange. Pawpaw has six times as much riboflavin as apple and twice as much as orange. Niacin content of pawpaw is twice as high as banana, fourteen times as high as apple and four times as high as orange. Pawpaw and banana are both high in potassium, having about twice as much as orange and three times as much as apple (Funnell *et al*., 2019). Pawpaw has one and a half times as much calcium as orange and about ten times as much as banana or apple. Pawpaw has two to seven times as much phosphorus, four to twenty times as much magnesium, twenty to seventy times as much iron, five to twenty times as much zinc, five to twelve times as much copper and sixteen to one hundred times as much manganese, as do banana, apple, or orange. The protein in pawpaw contains all of the essential amino acids. Pawpaw exceeds apple in all of the essential amino acids and it exceeds or equals banana and orange in most of them. The profile of fatty acids in pawpaw is preferable to that in banana.

Uses and Economic Importance of Pawpaw Fruit

Practically, every part of *Carica papaya* is of economic value. Its uses ranges from domestic to industrial uses in short, the benefits of pawpaw are enormous both the natural fruit and natural pawpaw supplements. The unripe papaya fruit has a high latex content that may make it unsuitable for raw consumption although raw shredded green papaya is often used in Asia for salads preparation, the unripe green pawpaw if peeled, seeded and chocked is used in a variety of savoury Asian dishes including pickles and chutneys and for canning in sugar syrup (Oliveira *et al*., 2018). The Green fruit leaves and flowers can also be used as a cooked vegetable (Rahman *et al*., 2019). The TIV ethnic group from Benue State Nigeria processes the unripe fruit into thin dry shreds and uses them as vegetables in soup preparation especially during the dry season when regular vegetables become scares. Soups have been known add variety to foods such as improve eye appeal, taste, flavour and aroma they by creating diet diversity. Papaya seeds have a peppery taste and can be dried in a dehydrator then grounded in a mortar and pestle and used as pepper (Baiyewu *et al*., 2019). The seeds are also medically important in the treatment of sickle cell condition and poisoning related disorder. Chewing the seeds of the ripe pawpaw fruit also helps to clear nasal congestion (Aravind *et al*., 2020). The seeds are used in some countries as a vermifuge, counter-irritant and abortifacient.

III. MATERIAL AND METHODS

Study Area

Owerri is the capital of Imo state in Nigeria, set in the heart of Igboland. It has an estimated population of about 750,000 as of 2011 and is approximately 100 square kilometers (40 sq mi) in area. Owerri is bordered by the Otamiri River to the east and the Nworie River to the south. The area is essentially an urban settlement with the presence of modern social infrastructural, amenities such as schools; roads, pipe borne water, markets and electricity, etc. several food vendors abound in various streets of Owerri hawking various fruits products. It is mostly inhabited by the working class, students, food sellers, traders, civil servants etc. generally, the cost of living is average.

Collection of Samples

20 ripe paw paw (*Carica papaya L.*) fruits were purchased from four major markets namely Ekeonunwa Market, Relief markets, Orji and Alaba

market, all located in Owerri, Imo State. The fruit samples were kept free from dust and insects at room temperature for up to 14 days to undergo a natural process of spoilage before taking them to the microbiology laboratory using a sterilized container for microbial assessment.

IV. METHODS

The culture media used for this study were prepared in accordance with manufacturers' instructions. Appropriate quantities of nutrient agar, MacConkey agar, Eosin Methylene Blue agar, and Sabouraud Dextrose Agar were dissolved in de-ionized water, allowed to stand for complete dissolution, homogenized, and sterilized by autoclaving at 121 °C and 15 psi for 15 minutes. After cooling to about 40 °C, the media were aseptically dispensed into sterile Petri dishes or bottles, allowed to solidify, and stored under refrigeration until required. For Sabouraud Dextrose Agar, chloramphenicol was added after cooling to suppress bacterial growth.

For microbial isolation, ripe pawpaw fruit samples were aseptically ground using a sterile mortar and pestle, and one gram of each sample was homogenized in 9 ml of sterile water. Serial dilutions up to 10^{-4} were prepared, and aliquots were inoculated using the pour plate method. Nutrient agar and potato dextrose agar were used for the isolation of bacteria and fungi, respectively, and plates were incubated at 37 °C for 24 hours for bacteria and 72 hours for fungi. Colony-forming units per gram of sample were calculated after incubation. Discrete colonies were subcultured to obtain pure cultures, which were stored at 4 °C and examined for cultural and morphological characteristics. Further identification was carried out using microscopic examination and standard biochemical tests, while fungi were identified based on morphological features. The microorganisms isolated included species of *Aspergillus*, *Penicillium*, *Pseudomonas*, *Bacillus subtilis*, *Bacillus cereus*, and *Escherichia coli*. Biochemical is the function of enzyme activity and some of the biochemical tests include catalase, oxidase, coagulase, urease, indole, citrate, carbohydrate fermentation test, methyl red / Voges Proskaeur test.

V. RESULTS

Table 3.1: Heterotrophic Total Bacteria and Fungi Counts Obtained from Ripe paw paw

Samples	Total Fungal Counts
A	2.0×10^5
B	5.0×10^5
C	1.6×10^5
D	2.5×10^5

Key: Cfu/g = Colony Forming Unit Per Gram

Table 3.2: Frequency of Occurrences of Fungi Associated with Ripe Paw paw

Fungi	No of occurrence	% of Occurrence
Aspergillus spp.	4	26.7
Rhizopus spp.	6	40
Penicillium spp.	5	33.3
Total	15	100

VI. DISCUSSION

In this study, the fungi associated with post-harvest diseases of different species of ripe paw paw, the result shows the total heterotrophic count of fungi isolated from ripe paw paw shows the fungal count ranges from 1.6×10^5 to 5.0×10^5cfu/g. The frequency of occurrences of fungi associated with ripe paw paw showed that of the three fungi species isolated from samples, *Rhizopus* sp. 6(40%) is the most predominant followed by *Penicillium* sp. 5(33.3%) and *Aspergillus* spp. 4(26.7%).

During the investigation, majority fungi were found as pathogenic to papaya fruits. According to literature survey they cause soft rot (Fusarium and Rhizopus), fruit rot (Aspergillus), fruit spot (Alternaria), anthracnose and damping-off (Colletotrichum), blue mold rot (Penicillium) and brown spot (*Helminthosporium*) of papaya fruits (Rahman, 2019). According to Oliveira *et al.,* (2018) Aspergillus rot, *Alternaria* rot and soft rot, *Anthracnose* and *fusarial* rot were reported as common fungal diseases of papaya fruits from Palam. Singh *et al*., (2021) reported *Fusarium* sp., *Rhizopus* sp., *Aspergillus* sp., *Penicillium* sp., *Alternaria* sp. and *Colletotrichum* sp. were common and major post-harvest pathogens of papaya fruits from Gorakhpur city.

VII. CONCLUSION

Pawpaw trees with an average life span of 20 years are well adapted to both tropical and subtropical regions in the world. Pawpaw fruits and others parts of the plant have both food and nonfood uses. The fruits both ripe and unripe are cheap and rich in several micronutrients thus consuming them often will help reduce micronutrient malnutrition (Nishijima, 2022). They can also be processed into various forms domestically and on industrial scale for juices, soups, meat tenderizers etc and can also be used to complement other foods to improve both nutrient and sensory attribute. The different fungal species identified in this study suggest that fungal contamination on ripe paw paw can be a potential risk to consumers. Such contamination can lead to food poisoning and food-borne illnesses. As a result, efforts should be made by consumers to discourage purchasing spoilt ripe paw paw from local markets in Owerri as they can predispose vendors and the general public to infection. It is advisable that ripe paw paw should be disposed instead of being consumed since its consumption could be detrimental to health. In addition, food handlers on our market should handle food product with care by practicing proper hygiene in the market environment, by using clean water to wash food products to avoid contamination by micro-organisms present in the water.

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