Determination Of Nutrient Composition And Associated Spoilage Fungi Of Different Varieties Of Breadfruit

Wekhe O. E., Chuku, E. C. & Nmom, F. W.
Department of Plant Science and Biotechnology, Rivers State University, Rivers State, Nigeria

Abstract: **Studies on the nutrient composition and associated spoilage fungi of different varieties of breadfruit were carried out in the Department of Plant Science and Biotechnology, Rivers State University. Four varieties comprising *Artocarpus altilis, A. camansi, A. heterophyllus and Treculia africana* were assessed in this study. Proximate analysis revealed that *T. africana* recorded highest values for lipid (11.87±0.06), fibre (3.27±0.06), carbohydrate (51.17±0.12) and energy (377.1±0.00). However, highest concentrations of moisture and protein were observed for *A. altilis* and *A. heterophyllus* respectively. *A. camansi* recorded highest ash content (3.8±0.00). Vitamins assessed were vitamin A and thiamine. *A. altilis* recorded highest value of vitamin A (9.2±11.95) while highest concentration of thiamine (1.8±0.00) was observed for *A. heterophyllus*. Eight fungal organisms viz: *Rhizopus spp, Aspergillus Niger, A. flavus, Mucor spp, Penicillium spp, Fusarium spp, Cryptococcus neoformans* and *Trycophyton rubrium* were isolated and associated with breadfruit in this study. Highest percentage incidence (26.7%) was recorded for *Rhizopus spp* while least incidence of 4.4% was observed for *Trycophyton rubrium*. In general, *A. africana* had more proximate and appreciable vitamin parameters than other varieties assessed.**

Keywords: **Breadfruit, varieties, proximate, vitamin and spoilage fungi**

I. INTRODUCTION

Breadfruits, of the genera *Artocarpus* and *Treculia* belong to the Family *Moraceae* and consist of over 50 species. Cultivars in these genera include *Artocarpus altilis, Artocarpus camansi*, and *Artocarpus heterophyllus*. *Treculia africana* Decne, of the genus *Treculia*, a member of the *Moraceae* family is a common cultivar in Africa. *Treculia africana* is commonly called African breadfruit [1], [2].

According to Morton and Miami [3], breadfruits are believed to be native to a vast area extending from New Guinea through the Indo-Malayan Archipelago to Western Micronesia. Breadfruits enjoy wide distribution and are now grown throughout the tropics [4]. *Artocarpus altilis, Artocarpus camansi*, *Artocarpus heterophyllus* and *Treculia africana* are grown in about 90 countries in the tropics and subtropics [5]. *Treculia africana* however, grows specifically in Africa [6]. Breadfruits grow easily in a wide range of ecological conditions with minimal input of labour or materials and require little attention or care [7]. Breadfruits are found from sea level to about 1,550 m elevation. The latitudinal limits are approximately 17°N and 17°S, but maritime climates extend that range to the Tropics of Cancer and Capricorn [4]. In Africa, breadfruits are found in Senegal, Guinea-Bissau, Cameroun, Sierra Leone, Nigeria, Liberia and Ghana [8]. An average sized breadfruit tree has a canopy cover of 25 m^2 yielding 400-600 fruits per year. Yields are superior to other starchy staples due in part to their verticality of production [7].

The nutritional quality of breadfruits cannot be overemphasized as it is highly nutritious, cheap and readily available in overwhelming abundance during its season [9], [10]. The world food program encourages the incorporation of highly nutritious but neglected foods in the diets as a means of combating malnutrition [11].

Infection of breadfruits by fungal pathogens has been known to cause rapid deterioration of the fruits leading to value reduction. These fungal pathogens penetrate through wounds, cuts or natural openings on the surface of the fruits and infect the inner tissues. Such wounds are caused by the insect pests, rodents and poor handling before, during and after harvest [12]

II. MATERIALS AND METHODS

A. Sample Collection and Preparation

Breadfruits *Artocarpus spp* and *Treculia africana* were harvested within the State. *Artocarpus altilis* were obtained from Igwuruta while *Artocarpus camansi* were obtained from Ozuaha all in Ikwerre Local Government Area of Rivers State. *Artocarpus heterophyllus* were obtained from Tere Ama in Phalga Local Government Area and *Treculia africana* were obtained from Bori in Khana Local Government Area respectively.

Freshly harvested matured unripe fruits were washed with clean water and transported immediately to the laboratory for proximate, mineral, vitamin and phyto-chemical content analysis.

Decaying breadfruits were also washed and packaged with sterilised polythene bags and taken to the laboratory for the cultivation of fungi.

B. Nutrient Determination

Mineral and proximate contents of *A. altilis*, *A. camansi*, *A. heterophyllus* and *Treculia africana* were determined by atomic absorption spectrometry, flame photometry and spectro-photometry according to the methods of AOAC [13].

C. Mycological Studies

The medium used was Sabouraud Dextrose 4% Agar (SDA) prepared according to the manufacturer's instruction. 1g of the fresh and boiled decaying fruit samples were grounded using sterile mortar and pistle. The ground samples were dissolved in test tube containing 9ml of normal saline. 1ml of the medium was transferred by a sterile pipette from the dilution to a test tube with 9ml normal saline to give 1/100 dilution.

An aliquot of 0.1ml of 10^{-2}, 10^{-3} and 10^{-4} dilutions was plated. These dilutions were plated out because of 10^{-1} and 10-^{2} dilution of bacteria and10^{-1} of fungi gave a confluent growth during a preliminary investigation. Cultured plates of fungi were incubated at 37°C for 3-5 days to allow the growth of fungal colonies. Sub-culturing was done to obtain pure cultures which were maintained following the method of Agrios, [14].

Identification of the fungi was mainly done based on colonial appearance, microscopic examination of the spore, hyphae, and characteristics of the stain preparations [15]

The pathogenicity tests of the isolates were done using the methods of Okigbo and Ikediugwu [16] while the method of Chuku *et al.*, [17] was adopted for the determination of isolate percentage incidence.

D. Data Analysis

All procedures were carried out in triplicates and data obtained were subjected to one way analysis of variance (ANOVA). The means were tested for significance at 5% level using Duncan's multiple range (DMR) test.

III. RESULTS AND DISCUSSION

Table 1: Proximate composition of four varieties of breadfruit

Breadfruit Seeds	Proximate Composition						
	Moisture %	Ash %	Lipids %	Fibre %	CHO %	Protein %	Kcal/kg Energy
A. altilis	70.4±0.1^{a}	2.4±0.1^{c}	1.61±0.01^{d}	2.52±0.07^{b}	13.2±0.1^{d}	9.67±0.08^{d}	3.12±0.16^{d}
A. camansi	23.1±0^{c}	3.8±0^{a}	9.1±0.1^{b}	1.5±0^{d}	47.5±0^{b}	15±0^{c}	331.9±0^{b}
A. heterophyllus	25.1±0.1^{b}	2.5±0.1^{c}	8.5±0.1^{c}	2.3±0^{c}	43.5±0.1^{c}	18.07±0.12^{a}	322.9±0^{c}
T. africana	14.2±0.1^{d}	3.1±0^{b}	11.87±0.06^{a}	3.27±0.06^{a}	51.17±0.12^{a}	16.4±0.1^{b}	377.1±0^{a}

Table 2: Vitamins composition of four varieties of breadfruit

Breadfruit Seeds	Vitamins mg/100g	
	Vitamin A	Thiamin
A. altilis	9.2±11.95	0.51±0^{c}
A. camansi	0.15±0	0.12±0^{d}
A. heterophyllus	2.1±0	1.8±0^{a}
T. africana	0.5±0	1.5±0^{b}

Table 3: Frequency of fungal count and percentage incidence

Fungal Organism	Frequency	Percentage Incidence (%)
Rhizopus spp	24	26.7
Aspergillus niger	15	16.7
A.flavus	13	14.4
Mucor spp	8	8.9
Penicillium spp	10	11.1
Fusarium spp	7	7.8
Crytococcus neoformes	9	10
Trycophton rubrium	4	4.4

The moisture content of breadfruit seeds and pulp varied between 14.2±0.1 to 70.4±0.1 (Table 1). The moisture content of A. altilis pulp recorded the highest value and was significantly different from the seeds at $p \leq 0.05$. The least moisture content was observed for *T. africana* (14.2±0.1). Generally, increased moisture level in seeds and flours are known to encourage microbial spoilage [18]. However, the high moisture content of the seeds of breadfruits observed in this study is an indication of the potency of the seeds and pulp to serve as diet for weight loss and an antioxidant that could boost the human immune system thereby preventing the accumulation of certain food materials in the body that could lead to serious health challenge [19].

Generally, the ash content of the pulp and the seeds ranged between 2.4±0.1 and 3.8±0 (Table 4.1). The ash content of *A. camansi* was higher than 3.1% reported by Nelson –Quartey *et al*. [20]. The ash content of breadfruits in this study ranged between (2.6 - 3.1±0) reported for lentils (a legume) but lower that cow pea [23]. It was also within the range of raw yam, boiled and roasted (2.61%- 2.64%) reported by Uchechukwu-Agua *et al*., [21]. Ash provides a measure of the total amount of minerals within a food [22].

It was observed that *T. africana* had the highest lipid content which was 11.87±0.06 while *A. altilis* pulp had the least 1.61±0.01 (Table 4.1). The result from this study is in line with Appiah, [23] who reported lipid content of not derived flours of 5.57% for *A. heterophyllus* and 9.08% for *T. africana*. Fats are essential is diets as they increase the palatability of foods by absorbing and retaining flavours [24]. In addition to being vital in the structural and biological functioning of cells and in the transport of nutritionally essential fat-soluble vitamins, diet high in fat contributes significantly with the energy requirement for humans. Consequently, the high fat content of *T. africana* would make it better source of fat than *A. camansi* and *A. heterophyllus* in food formulations and could be a better flavour enhancer.

T. africana seed yielded the highest fibre content (3.27±0.06) in this study while *A. camansi* gave the least value (1.5±0) as seen in Table 4.1. Nelson –Quartey *et al*. [21] recorded crude fibre content of 1.30% for *A. camansi* bean flour.

The carbohydrate content of the seeds and pulp of the breadfruit species varied between 13.2±0.1 – 51.17±0.12 (Table 4.1). *T. africana* had the highest carbohydrate content 51.17±0.12 while *A. altilis* pulp had the least 13.2±0.1. In this regard therefore, the high carbohydrate content of the seeds of breadfruits would make good sources of energy in breakfast. In addition carbohydrates assist in the metabolism of fat and are known to supply quick and metabolizable energy in the food [23].

The protein content of the pulp and seeds-based breadfruit species ranged between 9.67±0.08 in *A. altilis* pulp to 18.07±0.12 in *A. heterophylus* seed. The protein content was within 9.67% to 32.3% for grains and legumes reported by Ihekoronye & Ngoddy, [25]. Whereas this study reported 18.07±0.12 for *A. heterophylus*, Adu [26] and Giami *et al*. [27] reported 13.96% and 20.1% respectively. These differences could be due to geographical location, soil nutrient levels since soil nitrogen level could influence protein levels [28]. Protein enhances the replenishment of lost cells [29].

The vitamin A content of breadfruit seeds and pulp ranged between 0.15±0 to 9.2±11.95 (Table 4.3). *A. altilis* had the highest vitamin A content (9.2±11.95) while *A. camansi* had the least (0.15±0). The vitamin A content in this study was higher than *Pisum sativum* (4.2mg/100g and 2.5mg/100g) reported by Chuku *et al*. [17], *A. altilis* reported by Tukura & Obliva, [30] but lower than sweet orange, lemon and lime (500, 300 and 21mg/100g) reported by Chuku & Akani, [31]. Vitamin A promotes good eye sight [32].

The presence of Vitamin C provides antioxidants which help the body to develop resistance against infectious agents, and the production of collagen which provides elasticity to the skin and nourishment to the hair [32].

Thiamin is one of the B vitamins. The B vitamins are a group of water-soluble vitamins that are part of many of the chemical reactions in the body. The thiamin content of breadfruit seeds and pulp ranged between 0.12±0-1.8±0 (Table 4.3). *A. heterophyllus* recorded the highest value (1.8±0) while *A. camansi* had the least (0.12±0). Thiamin (vitamin B1) helps the body's cells change carbohydrates into energy. The main role of carbohydrates is to provide energy for the body, especially the brain and nervous system. Thiamin also plays a role in muscle contraction and conduction of nerve signals and its essential for the metabolism of pyruvate [33].

The fungal isolate from breadfruit varieties include *Rhizopus orizae*, *A. niger*, *Mucor*, *A. flavus*, *Penicillium spp*, *Fusarium spp*, *Cryptococcus neoformans*, *and Trycophyton rubrium*. The fungi isolates observed to be associated with spoilage of breadfruit seeds in this study are similar to Ajayi & Adebolu [34], they reported the presence of a strain of *Aspergillus spp*, two strains of *Penicillium spp* and a strain of *Molinia spp* [35]. The occurrence and equal incidence of *Mucor* and *Rhizopus* could be attributed to their taxonomic relationship as they both belong to the Mucorales order and are always associated with food spoilage [36]. *Aspergillus*, *Fusarium and Penicillium* have been reported to be most mycotoxigeneric genera of fungi. They are important in food safety due to their production of mycotoxins which have varying implications for health and the economy especially in developing countries. Fusarium spp produce fusarium toxins such as trichothecenes, discetoxy, scirpenol, Nivalenol and Zearalenone, these mycotoxins cause skin diseases, gastro-enteritis, rectal hemorrhage, vomiting and several other diseases [37]. Aspergillis flavus and *Aspergillus parasiticus* produce aflatoxins (B1, B2, G1, G2), of which aflatoxin B1 is highly carcinogenic causing hepatoma [37]. The organism may even secrete substances harmful to humans [38]. Fungi are the most important and prevalent pathogens, infecting a wide range of fruits and causing destructive and economically important losses of fruits during storage, transportation and marketing [39].

IV. CONCLUSION

Breadfruit has been profiled by this present study to contain enough nutrients. More so, it has also shown the fungal organisms that are associated with it. The occurrence of these microorganisms call for deliberate hygienic measures during production and preparation before consumption.

REFERENCES

[1] Enibe, S. O. (2001). Design, construction and testing of a breadfruit depulping machine. Landwards, Summer 2001, 16-21.
[2] Omobuwajo, T. O. (2007). Overview of the status of breadfruit in Africa. I International Symposium on Breadfruit Research and Development. ISHS Acta Horticulturae, 757, 60-63.
[3] Morton, J.F. & Miami, F.L. (1987). Breadfruit: Artocarpus altilis. Fruits of warm climates. pp.50-58
[4] Ragone, D. (2007). Breadfruit: Diversity, conservation andpotential. In Proceedings of the 1st
[5] International Symposium on Breadfruit Research and Development. Acta Horticulturae, 757, 19-30.
[6] Rotary International (2007). Environmental challenges and opportunities; using land wisely. http://www.rli33.org/downloads/2007/2007_Part_III_RLI_CD/internationalservice/materials/SubjectAreaHandbooks/PlanetEarthHnbk.pdf. Aaccessed16th September, 2020.
[7] ICRAF, (2010). AgroForestry Tree Database. A tree species reference and selection guide. International Center for Research in Agroforestry. Retrieved on the 3rd of June, 2020 from http://www.worldagroforestry.org/sea/Products/AFDbases/af/asp/SpeciesInfo.asp?SpID=1734.

[8] National Tropical Botanical Garden (NTBG), (2009). Hunger Initiative Breadfruit Institute. National Tropical Botanical Garden. Retrieved (http://www.ntbg.org/breadfruit/hunger.phb

[9] Burkill, H. M. (1997). The Useful Plants of West Tropical Africa. 2nd Edn. Royal Botanic Gardens, Kew, pp: 160-161.

[10] Ajani, A. O., Oshundahunsi, O.F., Akinso, R., Arowora,K .A., Aboidun A. A., & Pessu P. O. (2012). Proximate composition and sensory qualities of snacks produced from breadfruit flour.

[11] Global Journal of Science Frontier Research Biological Sciences, 12(7), 2249-4626.

[12] Elevitch, C., Ragone, D., & Cole, I. (2014). Breadfruit Production Recommended Practices for growing, harvesting and handling (2nd Edition). Breadfruit Institute of the National tropical Botanical Garden, Kalaheo, Hawai'i and Hawai'i Home grown Food Network, Holualoa, Hawai;i. Retrieved from www.breadfruit,org and www,breadfruit.info.

[13] Grosskinsky, B. & Gullick, C. (2000). Exploring the Potential of Indigenous Wild Food Plants in Southern Sudan. Proceedings of a Workshop Held in Lokichoggio, Kenya, June 3-5 1999. http://pdf.usaid.gov/pdf_docs/pnacg706.pdf. Accessed September 4, 2020.

[14] Shamsi, S., Razia, S. W. & Yasmin. F. (2012). Association of fungi with breadfruit (Artocarpus altilis Fosh.). Journal of Bangladesh Academy of Science, 36. (1), 143-146

[15] AOAC. (2010). Official methods of food analysis (15th edition). Williams S. (ed) Association of Official Analytic alchemists, Washington D.C. pp. 152164.

[16] Agrios, G.N. (2005). Plant Pathology 5th edition. Elevier Academic Press USA 383-557.

[17] Chuku E. C. & Wekhe E. O. (2017). Effect of fungi flora of Artocarpus altiis on the nutrient component. International Journal of Agriculture and Earth Science, 3(8); 2489-0081.

[18] Okigbo, R.N. & Ikediugwu, F.E.O. (2000). Studies on biological control of post harvest rot of yam (Dioscorea sp.) with Trichoderma viride. J. Phytopathol, 148, 351 - 355.

[19] Chuku E. C., Emiri. U & Agbagwa, S. S. (2019) Microflora and Nutritional Constituent of green pea (Pisum Sativum). International Journal of Agriculture, Environment and Bioresearch, 4(66), 2456-8643

[20] Oduro, I., Larbie, C., Amoako, T. N. E. & Antwi-Boasiako, A.F. (2009). Proximate composition and basic phytochemical assessment of two common varieties of Terminalia catapa (Indian Almond). Journal of Science and Technology, 29 (2), 1-6.

[21] [Chuku E. C, chuku O. S & Ajuru, M. G (2018) Studies on the propagation, phytochemical properties, storage utilization and shelflife of Asystasia gangetica. Journal of Agriculture and Veterinary Science, 2, 63-67.

[22] Nelson-Quartey, F. C., Amagloh, F. K., Oduro, I. and Ellis, W. O. (2007). Formulation of an infant food based on breadfruit (Artocarpus altilis) and breadnut (Artocarpus camansi). Acta Horticulturae (ISHS), 757, 212-224.

[23] Uchechukwu-Agua, A. O., Caleb, O. J., Manley, M. & Opara, U. L. (2015). Effect of storage conditions and Microbial quality of the flour of two cassava cultivars (TME 419 and UMUCASS 36). CYTA-Journal of Food, 13(4), 635-645.

[24] Obadina A., Ashimolowo H., & Olotu F (2016). Quantity changes in cocoyam flours during storage. Food Science of Nutrition, 4(6), 818-827.

[25] Appiah, F. (2011). Nutritioanal composition, Functional properties, Digestibility and formulation of selected food product from breadfruits (Artocarpus Spp). And Treculia africana. (Publishe Ph.D. Thesis). Kweme Nkrumah University of Science and Technology Kumas, Ghana.

[26] Aiyesanmi, A. F. & Oguntokun, M. O. (1996). Nutrient composition of Dioclea reflexa seed–an underutilized edible legume. Rivista Italiana delle Sostanze Grasse. 73, 521–523.

[27] Ihekoronye, A. I. and Ngoddy, P. O. (1985). Integrated Food Science and Technology for the Tropics. MacMillan Publishers, London pp 306

[28] Adu, G. A. (2006). Production of Spice from Treculia africana. An unpublished dissertation submitted to the Department of Biochemistry,

[29] Giami, S. Y., Adindu, M. N., Akusu, M. O. & Emelike, J. N. (2000). Compositional, functional and storage properties of flours from raw and heat processed African breadfruit (Treculia africana Decne) seeds. Plant Foods for Human Nutrition (Dordrecht, Netherlands), 55(4), 357- 368.

[30] Blumenthal, J., Baltensperger, D., Cassman, K. G., Mason, S. & Pavlista, A. (2008). Importance

[31] and Effect of Nitrogen on Crop Quality and Health .AgronomyFacultyPublications.Paper200.[http://digitalcommons.unl.edu/agronomyfacpub/200. Accessed September 1, 2020.

[32] Andrew, J. B. (2008). Microbiological and effects of selected Antimicrobial agents and microbial load of fluted pumpkin, cabbage and bitter leaves. The internet journal of microbiol., 7(2):1-8.

[33] Tukura, B. W. & Obliva, O. (2015). Proximate and Nutritional composition of breadfruit (Artocarpus altilis) seeds.

[34] Chuku E. C & Akani N. P (2015). Determination of Proximate Composition and Microbial Contermination of fresh juice from three citrus species. International Journal of Biology and Genetic Research, 1, 1-8.

[35] World Health Organisation (WHO) (2004). Values and meanings in medicinal plants. WHO publication, Geneva, pp. 1-25.

[36] Bender, D. A. (2003) Nutritional Biochemistry of the Vitamins, Cambridge University Press, Cambridge, New York.

[37] Ajayi O. B & Adebolu T. T (2013) Microbial contribution to spoilage of Africa breadfruit (Artocarpus Communis, Forst) during storage. Food Science snd Nutrition, 1(3), 235-240.

[38] Amusa, N. A., Kehinde, I. A. & Ashaye, O. A. (2002). Biodeterioration of breadfruit (Artocarpus communis) in storage and its effects on the nutrient composition. African Journal of Biotechnology 1 (2): 57-60.

[39] Salako, E. A. & Anjorin, S. T. (2012). Principle of general mycology, 2nd edition. Print Villa Publishers, pp 69.

[40] Ogaraku, A.O. & Usman H.O. (2008). Storage rot of some yams (Dioscorea spp) in Keffi and environs, Nasarawa State. Department of Biological Sciences, Nasarawa State University, Keffi, Nigeria.

[41] John, O.O., Dooshima, .S. Simon, T.U. & Tseaa, S. (2015). Isolation of six microorganisms from rotten Dioscorea alata (water yam), and antimicrobial sensitivity test with nine plant extracts. Food and Nutrition Sciences, 6, 1381- 1394.

[42] Beuchat L. R.(2006). Vectors and Conditions for preharvest contamination of fruits and vegetables with pathogens capable of causing enteric disease. Britain FoodJournal, 108, 38-53.