



EFFECT OF ESSENTIAL OIL OF GRAPE (*CITRUS PARADISI*) PEEL ON THE SHELF LIFE AND PACKAGING MATERIALS ON SMOKED CATFISH (*CLARIAS GARIUPINUS*)

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ABSTRACT

The essential oil derived from grapefruit (*Citrus paradisi*) presents a viable alternative to synthetic preservatives in food products. A study was conducted over eight weeks to assess the antimicrobial properties of this essential oil, as well as its effectiveness when used with packaging materials, specifically regarding the shelf life of smoked catfish (*Clarias gariepinus*). The results indicated that smoked fish coated with grapefruit peel essential oil began to show signs of spoilage after six weeks, whereas the uncoated fish exhibited spoilage after just four weeks. It was noted that the combination of grapefruit peel essential oil and ambient packaging provided the most significant protection against microbial decomposition of the fish. These findings suggest that grapefruit essential oil can effectively extend the shelf life of smoked catfish (*Clarias gariepinus*) when stored in ambient conditions.

Keywords: Essential oil, Catfish, Smoking, Processing, Preservation

INTRODUCTION

Fish processing is vital to Nigeria's agricultural economy because it provides jobs for fisher folk, supplies essential protein to the population, and generates foreign exchange earnings. The processing and consumption of fish contribute to the overall food and nutrition security of a country with a growing population and a significant protein deficit (Ogunji and Wuertz, 2023). Fish is an important dietary component because it provides essential nutrients like protein, vitamins, and minerals that are often lacking in cereal-based diets. It is a cheap and easily digestible source of high-quality protein and is rich in essential fatty acids, vitamins, and minerals like iron, calcium, and zinc, which are vital for preventing diseases and ensuring proper growth and development (Fawole *et al.*, 2007).

African catfish (*Clarias gariepinus*) is a highly important freshwater fish for aquaculture in Nigeria, where it accounts for about 85% of all freshwater fish farmed annually. This popularity is due to its ability to thrive in a variety of conditions, including low oxygen levels and high pollution, and its fast growth rate (Chukwu *et al.*, 2023). It is characterized by long bodies with dorsally flattened head endorsed by bone plates. They have long mouth and pairs of simple barbells, both the anal and dorsal fins are without space and very long reaching almost to caudal fin (Souza da Silva *et al.*, 2022). Fish oil contains fat-soluble vitamins, while fish is also a source of B vitamins like thiamine and riboflavin, and minerals such as calcium, phosphorus, iron, zinc, iodine, and magnesium. Due to high temperatures, fish deteriorates quickly after being caught, making preservation crucial in Nigeria's fisheries sector to maintain quality and safety (Shweta Pandey and Ravi Kant Upadhyay, 2022).

Methods to prevent fish spoilage include controlling temperature, using traditional preservation techniques like salting, smoking, and drying, and modern approaches such as freezing, canning, and chemical preservation. Other strategies involve proper handling to prevent physical damage, improved sanitation, and the use of packaging like modified atmosphere packaging (MAP) to extend shelf life by

inhibiting spoilage bacteria and oxidation (Wang and Zheng, 2025).

Citrus fruits are a major global crop, prized for fresh consumption and use in juices and wines. A significant portion of citrus production becomes waste, but this by-product is rich in valuable compounds like essential oils, flavonoids, and carotenoids, which have numerous applications in food, pharmaceutical, and industrial sectors. By-products can be utilized to create products such as natural food preservatives, health-promoting supplements, and flavorings, making citrus a valuable and sustainable resource (Andrade *et al.*, 2023)

The second largest world produced citrus fruit is grape; with an average of more than 60 million annual productions. Grape fruit (*Citrus paradisi*) belongs to the Citrus genus, a flowering plants in the family Rutaceae. Grape is one of the citrus fruits cultivated and consumed in Nigeria (Wahab *et al.*, 2023). Every year, a significant quantity of waste is produced because the yield of grapefruit and orange juice is only around half of the fruit weight (Duru, 2011). Nigeria has the capacity to produce more than the current 0.3 million tons per year. In many Nigerian streets and marketplaces, this is one of the main agro-wastes that pose a health and environmental risk. Natural plant products are being continuously explored for new antibiotic agents due to the growing issues of antibiotic medication resistance by pathogenic organisms in recent decades.

MATERIALS AND METHODS

Study Area

Borgu Local Government is an administrative region in Niger State, Nigeria, with its headquarters in New Bussa as shown in Figure 1. It has a population projection of 296,500 according to the 2022 National Population Commission figures. Borgu Local Government has an area of 11,267 Km² with a density of 21.55 Km². It lies in the northwestern area of the state and covers the districts of Borgu, Dugga, Babanna, Karabonde, Konkoso, Malale, New Bussa, Shagunu, Wawa and Riverine areas as shown in figure 1. Borgu Local

Government is bordered by Agwara, Mashegu and Mokwa Local Governments. Borgu Local Government Council

controls the public administrative council makes law that governs the local government area.



Figure 1: Kainji Lake River Basin Area

Preparation of Grape Essential Oil

In accordance with Priti *et al.*, (2018) methodology, the extraction was carried out by first drying the grape peels for three hours at 65°C in an electrical oven. After being ground with mortar, the dried peels were put into a 1000 ml flask with a flat bottom. A 1000 ml measuring cylinder was used to measure 650 ml of ionized water, which was then added to the 1000 ml distillation flask. After that, boiling chips were added to the distillation flask to make sure the boiling process went smoothly. After then, the experiment was prepared. A Stuart hot plate magnetic stirrer was then used to gradually start heating the distilling flask.

The distillation rate was set at about 20 drops per minute by adjusting the heat source. Deionized water was added through the separation funnel in the setup as the mixture boiled and distilled. This was done to keep the water level at the operation level and avoid it dropping too low, which could cause the sugar in the puree to caramelize, and to maintain a low, constant temperature. The distillates were gathered in each instance and moved into a 250 ml separating funnel. To extract the oil, 20 milliliters of diethylether were added to the distillate in the separating funnel. Because diethylether is extremely flammable, it was made sure that no hot plate or flame source was present when it was being used. After draining the water layer from the separating funnel, the diethylether layer was gathered, and a tiny amount of anhydrous magnesium sulfate was applied to remove any remaining water. After that, the oil was measured and noted.

Preparation of Fish Sample

The fish sample (*Clarias gariepinus*) was purchased from Federal College for Freshwater Fisheries Research (FCFFT) Fisheries Department Fish Farm New Bussa, Niger state. The fish were transported in kegs to the Department of Agricultural Technology, Engineering Section, Farm

Mechanization Unite, Agricultural products and storage laboratory. New Bussa, Niger state. The fish were then slaughtered with salt, gutted, washed, soaked with Grape essential oil and smoked using improved smoking kiln at average temperature of 65 °C till the fish were completely dried to safe moisture content level.

Shelf life Studies

The fish sample coated using essential oils from Citrus paradise peels were packed in three places: one packed in plastic plate and stack in a carton, the second one packed in a white nylon and stack in a carton and the third one was placed in a carton without any other material. The organoleptic qualities were checked weekly for two months (8 weeks). Quality attributes studied include microbial growth, flesh and skin.

RESULTS AND DISCUSSION

Results

The results of this study showed a variation in smoked catfish (*Clarias gariepinus*) samples coated with essential oil of grape fruit (*Citrus paradisi*) and uncoated smoked catfish samples. There were also variations among different packaging material. Table 1 shows the organoleptic changes of uncoated smoked catfish packed plastic bowl, nylon and ambient condition for eight weeks. The result shows that the fungal growth increased progressively from the fourth week to the final sampling time, when it was completely unfit for consumption in the three packaging. Table 2 shows the organoleptic quality of the improved smoking kiln catfish samples are also coated with the essential oil of grape fruit and stacked into the different packaging materials. The preserved catfish stayed for seven weeks before spoilage characteristic could be manifested.

Table 1: Organoleptic Changes of Uncoated Smoke-Dried Catfish (*Clarias Gariepinus*) with Essential Oil of Grape Fruit Peel

Week	PG Materials	Microbial growth	Skin	Flesh
1	Ambient	No growth	Dark	Firm and solid
	Nylon	No growth	Dark	Firm and solid
	Plastic	No growth	Dark	Firm and solid
2	Ambient	No growth	Dark	Firm and solid
	Nylon	No growth	Dark	Firm
	Plastic	No growth	Dark	Firm
3	Ambient	No growth	Dark	Neither firm nor soft

Week	PG Materials	Microbial growth	Skin	Flesh
4	Nylon	No growth	Dark grey	Firm
	Plastic	Little growth	Dark grey	Firm
	Ambient	No growth	Dark	Neither firm nor soft
5	Nylon	Fungal growth	Discolouration	Less firm
	Plastic	Fungal growth	Discolouration	Less firm
	Ambient	Fungal growth	Dark grey	Firm
6	Nylon	Fungal growth	Discolouration	Soft
	Plastic	Increased fungal growth	Discolouration	Flabby
	Ambient	Fungal growth	Discolouration	Soft
7	Nylon	Fungal growth	Discolouration	Soft
	Plastic	Decomposition began	Lost of value	Soft
	Ambient	Fungal growth	Discolouration	More soft
8	Nylon	Increased fungal growth	Discolouration	Very soft
	Plastic	Decompose	Discolouration	Very soft
	Ambient	Increased fungal growth	Discolouration	Flabby
	Nylon	Decompose	Discolouration	Very soft
	Plastic	Decompose	Ammonal odour	Very soft

Table 2: Organoleptic Changes of Smoke-Dried Catfish (*Clarias Gariepinus*) Coated with Essential Oil of Grape Peel

Week	PG Materials	Microbial growth	Skin	Flesh
1	Ambient	No growth	Dark	Firm and solid
	Nylon	No growth	Dark	Firm and solid
	Plastic	No growth	Dark	Firm and solid
2	Ambient	No growth	Dark	Firm and solid
	Nylon	No growth	Dark	Firm and solid
	Plastic	No growth	Dark	Firm and solid
3	Ambient	No growth	Dark	Firm and solid
	Nylon	No growth	Dark grey	Firm
	Plastic	No growth	Dark grey	Firm
4	Ambient	No growth	Dark	Firm
	Nylon	No growth	Dark	Less Firm
	Plastic	No growth	Discolouration	Less firm
5	Ambient	No growth	Dark	Firm
	Nylon	No growth	Dark	Less firm
	Plastic	No growth	Discolouration	Neither soft nor firm
6	Ambient	No growth	Discolouration	Firm
	Nylon	No growth	Discolouration	Less firm
	Plastic	Little growth	Discolouration	Neither firm nor soft
7	Ambient	No growth	Dark	Firm
	Nylon	No growth	Discolouration	Less firm
	Plastic	Fungal growth	Brownish	Soft
8	Ambient	No growth	Discolouration	Firm
	Nylon	No growth	Discolouration	Soft
	Plastic	Delayed fungal growth	Brownish	Soft

Discussion

Fish smoking itself is value addition to fish product, this conform with opinion of Olayemi *et al* (2013) that one of the major ways of adding values to fish in the tropics is by smoking and drying. Clucas (1982) also reported that smoking reduces the moisture content of the product, it also impacts a desirable flavor, appearance and texture to the product. Table 1 showed that after three weeks the smoked fish are till palatable for consumption. This could be as result of efficacy and efficiency of smoke on the fish products, this corroborates Eyo (2001) who stated that smoking has bacteriostatic effect as it slower bacterial growth, bactericidal effect is associated with phenols in smoke as it possesses inhibitory ability on bacterial and antioxidant activity which prolong the shelf life of fish.

Reduction in the organoleptic quality was observed in the fourth week in table 1 and after sixth week in table 2. This agrees with the opinion of Daramola et al (2007) who established that reduction in the physio-chemical qualities of smoked fish species stored at ambient temperature with increasing storage period could be attributed to high activities of the spoilage agent. Llobreda *et al* (1986) expressed similar result for their result for their research on the storage of oyster. Between the two tables noticeable microbial growth were fist observed on fish sample packed in plastic container. This showed that packaging material has effect on the keeping quality of smoked catfish, this is in line with Bart (2004) who stated that antimicrobial efficacy of plant antimicrobials depends on several factor including genetic factor, post-harvest condition method of extracting essential oil, growth phase and intrinsic or extrinsic properties of the food such as

packaging procedure and physical structure of food as well as oxygen concentration. This could also be the resultant variation in color of smoked fish samples packed differently as transparency differs.

The time variation between the two tables for the initial growth of microbes agrees with Choi et al (2002) who opined that the use of lime essential oil increases the time needed for the natural micro flora to reach concentration able to produce a perceivable spoilage and reduce the risk of disease associated with consumption of contaminated product.

CONCLUSION

Antimicrobial properties were exhibited by essential oil from the peel of grape fruit (*Citrus paradisi*). The efficacy of the antimicrobial was affected by the packaging material and the quantity of the essential oil used. Fish coated with grape fruit (*Citrus paradisi*) essential oil with ambient packaging give the best inhibitory properties among plastic and nylon containers. The grape fruit (*Citrus paradisi*) essential oil were unable to completely inhibit the activities of microbes on the smoked catfish (*Clarias gariepinus*) after six weeks because of the concentration used. The grapefruit essential oil was considered efficient in lengthening the shelf life of smoked catfish.

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