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**Original Research Article**

# Evaluation of rancidity rate of oil in selected fish species harvested from Hadejia-Nguru Wetlands, Nigeria

**U. S. Ukekpe[1], I. B. Gashua[1,2,*] and U. J. Okoye1[1]**

[1]Department of Science Lab. Technology, Federal Polytechnic Damaturu, Nigeria
[2]University of Wolverhampton, School of Applied Sciences, United Kingdom
**Corresponding author*

**A B S T R A C T**

Fish contains fats/oils as part of their nutrients which undergo rancidity just as other oils. The rancidity of oils within fishes denotes fish spoilage. In this work, time course monitoring of oil rancidity in five fish species; tilapia, mud, cat, elephant snout and butter fishes harvested from Hadejia-Nguru wetland was carried out by the thiobarbituric acid (TBA) value method to know their keeping quality. It was found that, at six hour keeping, elephant snout, Mud and butter fishes were no longer fresh based on their respective TBA values of 7.40, 7.10 and 6.50 mgMA/kg. The TBA values of 9.50, 11.0 and 8.50 mgMA/kg, respectively for butter, elephant snout, and mud fishes at twelve hours of keeping indicated that they have spoiled, while Tilapia and cat fishes with TBA values of 6.60 and 8,00mgMA/kg, respectively at the same twelve hours of keeping show the fishes to have better keeping quality than the other three species. Generally, preservative measures are required for cat, tilapia and mud fishes within nine hours of storage and elephant snout and butter fishes need preservative measures immediately after harvest for their long keeping.

**Keywords**

Rancidity, Thiobarbituric acid, Lipids, Wetlands, Spoilage

## Introduction

Fish is a high quality food that is rich in protein, fat, vitamin, water and minerals (Lands, 2002). Fish also contains 2–4% lipids which comprises of high level of polyunsaturated fatty acid that are prone to oxidation, resulting in off-flavour, changes in colour, taste and texture or even loss of nutrient (Saeed and Howell, 2002). It is an extremely perishable food with most species becoming inedible within twelve hours at tropical temperatures and spoilage begins as soon as the fish dies (George, 2006). The biggest problem with deterioration in the quality of fish oil is rancidity and the main cause of fish rancidity is oxidation.

Rancidity can be refers to unpleasant taste and smell of fatty foods that have undergone decomposition, liberating butyric acid and other volatile lipids. It can also be described as a condition produced as a result of aerial oxidation of unsaturated fats present in foods and other products marked by unpleasant odour or flavour. In general terms, it is the chemical decomposition of fats, oils and lipids into aldehydes and ketones with undesirable taste and odour. Although not much have been encountered in the literature search on rancidity rate of specific tropical fish species, Kolakowska and Deutry (1983) studied the rancidity of different species of frozen fish by means of TBA values, organoleptical scoring and peroxide value.

Lipid oxidation is one of the major causes of food spoilage (John *et al.*, 1999). It leads to the development of various off-odour generally called rancidity and discolouration, which render the fish unacceptable or reduce their shelf-life. In addition, oxidation reaction can decrease the nutritional quality of food and certain oxidative products are potentially toxic (George, 2006). Primary lipid peroxidation product includes hydroperoxide that are unstable and decomposes to generate various secondary products, such as aldehydes that contribute to fish rancidity.

The determination of aldehyde in oxidized fish oils is done by means of monitoring thiobarbituric acid value (TBA). TBA and peroxide values are determined during oxidation of fish oils (Dahel *et al.*, 2008). Thiobarbituric acid-reactive substance (TBARS) is a common assay used to follow lipids oxidation in food stuffs based on spectrophotometric determination of malondialdehyde (MDA) (Ladikos and Lougovois, 1999). However, other aldehyde products can also react with TBA, and thus, the TBARS method can be used to assess other aldehyde formed during lipid oxidation (Vyncke, 1975).

The presence of aldehydes in food, including fish has attracted attention because of their effect on food quality and safety. In addition, an unsaturated aldehyde like malondialdehyde extract from fish muscles is a well-known lipid peroxidation product. Since fatty fishes have high content of polyunsaturated fatty acids, lipid peroxidation products contributes to rancidity and food deterioration (Tsakins *et al.*, 1999). Both high temperature and exposure to light are known to increase the rate of oxidation and the Hadejia-Nguru wetlands is located in area of high temperature and light intensity which are important factors that can increase oxidation and rancidity rate of fish.

The Hadejia-Nguru wetlands lie on the southern edge of the Sahel savannah in northern Nigeria. The area comprise of a mixture of seasonally flooded lands and dry uplands. It is named after two major towns within the wetlands, Hadejia and Nguru, in Jigawa and Yobe states respectively (Ukekpe and Musa, 2009). The wetlands supplied the Hadejia-Jama'are River that meets at the lines of ancient sand dunes aligning northeast to southwest forming the Yobe River, which discharge into Lake Chad (F.A.O., 2008). The Hadejia-Nguru wetland has been recognised as an important centre of fish production (Thompson, 2005). The favoured period of fishing in the wetlands is the beginning of the dry season when fishes are returning to areas of steady water (Ukekpe and Musa, 2009).

Among the common fish species harvested at the wetland are tilapia, mud, cat, elephant snout, and butter fishes. These five species are always hawked in the open when harvested. Majority of the rural fish sellers do so without considering appropriate handling methods. It has always been observed that the state and odour of fish normally changes after some time and in most cases the fish deteriorate with keeping. Therefore the objective of the work is to determine one of the major causes of deterioration of fish quality with keeping time. It is aimed at investigating the thiobarbituric acid value of five most abundant and commonly consumed fish species in the Hadejia-Nguru wetlands with keeping time, with the view of determining the rate of rancidity of the fish oil which is an index of their keeping quality.

## Materials and Methods

### Sample collection and treatment

Live samples of five different fish species identified as tilapia, mud, butter cat and elephant snout fishes harvested from Hadejia-Nguru wetlands were obtained from fishermen at Nguru town and transported to the laboratory within three hours in aquarium setting.

The fishes were slaughtered and minced at room temperature ($31^0$C) for analysis.

### Method

The time course monitoring of thiobarbituric acid (TBA) values was adopted. Spectrophotometric method was used in the determination of the TBA values with keeping time in which 10g of the minced fish was macerated with 50ml of distilled water at an interval of 2 minutes, then washed and transferred to a distillation flask with 47.5ml of water (Dandago *et al.*, 2004). 2.5ml of 4N HCL (antifoam liquid) and 5 glass beads were added.

The mixture was distilled at the rate of 5ml/min, the distillate (5ml) was taken in a glass stoppered tube and 5ml of TBA reagent added and heated in boiling water for 35 minutes. The sample was allowed to cool and absorbance measured against blank at 538nm. Each absorbance was used to calculate the TBA value (Dandago *et al.* 2004).

The rate of deterioration in these tropical fish species have also being monitored and rated on a scale of 1–10 with value of 1 as excellent condition, 2–3 good, 4–5 bad, and 5–10 spoilt.

## Results and Discussion

The five most abundant fish species harvested and consumed by the local community of the Hadejia-Nguru wetlands were selected for this study. The results of monitoring of TBA values of the different fish samples with keeping time are presented in Figures 1–5.

The fish samples analysed were found to have TBA values of 0.42, 0.58, 0.63, 0.81 and 0.92 mgMA/kg for tilapia, cat, mud, butter and elephant snout fish, respectively at one hour of keeping. This implies that the fishes were still fresh as fresh fish have TBA value below 5.0 mgMA/kg.

At six hours of keeping, it was found that elephant snout, butter and mud fishes with TBA values of 7.40, 7.10 and 6.50 mgMA/kg (Figures 1–3), respectively can no longer be considered fresh but cannot said to be spoiled since the TBA values for spoiled fish is above 8.0 mgMA/kg [15] while tilapia had value of 4.10 (Figure 4) and cat fish (Figure 5) with 5.0 were still fresh within the same period of time, but at nine hours of keeping all the fish samples analysed were no longer fresh as the TBA values were above 5.0 mgMA/kg.

Elephant snout at a value of 9.40 and butter fish at 8.4 could be considered spoiled at nine hours of keeping while tilapia (5.0), cat fish (7.0) and mud fish (7.6) were not yet spoiled.

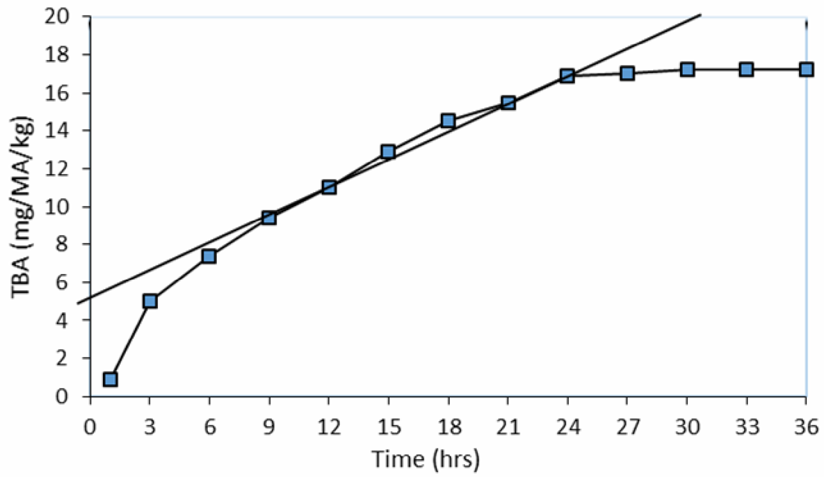


Figure 1. Change in TBA value with time in Elephant snout fish

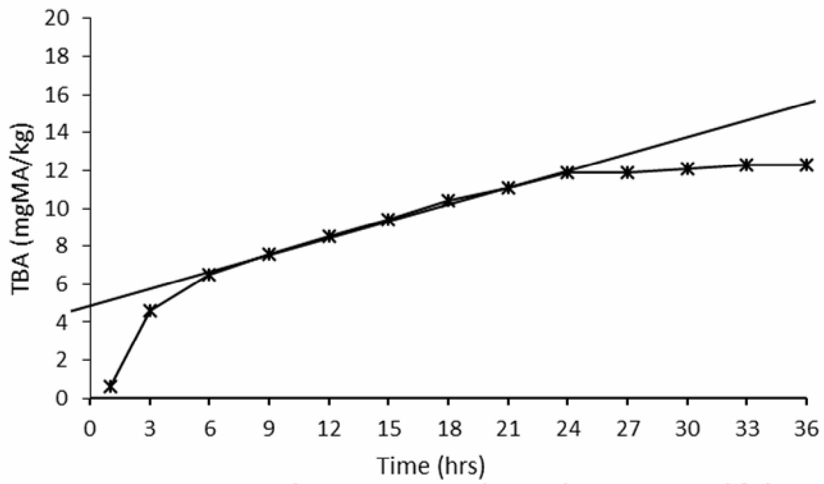


Figure 2. Change in TBA value with time in Mud fish

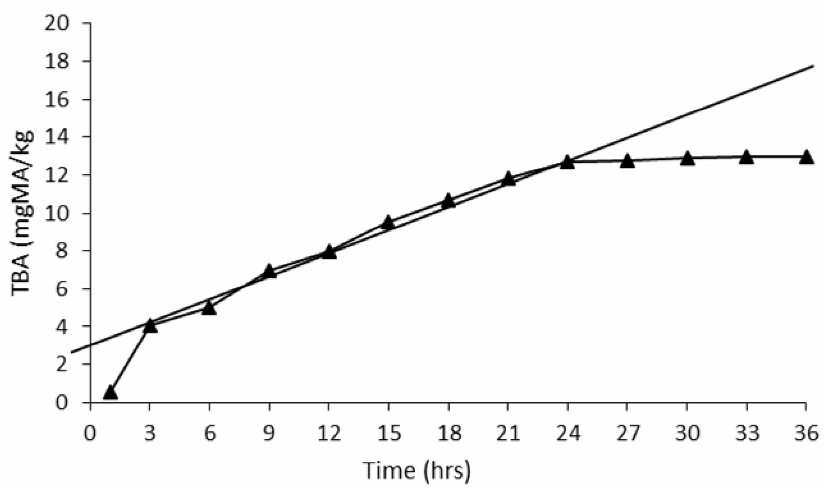


Figure 3. Change in TBA value with time in Cat fish

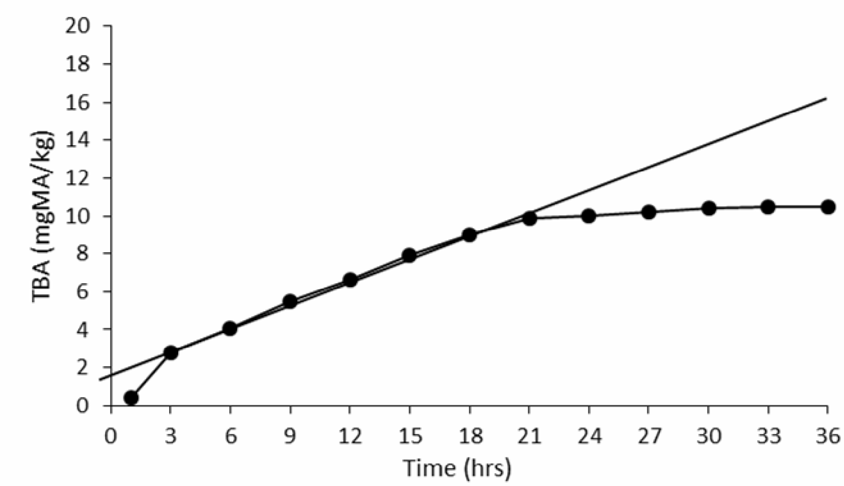


Figure 4. Change in TBA value with time in Tilapia fish

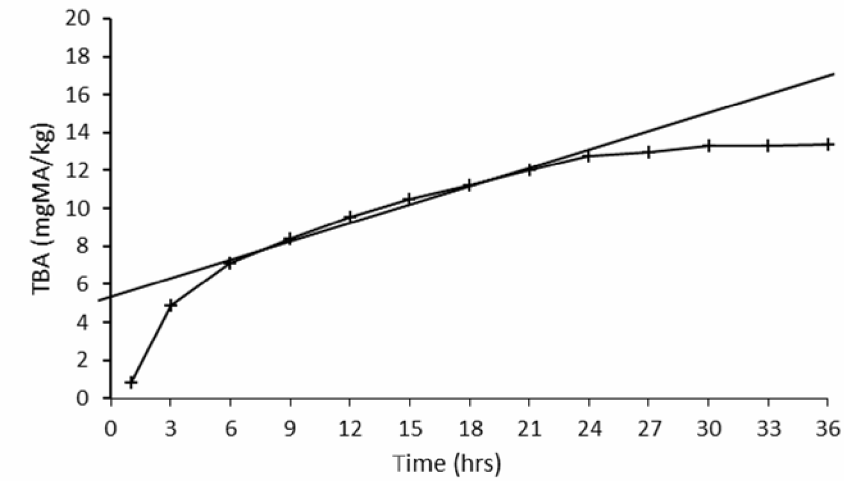


Figure 5. Change in TBA value with time in Butter fish

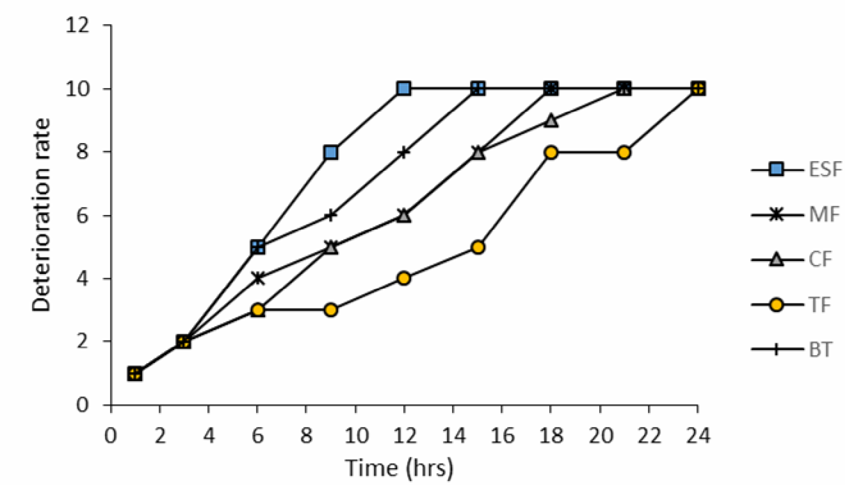


Figure 6. Variation in rate of deterioration of some tropical fish species

ESF=Elephant snout fish, MF=Mud fish, CF=Cat fish, TF=Tilapia fish, BT=Butter fish.

Figures 4 and 5 showed that tilapia and cat fishes were not spoiled at 12 hours of keeping with TBA values of less than 8.0 mgMA/kg in both species. This indicates that, both fish types (tilapia and cat fish) have better keeping quality compared to the elephant snout, mud and butter fish types based on their TBA values over time, but at 18 hours of keeping, the five species were found to have a TBA values above 8.0 and therefore have all spoiled.

Generally, the five fish species showed rapid increase in TBA values from 3 hours of keeping and peaked at 24 hours, after which there was no significant increase in the TBA values. This could be that after 24 hours of keeping, the aldehyde (malondialdehyde) produced during rancidity process of the lipid had diminished to a concentration that the change in TBA was no longer significant. This could mean that the lipids had completely gone rancid at this point and further keeping cannot produce more aldehydes. Barring other factors, the maximum TBA values recorded can give a clue to the comparative amount of lipid contents of the different fish species. Therefore, the variation in TBA values observed for fishes of different types can also be an indication that there is indeed variation in the lipid contents of fishes which determine their variability in keeping quality with time.

The rate of deterioration of the different fish species studied is presented in Figure 6, and agrees closely with the trend of the TBA values obtained in which spoilage of fish increases rapidly with time in all the species. Only tilapia showed some slightly slower rate while the rate at which the elephant snout fish spoils was very rapid and continuous. At the value of 10 all the species are completely spoilt and all the rate seems to be uniform.

The monitoring of the TBA values of the five fish species with keeping time showed that tilapia and cat fish had better keeping quality than elephant snout fish, mud fish and butter fish. Since rancidity rate denote spoilage rate, therefore elephant snout fish had the least keeping while tilapia is considered the best of the five sampled for this study.

This work also showed that fish spoilage begins as soon as the fish dies as shown by the TBA values after just 1 hour probably due to high temperature and light intensity experienced in this region which was both factors that favours oxidation and rancidity rate in fish. This is in agreement with the observation of earlier workers (Saeed and Howell, 2002). The monitoring of trimethylamine (TMA) level of fish species with time also showed significant level after three hours of storage indicating the deterioration of the quality of the fishes (Tsakins *et al.,* 1999). Based on the findings of this study, that fish start spoilage immediately after it dies, it is recommended that, irrespective of the fish species, appropriate preservation method should be used on fresh fish immediately after harvest.

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