# PROCEEDINGS

of the

# 27TH ANNUAL CONFERENCE *and* BIENNIAL GENERAL MEETING

## OF THE FISHERIES SOCIETY OF NIGERIA

**HELD AT:**
**BANQUET HALL GOVERNMENT HOUSE/FACULTY OF LAW,**
**NIGER DELTA UNIVERSITY BAYELSA STATE**
**25th-30th NOVEMBER 2012**

*Tagged*

# BAYELSA 2012

**PUBLISHED BY**
**FISHERIES SOCIETY OF NIGERIA**
**Old College by NIOMR, Wilmot Point Road, Ahmadu Bello Way, Bar Beach B/Stop,**
**Victoria Island, P.O. Box 2607, Apapa, Lagos.**
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# EVALUATION OF THE PRODUCT QUALITY, ECONOMY AND EFFICIENCY OF WOOD SHAVINGS AND RICE HUSK AS ALTERNATIVE FUELS FOR FISH SMOKING

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## ABSTRACT

This study evaluated the economy, and efficiency of the rice husk and wood shavings as alternative source of energy for smoking fish. Thirty six specimens of *Tilapia Zilli* weighing between 60 – 100g each were obtained from fresh fish market in Minna, Niger State. Twelve specimens each were smoked with fuel wood, rice husk and wood shavings respectively in a Kanji portable smoking kiln. Fuel wood served as the standard. Fuel economy, efficiency, proximate composition and sensory quality evaluation were conducted. The sensory quality examination was evaluated by a panel of fifteen volunteers. The results showed that, the products were not significantly different ($p>0.05$) in moisture content, lipid and ash, while there was significant difference in the percentage crude protein ($p<0.05$). There was no significant difference in the colour, texture and overall acceptability ($p > 0.05$), while there was significant difference ($p< 0.05$) in the appearance, taste and flavour. The total colony forming unit (log 10 CFU/g) of smoked fish ranged between 1.16 + 9.41 -2.20± 4.36 and 5.10 ± 6.66 – 5.40 ± 6.00 for the first week and eight (8) weeks respectively. There was significant difference between the microbial load of week 1 and 8. The microbial load was relatively higher in the products of rice husk in the first week, while it was relatively greater in the products of wood shavings in the $8^{th}$ week. Cost analysis revealed that 1.144 kg; 3.0kg and 0.786kg of fuel wood, rice husk and wood shavings were used per kg of fresh fish at ₦150.00, ₦50.00 and ₦50.00 respectively. Smoking durations were 4 hrs 30 minutes, 6hrs 50 minutes and 5 hrs 52 minutes for fuel wood, rice and wood shavings respectively.

**Keywords: Efficiency, economy, wood-shavings, rice-husk, quality, smoked, *Tilapia zilli***

## INTRODUCTION

Fish protein compares favourably with that of eggs, milk and meat, and often have higher value of the essential amino acid, methionine, (Boragstron, 1992). Fish is rich in vitamin A, D and iodine. Preservation of fish is therefore of great importance to mankind especially in developing countries where the daily intake of protein is low. According to FAO (2003) fish provides 22% of the protein intake in Sub-Sahara Africa. Prevention of microbial spoilage of fish may be achieved by different methods such as smoking, drying, use of chemical, freezing or by use of modified atmosphere storage (Efuewene and Iweanoge, 1991; Awan and Okaka and, 1985; kumolu-Johnson, et al, 2010). Some of these methods are often expensive and not within the reach of the common populace. Smoking as a method of preservation of foods dates back to civilization and is still widely used for this purpose among several communities in the third world. Drying is one of the most important and the oldest method of preserving fish worldwide. Gupta and Gupta, (2006), noted that smoking, a form of dry cooking, preserved about 3% of the world catch compared to other preservation method. Human population is growing rapidly; hence too much pressure is placed on the use of fire wood as a conventional method of smoking fish in Nigeria (Eyo, 2001). The bacteria contamination of hot smoked fish just out of the smoke house is usually below $10^3$ per gram (Doe, 1998). A number of smokers have been developed in different parts of the world which utilizes locally available material such as wood, charcoal, wood shaving, etc as energy sources (Adelowo, 2005). Da Silva (2002), reported that out of the 100 million tonnes of world's estimated fish production in 1989, fifteen percent were cured and one third of the cured fish were smoked. Oyelese (2006), reported that smoked fish attracts high foreign exchange to Nigerian Government. Rice husk and wood shavings offers much potential for energy generation and biomass to energy projects that can create sustainable enterprises, protect the environment, reduce poverty and improve the quality of life for the rural population.

## MATERIALS AND METHODS

### Experimental site and design

The experiment was carried out at the Federal University of Technology Teaching and Research Farm, Bosso Campus, Minna, Niger State. A complete randomized design (CRD) consisting of three (3) treatments was used. Each treatment has three (3) replicates of *Tilapia Zillii* randomly distributed.

### Samples preparation

The samples collected were gutted, descaled and washed before feeding into the kiln for smoking. Prior to weighing and smoking, the fish samples were pre-dried in the shade for 1 hour, to enhance the surface gloss of the product.

Determination Fuel consumption

The consumption of the various wood material were measured by weighing load of each of the fuel material at the beginning of the smoking process and weighing any remaining and partial burnt at the completion of smoking. Fuel usage was expressed as the actual amount of the fuel materials used

Weight of wood material per kilogram of smoked fish = $\frac{weight\ of fuel\ material\ used}{weight\ of fish\ smoked}$

Duration of smoking. Time clock was used in determining the smoking duration of the products

The smoking process

The fish specimens were subjected to three treatments, namely; Treatment I - Fuel wood (T1), Treatment II – Rice husk (T2) and Treatment III – Wood shavings (T3). Each treatment has three replications. Each treatment (fish specimen) was weighed before smoking. The fuel materials

were also weighed before being ignited. Smoking racks were laid in the smoking chamber after the flame put off. Thermometer was used to record smoking temperatures at a period interval of 30 minutes. The products were weighed immediately after smoking and re-weighed after cooling.

Determination of microbial load

The smoked fish samples were macerated in a mortar and one gram of fish tissues was dissolved in test tube containing 9ml of sterilized distilled water. Serial dilution up to 7g in to 250ml was carried out, and 0.5ml was placed in to Petri dishes which were mixed with the media. And this was transfer in to the replicates of three. Nutrient agar was added. The dishes were rotated by hand in a swirling motion so that the inoculums were uniformly dispersed in the medium. The agar was allowed to solidify and incubated at $37^{oc}$ for 48 hours. Microbial colonies counts were taken using a colony counter.

Cost analysis of fuel wood, rice husk and wood shavings

Cost analysis was computed based on the experimental findings of the various materials.

The indices used for the cost analysis were: cost of fuel material and cost of transportation of fuel materials.

Cost of fuel material per kg of fish smoked = $\frac{cost of fuel used\ (₦)}{1kg of fish smoked\ (kg)}$

Organoleptic assessment

The sensory quality attributes were evaluated by a panel of eleven volunteers. Some of the panellists have previously participated in sensory evaluation of fish. They were asked to evaluate fish samples for visual appearance, taste, colour, flavour, and overall acceptability on 5-point scale where 1 =Excellent, 2 = very good, 3 = good, 4 fair, 5 = poor (Afolabi et.al, 1984)

Proximate Analysis

Proximate analysis was carried out using the standard method of Association of Official Analytical Chemists (A.O.A.C, 1992).

The data collected were subjected to statistical analysis using one way analysis of variance (ANOVA) and Duncan Multiple Range Test for mean separation.

**RESULTS**

The relative proximate composition, organoleptic evaluation, cost of fuel materials and microbial of the three products is presented on Tables 1, 2, 3 and 4 respectively. The relative percentage protein of the three products shows that product of fuel wood were significantly different from those of rice husk and those of wood shavings ($P < 0.05$). There was however no significant difference between the products of rice husk and those of wood shavings ($P>0.05$).The percentage protein value was greater and more relatively stable in the products of rice husk throughout the eight (8) weeks of storage. This was followed by wood shavings product, while fire wood (fuel wood) recorded the least percentage protein. The lower percentage protein recorded in the product smoked with fire wood may be as a result of the effect of the excessive heat which usually has denaturing effect on protein.. There was no significant difference (p[illegible]0.05) in the percentages moisture content of the three products.

Table 1: Summary of mean (S.E) percentage proximate composition of Tilapia zilli smoked with fuel wood, rice husk and wood shaving

| Parameters | $T_1$ | T2 | T3 | LS | SEM |
|---|---|---|---|---|---|
| Crude protein | $43.09\pm5.53^{b}$ | $55.48\pm1.49^{a}$ | $51.40\pm2.19^{ab}$ | ** | 2.23 |
| Moisture | $11.17\pm0.91^{a}$ | $9.15\pm0.56^{a}$ | $9.97\pm0.58^{a}$ | ns | 0.42 |
| Lipid | $21.30\pm0.90^{a}$ | $19.63+0.92^{a}$ | $20.76\pm0.62^{a}$ | ns | 0.48 |
| Ash | $17.49\pm0.66^{a}$ | $18.42\pm0.63^{a}$ | $18.49+0.46^{a}$ | ns | 0.33 |

Table 2: Summary of mean (S.E) of sensory evaluation of *Tilapia Zilli*smoked with fuel wood, Rice husk and wood shavings

| Parameter | T1 | T2 | T3 | SL | SEM |
|---|---|---|---|---|---|
| Appearance | $1.90\pm0.21^{b}$ | $3.09\pm0.31^{a}$ | $2.27\pm0.33^{ab}$ | ** | 0.18 |
| Colour | $1.54+0.27^{b}$ | $3.09\pm0.28^{a}$ | $2.92\pm0.40^{a}$ | | 0.28 |
| Taste | $1.72\pm0.24^{b}$ | $2.72+0.36^{a}$ | $2.55\pm0.31^{a}$ | ** | 0.18 |
| Texture | $1.72\pm0.24^{a}$ | $2.36\pm0.30^{a}$ | $2.36\pm0.28^{a}$ | ns | 0.16 |
| Flavor | $1.81\pm0.26^{b}$ | $3.00\pm0.40^{a}$ | $2.09\pm0.31^{ab}$ | ** | [0.20 |
| General Acceptability | $1.81+0.33^{a}$ | $2.18\pm0.35^{a}$ | $2.27\pm0.36^{a}$ | ns | 0.19 |

Table 3: Summary of fuel wood, rice husk and wood shavings consumption, cost smoking duration and temperature.

| T1 | Treatment | Weight of fresh fish smoked (kg) | Weight of material used (kg) | Cost of fuel material used (₦) | Wt of fuel kg of fresh fish | Cost of fuel fresh fish (₦) | Processing duration (hr) | Smoking temperature (°c) |
|---|---|---|---|---|---|---|---|---|
| | *(Fire wood)* 0.45kg | 1.144kg | 150.00 | | 2.54 | 164.49 | 4.30 | 62-75 |
| T2 | (Rice husk) 0.45kg | 3.0kg | 50.00 | 7.5 | 120.33 | 6.50 | 44-55 | |
| T3 | (Wood shavings) 0.45kg | 0.786kg | 50.00 | | 2.62 | 70.20 | 5.52 | 57-68 |

Table 4: Summary of mean (S.E) percentage microbial count for week1 and week 8 *Tilapia Zilli* smoked with fuel wood, Rice husk and wood shavings.

| Week | T1 | T2 | T3 | LS | SEM |
|---|---|---|---|---|---|
| 1 | $2.20+4.36^{b}$ | $7.73\pm6.13^{a}$ | $4.16\pm9.41^{c}$ | ** | 3.49 |
| 8 | $5.40\pm6.00^{a}$ | $5.10\pm6.66^{a}$ | $7.13\pm66.67^{b}$ | ** | 4.09 |

## DISCUSSION

The high degree of dehydration achieved in the three products may be responsible for the high percentage protein recorded. This is in line with Afolabi et.al 1984; Asiedu et al; 1991) who stated that decrease in percentage moisture result in increase in percentages of other constituents. The percentage lipids content of the three products were relatively stable over the period of storage. There was no significant difference among the products ($P>0.05$). The percentage values of the lipid of the three products were 21.30, 19.63 and 20.76 for the fuel wood, rice husk and wood shaving respectively. It can therefore be asserted that the relatively high heat associated with fuel wood has not established any significant difference in the lipid content of the three products. Variations among treatments may be due to variations in the level of heat treatment, size, dehydration and age of fish sample, duration of smoking, drip loss due to thawing and the state of the raw fish prior to smoking ranges. The percentage lipid recorded in the products were relatively higher than those of the works of Onyejiaka (2001) which ranged between 12.30% - 19.17% and 8.70% - 14.30% respectively.

There was no significant difference in the relative percentage ash contents of the three products (P> 0.05). The mean ash contents of the three products were 17.49, 18.42 and 18.49 percent for fuel wood, rice husk and wood shavings respectively. The values obtained were comparatively greater than those obtained by Onyejiaka (2001), whose obtained values ranged between 2.08%-4.43%. The relative percentage of one factor of the proximate constituents determines the percentage of other constituents. Doe and Olley (1998), reported that smoking resulted in concentration of nutrients (crude protein and fat).

The cost of fuel materials used in smoking the various samples of *Tilapia Zilli* shown in table 3 revealed that, it cost 150.00k to smoke 0.45kg of the fish sample using fuel wood; while 50.00k each for smoking 0.45kg of fish samples for rice husk and wood shavings respectively. Fuel material consumption as indicated in the table showed higher rate of consumption in the use of fire wood. This may be attributed to its fast combustion rate and higher temperature (heat) generated. Smoking duration was however substantially longer in the use of rice husk; 6 hr 50 minute considering 4 hours 30 minutes and 5 hours 52 minute for fuel wood and wood shavings respectively. This may be attributed to the low temperature generating capacity of rice husk and wood shavings which make its use in fish smoking more laborious and time consuming.

The smoking temperature ranged from 44°C-55°C and to 62°C -75°C for rice husk and wood shavings respectively. Excessive heat treatment impairs the nutritional value of protein. Smoking length of smoking period was relatively longer with rice husk material.

Table 2 shows that there were significant differences ($p < 0.05$) among the three products in appearance, taste and flavour, while there was no significant difference of preference in terms colour, texture and overall acceptability($p > 0.05$). The mean preference scores for appearance of 1.90, 390 and 2.27 for fuel wood, rice husk and wood shaving products respectively showed that the rice husk smoked product was the most preferred, followed by the wood shaving products. The panellists preferred the products of rice husk and wood shaving in terms of colour and there was no significant difference in this relation. There was no significant difference in number of panellist's preference for texture of the three products. However, there was significant difference in the numbers of panellists flavour preference of the products. Rice husk smoked product was the most preferred, followed by wood shaving smoked fish products. There was no significant difference in the general acceptability of the three products.

The weekly changes in microbial loads of smoked *Tilapia Zilli* are presented in table 4.There was significant difference in the microbial loads of the three products in the first week of storage ($P < 0.05$). There was no significant difference between fire wood and rice husk products ($P > 0.05$) in the eight week of storage. There was however significant difference among the wood shaving, fire wood and rice husk products ($P < 0.05$) in the eight week of storage. Dolakoglu, (2004), Bilgin, et. al (2008), reported that growth and multiplication of microbes may be attributed to relative moisture content. Microbial load increased steadily between 2[nd] and 8[th] week in spite of the reduced moisture content of the products. There was however no element of moisture re-absorption in all the two products. Abolagba and Melle, (2008) reported that improper smoking and lack of proper hygienic handling of smoked fish products resulted in a very high microbial load. Salain et al (2006) observed that smoking inhibits microbial growth in stored fish products. Hood et al. (1983) reported that microbial load increases with duration of storage and under favourable reduced temperature. This suggests that one single factor may not account for these microbial changes. Cross contamination, PH, and sanitary conditions are among other factors that can influence microbial changes. The TVC of the the wood shaving and rice husk smoked products between the first and the 1[st] and 6[th] week were all below $5\times10^5$ CFU/g. This signified the two products were still of good microbial quality. The fire wood smoked product recorded TVC higher than $5\times10^5$ CFU/g in the 8 week, higher than the recommended limit 7.0 log CFU/g (ICMSF, 1986).

## CONCLUSION

This study on the product quality, economy and efficiency of rice husk and wood shaving as alternative source of energy for fish smoking has proved in this research that the materials are good and reliable alternatives to the conventional fire wood (fuel wood). The proximate analysis, fuel consumption, smoking duration and microbial loads recorded in this work provide clear testimony. The use of these materials will lead to reduce the pressure on forest wood resources hence checking global warming caused as a result of deforestation, and also reduce water pollution. It is therefore recommended for use in fish preservation.

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