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Comparative Analysis of two Preservation Methods on Two Fish Species from Wild and Homestead Pond in Ibadan Oyo State Nigeria

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Abstract: This study compared the analysis of different processing methods on two fish species *(Clarias gariepinus and Tilapia sp.)* collected from the wild (Eleyele River) and a named homestead pond. Fish were filleted, smoked (8 hours) and boiled (10 minutes). Proximate analysis was carried out on fresh, smoked and boiled samples while the organoleptic qualities was determined by filling questionnaire after testing. All preservation methods significantly ($p>0.05$) reduced moisture content in the fish samples used with the least (9.29%) % *Tilapia sp.* from homestead pond. The result shows that *Tilapia spp.* from both wild and homestead pond had the highest mean: crude protein (79.75), ash (13.00), crude fibre (0.13) and dry matter (90.71) while *C. gariepinus* from both wild and homestead pond had highest mean value of 12.00 and 73.20 in fat/ether extract and moisture content respectively in all the treatment. The organoleptic properties revealed that smoked *Tilapia spp.* and *C. gariepinus* samples from homestead pond had the best appearance (2.1) and flavor (1.8) while boiled *Tilapia spp.* and *C. gariepinus* from the wild had the best taste (2.0). Smoked *Tilapia spp.* from the wild was accepted with mean value of 8.4. Boiled *C. gariepinus* from homestead pond had the highest mean value for tenderness (1.6) and juiciness (1.8). In conclusion, this study showed that moisture content was reduced in all smoked samples making them free from spoilage and microorganisms attack and boiled samples from each sources had higher nutritional composition and appreciable organoleptic properties.
Keywords: Comparative Analysis, preservatives, Wild, Homestead, Pond.

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Introduction

Protein is the most important component of the diet of fish because protein intake generally determines growth, it has a high cost per unit and high levels are requires per unit (Cho and Kaushik, 1990). In recent times, fish has been reported as the deficiency in human diets in the tropic region (Akinwumi, 2011). The knowledge of fish composition is essential for its maximum utilization. The nutritional composition of fish varies greatly from one species and individual to another, depending on age, feed intake, sex and sexual changes connected with spawning, the environment and season (Silva and Chamul, 2000). Processors have direct

interest in the proximate composition of fish in order to know the nature of the raw material before chilling, freezing, smoking or canning can be correctly applied (FAO, 2008).

Spoilage is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory and nutritional characteristics (Doyle, 2007). The processing and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and also to prevent economic losses (Okonta and Ekelemu, 2005). If fish is not sold fresh, preservation methods should be applied to extend the shelf-life. It remove moisture by the process of osmosis, creating medium unsuitable for microbial growth. The rate of salt uptake and moisture loss is influenced by such factors as temperature, thickness of the flesh, fattiness of the flesh, freshness of the fish and the chemical purity of the salt used for curing. The purpose of this research is to find out which of these methods of preservation, smoking and boiling gives a better proximate and organoleptic composition.

The study examined the comparative analysis of two preservative methods using different fish species from homestead and wild pond, the comparative examination on the proximate composition of the different fish species from the two different sources, determine the organoleptic properties of different fish species from homestead and wild pond, determine the best processing method for fish species from homestead and wild pond.

To ensure the availability of fish throughout the year, especially during the lean season, it is essential to process the fish to preserve it in appreciable quantities in good condition until its use is required (FAO, 2001). Taking note of the moisture content, fish is extremely perishable. Fish is highly susceptible to deterioration if no preservative or processing measure is taken immediately after death, a number of physiological and microbial deterioration set in and thereby degrades the fish (Davies and Davies, 2009). It has been estimated that in the high ambient temperatures of the tropics, for which Nigerians is a part, fish spoils within 12-20 hours of caught, depending on species and size hence a considerable proportion of the landed catch is processed to preserve most of their catch by artisanal methods (FAO, 2001). The need to look at effect of various preservation methods is essential in order to know the one that has the ability to preserve to the highest level or proportion of the nutritional component.

Materials and Method

Experimental fish and systems

Fresh *Tilapia spp* (11) and *Clarias gariepinus* (7) were gotten from Eleyele River Ibadan and Mashopa Agricultural Development Company in Ibadan, Oyo State, Nigeria. The fish samples were degutted and washed with clean tap water. Six and three respectively were allotted for smoking, visceral removed and washed with clean water. The fish samples were placed inside the smoking kiln for 8hours. The fish was turned at intervals to ensure uniform smoking and cooking of the fish. Four and three samples respectively were allotted for boiling, visceral removed and washed in clean water, boiled for about 10 minutes until the pieces were well cooked and tendered. Fresh samples of both were degutted and washed with clean water. Samples were taken to the laboratory to examine the nutritional composition. AOAC Crude protein was done by modifying micro Kjeldahl method (AOAC, 2000) involving the official method was used for moisture determination (Oparaku and Nwaka, 2013). Ether extract (Fat) determination method was used to determine the crude fat content. Apparatus used included Whatman No.2 filter paper, absorbent cotton wool and Soxhlet apparatus. Process the setup was allowed to cool at room temperature. The flask was then

weighed on the scale. But before the weighing was done, all dirt and moisture on the flask were carefully removed so as to obtain a true value.

Subjective analysis was used for organoleptic characteristics analysis. The parameters used were flavour, tenderness, appearance, juiciness, taste and acceptability.

Statistical analysis

Significant differences between means of experiments were determined by Least Significant Difference (LSD). SPSS 16.0 statistical tool was used to analyze the data obtained.

Results and Discussion

Table 1. Proximate Composition (%) of Fresh Samples

Treatment	% Crude Protein	% Ash	% Crude Fibre	% Fat/Ether extract	% Dry Matter	% Moisture Content
HCG	61.65	6.00	0.07	12.00	23.50	76.50
WCG	70.90	5.00	0.06	11.00	26.80	73.20
WTS	79.75	11.00	0.13	7.00	28.00	72.00
HTS	71.25	7.00	0.10	7.00	30.00	70.00

Table 2. Proximate Composition (%) of Boiled Samples

Treatment	% Crude Protein	% Ash	% Crude Fibre	% Fat/Ether extract	% Dry Matter	% Moisture Content
WCG	76.50	6.00	0.09	11.00	27.93	72.07
HCG	64.55	3.00	0.11	8.50	27.59	72.41
HTS	68.01	12.00	0.12	8.00	28.97	71.03
WTS	73.35	13.00	0.11	7.00	29.82	70.18

Table 3. Proximate Composition (%) of Smoked Samples

Treatment	% Crude Protein	% Ash	% Crude Fibre	% Fat/Ether extract	% Dry Matter	% Moisture Content
WCG	63.80	6.00	0.09	11.00	88.21	11.79
HCG	53.60	8.00	0.08	9.00	89.15	10.85
WTS	74.05	7.00	0.13	7.00	89.92	10.08
HTS	78.30	11.00	0.10	7.00	90.71	9.29

WCG: Wild *Clarias gariepinus;* HCG: Homeststead *Clarias gariepinus*
WTS: Wild *Tilapia species;* HTS: Homestead Tilapia species

From the table 1 above, higher protein content (76.50) was recorded in boiled sample followed by (70.90) in fresh sample while the least was recorded in smoked sample with the mean value of 63.80 ($p < 0.05$). The result showed that the protein content of boiled catfish is higher than the smoked and fresh samples. This is in agreement with the findings of Oparaku and Nwaka, (2013) in effect of different processing methods on proximate composition of the fish species (*Synodontis clarias*, *Trachurus trecae* and *Clarias gariepinus*) where boiled *Trachurus trecea* had the highest crude protein (37.40%). The ash content (6.0) was high in boiled and smoked samples than fresh sample with mean value of 5.0 ($p < 0.05$).

Crude fibre shows a significant difference ($p < 0.05$) with the highest mean value of 0.09 found in boiled and smoked catfish from the wild while the least mean value of 0.06 was found in fresh sample. There was no significant difference observed in fat content among all the samples analyzed ($p > 0.05$) with the mean value of 11.00. Dry matter content was observed in all the samples with the mean values of 26.80, 27.93 and 88.21 respectively. The highest moisture content (73.20%) was recorded in fresh samples and increased moisture content was noticed in all processing methods except for the smoked samples. The differences in water contents between fresh, boiled and smoked *C. gariepinus* from wild were found to be insignificant and this agrees with the findings of Unlusayin *et al.*, (2001) that catfish belongs to category of fish having high water or moisture content. These changes were similar to those reported by Gokoglu *et al.*, (2004) in rainbow trout and Garcia-Arias *et al.*, (2003b) in sardines where all samples had higher moisture content in their findings. Accordingly, protein, ash, crude fibre, fat and dry matter found in smoked *C. gariepinus* in wild is explained by the reduction in moisture, this was supported by Gall *et al.*, (2003), that deep fried fish fillet had significantly higher nutritional composition than raw fillet.

The result also showed that higher protein content was recorded in boiled sample with mean values of 64.55, followed by (61.60) in fresh sample while the least was recorded in smoked sample with the mean value of 53.60 ($p < 0.05$). Significantly higher ash content (8.0) was observed in smoked sample, followed by (6.00) in fresh sample while the least was found in boiled sample with mean value of 3.0 ($p < 0.05$). This was in line with Salan *et al.*, (2006) where the ash content of *C. gariepinus* from homestead pond show high percentage in smoked fish samples compared to fresh and boiled samples. The increase in ash content of smoked *C. gariepinus* is due to loss of humidity. Crude fibre shows a significant difference ($p < 0.05$) with the highest mean value of 0.11 found in boiled sample, followed by (0.08) in smoked sample while the least value of 0.07 was found in fresh sample. The mean values of 12.00, 8.50 and 9.00 in fresh, boiled and smoked fish respectively shows significant ($p<0.05$) difference in fat content of *C. gariepinus* from the pond. There was no significant difference observed in dry matter content among fresh, boiled and smoked fish ($p > 0.05$) with the mean values of 23.50, 27.59 and 89.15 respectively. The highest moisture content (76.50%) was recorded in fresh samples and increased moisture content was noticed in all processing method except for the smoked samples. This corroborate with the findings of Unlusayin *et al.*, (2001) that catfish belongs to category of fish having high water or moisture content.

Table 2 shows that fresh *C. gariepinus* from homestead pond recorded the highest value in moisture, ash and fat content with the mean value of 76.50, 6.00 and 12.00 respectively with low content of crude protein, and dry matter (61.65, 23.50 respectively). The result further shows that smoked *C. gariepinus* from pond had the highest mean value of 8.00 and 89.15 in ash content and dry matter respectively. It also shows insignificant ($p >0.05$) least performance of smoked *C. gariepinus* from the pond in terms of moisture content with the mean value of 10.85. There is significant ($p<0.05$) difference in the moisture content of fresh *C. gariepinus* from the wild, fresh *C. gariepinus* from pond, boiled *C. gariepinus* from wild and boiled *C. gariepinus* from pond while there is no significant ($p >0.05$) difference in smoked *C. gariepinus* from wild and smoked *C. gariepinus* from pond. There is significant ($p<0.05$) difference in crude protein, ash content, crude fibre and fat content from both wild and homestead pond. Percentage crude protein recorded in *C. gariepinus* from the wild and homestead showed that the crude protein content was higher in *C. gariepinus* from the wild than *C. gariepinus* from homestead pond. This is in line with Oparaku and Nwaka (2013) in which percentage crude protein recorded in the sun and solar dried *C. gariepinus* showed that the crude protein content was higher in sun dried fishes than solar dried fishes. Also, fresh *C.*

gariepinus from the pond had highest fat content than that of the wild which is in accordance with Grigorakis *et al.*, (2003) that the cultured fish depends largely on compounded feed which contribute to its higher fat content.

Table 3, *Tilapia spp.* collected from the wild were generally high in crude protein which is in line with Tidwell and Allan, (2001) in their experiment that protein contents were generally high in the processed red fish studied. Fresh sample recorded the highest crude protein (79.75), followed by smoked sample with 74.05 while boiled samples had the least protein content with mean value of 73.35. Significantly higher ash content (13.0) was observed in boiled sample, followed by (11.00) in fresh sample while the least was found in smoked sample with mean value of 7.0 ($p < 0.05$). The difference between the crude fibre content was significant from each other. Fresh and smoked *Tilapia spp.* from wild had the highest mean value of 0.13 while the least mean value of 0.11 was recorded in boiled *Tilapia spp.* There was no significant ($p > 0.05$) difference observed in fat content among fresh, boiled and smoked fish with the mean value of 7.00. The preservation method had no effect on the fat content of the *Tilapia spp.* from the wild. The insignificant increase in dry matter content was observed in fresh, boiled and smoked samples with the mean values of 28.00, 29.82 and 89.92 respectively.

Fresh *Tilapia spp.* from the wild recorded the highest mean value of 72.00, followed by boiled samples with mean value of 70.18 while smoked samples had the least mean value (10.08) moisture content. Smoked *Tilapia spp.* from the wild recoded the lowest moisture content similar to the work by Kumolu-Johnson *et al.*, (2010) that water losses occurring during frying and smoking resulted in lower moisture content in fried and smoked fish as compared to the raw fish fillets. The result showed protein contents of smoked *Tilapia spp.* samples was higher than that of boiled and fresh samples with significant ($p < 0.05$) difference in the mean values. This is in line with Tidwell and Allan, (2001) in their experiment that protein contents were generally high in the processed red fish studied. Furthermore, there is significant high ash content (12.0) in boiled *Tilapia spp.* from pond, followed by (11.00) in smoked samples while the least was found in fresh sample with mean value of 7.0 ($p < 0.05$).

The difference between the crude fibre content was significant in the treatments with highest mean value of 0.12 found in the boiled samples while fresh samples and smoked samples of *Tilapia spp.* from homestead pond had the least mean value of 0.10. Also, the mean value of 8.00 was recorded in boiled samples while fresh and smoked samples of *Tilapia spp.* had 7.00 mean value which shows significant ($p<0.05$) difference in fat content of *Tilapia spp.* from the pond, there is no significant increase in dry matter content in fresh, boiled and smoked samples with the mean values of 30.00, 28.97 and 90.71 respectively. Boiled *Tilapia spp.* from the pond recorded the highest (71.03), followed by fresh with mean value of 70.00 while smoked fish sample had the least mean value (9.29) moisture content.

Smoked *Tilapia spp.* from the homestead pond had the lowest moisture content similar to the work by Kumolu-Johnson *et al.*, (2010) that water losses occurring during frying and smoking resulted in lower moisture content in fried and smoked fish as compared to the raw fish fillets. Fresh *Tilapia spp.* from the wild had highest value in crude protein, crude fibre and moisture content with the mean values of 79.75, 0.13 and 72.00 respectively with low content of dry matter (28.00). Smoked *Tilapia spp.* from homestead pond had the highest mean value of 78.05 and 90.71 in crude protein and dry matter respectively. This agrees with the findings of Akinwumi (2011) where smoked *Tilapia niloticus* had higher protein.

The result further shows insignificant (p >0.05) difference of smoked *Tilapia spp.* from the homestead pond in terms of moisture content with the mean value of 9.29. There is significant (p<0.05) difference in the moisture content of fresh *Tilapia spp.* from wild, fresh *Tilapia spp.* from pond, boiled *Tilapia spp.* from wild and boiled *Tilapia spp.* from pond while there is no significant (p >0.05) difference in smoked *Tilapia spp.* from the wild and smoked *Tilapia spp.* from the pond. Generally, *Tilapia spp.* from the wild had higher crude protein content than *Tilapia spp.* from homestead pond. Also, *Tilapia spp.* samples from homestead pond had highest fat content than that of samples from the wild. The significant (p<0.05) difference in crude protein, ash content, crude fibre and fat content from wild and homestead pond is in accordance with the result gotten by Grigorakis *et al.*, (2003) that the cultured fish depends largely on compounded feed which contribute to its higher fat content. The difference in the nutrient composition of *C. gariepinus* and *Tilapia spp.* samples collected from the wild.

The processing methods had significant effect on the nutrient composition of the fish species. *Tilapia spp.* from the wild perform best in terms of crude protein, ash content, crude fibre and dry matter with the mean value of 79.75, 11.00, 0.13 and 89.92 respectively but lower fat and moisture content with the mean value of 7.00 and 10.08 respectively. This finding is in line with Gall *et al.*, (2003), that deep fried fish fillet had significantly higher nutritional composition than raw fillet. *C. gariepinus* fish collected from the wild had lowest value in crude protein, ash content, crude fibre and dry matter with the mean value of 63.80, 5.00, 0.06 and 26.80 respectively but higher in fat and moisture content with the mean value of 11.00 and 73.20 respectively. Unchanging fat content of the *C. gariepinus* from the wild is related to the insignificant effect of the treatments on the fish species. This disagrees with the findings of Oparaku and Nwaka (2013) that fat loss phenomenon was intensive in the boiling and solar dried fish than in smoked samples. *C. gariepinus* and *Tilapia spp.* from wild had significant (p<0.05) difference in crude protein, ash content, crude fibre and fat content while dry matter and moisture content were not significantly (p >0.05) different from each other.

Tilapia fish sample from the pond in table 8 had the highest mean value in crude protein, ash content, crude fibre and dry matter with the mean value of 78.30, 12.00, 0.12 and 90.71 respectively but lower fat and moisture content with the mean value of 7.00 and 9.29 respectively while *C. gariepinus* species from the pond recorded the lowest value in crude protein, ash content, crude fibre and dry matter with the mean value of 53.60, 3.00, 0.07 and 23.50 respectively but higher in fat and moisture content with the mean value of 12.00 and 76.50 respectively. There is significant (p<0.05) difference in crude protein, ash content, crude fibre and fat content from *C. gariepinus* and *Tilapia spp.* from homestead pond and no significant (p >0.05) difference in dry matter and moisture content as confirmed by Holman and Maalekuu (2013) that smoked fish recorded the highest crude protein content, crude fibre, ash content and fat content.

The organoleptic properties of smoked and boiled *C. gariepinus* from wild and homestead pond. The overall performance showed that for appearance, the highest value recorded was 1.8 in smoked *C. gariepinus* from homestead pond while the least value was 1.2 in the smoked *C. gariepinus* from wild. (Webster *et al.*, 1993) confirm that colour of the flesh and general appearance of skin and flesh differs significantly between wild and cultured fish in many cases. For flavour, the highest value recorded was 1.8 in the smoked *C. gariepinus* from pond while the least value was 1.2 in smoked *C. gariepinus* from wild and boiled *C. gariepinus* from homestead pond. This agrees with the findings of Mohr, (2006), that the flesh of cultured fish tends to be softer in texture, and has a milder, less flavour than wild

fish. For the taste, the highest value recorded was 2.0 in boiled *C. gariepinus* from the wild while the least value was 1.0 in boiled *C. gariepinus* from the homestead pond. However, there were non-significant differences ($p>0.05$) seen in smoked *C. gariepinus* from the wild and homestead pond. This agrees with the findings of Oparaku and Nwaka (2013) that there is non-significant differences ($p>0.05$) seen in smoked, solar dried and boiled in palatability of *C. gariepinus* while the palatability of oven dried significantly differed ($p<0.05$) from solar dried, smoked and boiled. Also, the tenderness was high in boiled *C. gariepinus* from homestead pond with mean value of 1.6 while boiled *C. gariepinus* from the wild had the least (1.4) performance.

Table 4. Organoleptic properties of *Clarias gariepinus* from Wild and Homestead Pond. Data = Mean ± SD, n = 4

Treatment	Appearance	Flavour	Taste	Tenderness	Juiciness	Acceptability
CBW	1.6±0.5^{ab}	1.6±0.5^{ab}	2.0±0.0^{a}	1.4±0.5^{ab}	1.2±0.4^{ab}	7.4±0.5^{ab}
CBP	1.4±0.5^{b}	1.2±0.4^{b}	1.0±0.0^{b}	1.6±0.6^{a}	1.8±0.4^{a}	6.0±0.7^{b}
CSW	1.2±0.4^{bc}	1.2±0.4^{b}	1.6±0.5^{ab}			7.8±0.4^{a}
CSP	1.8±0.4^{a}	1.8±0.4^{a}	1.6±0.5^{ab}			7.4±1.5^{ab}

Figures with the same alphabet in superscript are not statistically different ($P<0.05$)

Note: *CBW - C. gariepinus Boiling Wildz; CBP - C. gariepinus Boiling Pond*
CSW - C. gariepinus Smoked Wild; CSP - C. gariepinus Smoked Pond.

Table 5. Organoleptic properties of *Tilapia spp* from Wild and Homestead Pond. Data = Mean ± SD, n = 4

Treatment	Appearance	Flavour	Taste	Tenderness	Juiciness	Acceptability
TBW	1.6±0.5^{a}	1.8±0.4^{a}	1.8±0.4^{a}	1.6±0.5^{a}	1.6±0.5^{a}	7.8±0.8^{ab}
TBP	1.4±0.4^{a}	1.4±0.5^{b}	1.2±0.4^{b}	1.4±0.4^{ab}	1.2±0.4^{ab}	6.0±1.2^{b}
TSW	1.0±0.0^{ab}	1.6±0.5^{ab}	1.6±0.4^{ab}			8.4±0.5^{a}
TSP	2.0±0.0^{ab}	1.4±0.5^{b}	1.2±0.4^{b}			7.0±0.0^{ab}

Figures with the same alphabet in superscript are not statistically different ($P<0.05$)

Note: *TBW - Tilapia Boiling Wild; TBP - Tilapia Boiling Pond*
TSW - Tilapia Smoked Wild; TSP - Tilapia Smoked Pond.

From the table 4 above, the organoleptic result shows that smoked tilapia fish from homestead pond had the best performance in appearance with the mean value of 2.0 with the least mean value of 1.0 in the smoked *Tilapia spp.* from the wild. (Webster *et al.*, 1993) confirm that colour of the flesh and general appearance of skin and flesh differs significantly between wild and cultured fish in many cases. Highest mean value of 1.8 was recorded in boiled *Tilapia spp.* from the wild while the least value was 1.4 in boiled *Tilapia spp.* from the wild and homestead pond. Boiled *Tilapia spp.* from the wild had the appreciable taste value of 1.8 with the least value of 1.2 recorded in boiled and smoked *Tilapia spp.* from the homestead pond. Also, the tenderness in boiled *Tilapia spp.* from the wild had mean value of 1.6 while boiled *Tilapia spp.* from homestead pond had the least (1.4) performance. This agrees with the findings of Mohr, (2006), that the flesh of cultured fish tends to be softer in texture, and has a milder, less flavour than wild fish. Further, the juiciness of the fish samples was high in boiled *Tilapia spp.* from the wild with the mean value of 1.6 while the least value of 1.2 was found in boiled *Tilapia spp.* from homestead pond.

The highest mean value of 8.4 was recorded for smoked *Tilapia spp.* from the wild and the least mean of 6.0 was found in boiled *Tilapia spp.* from homestead pond in terms of acceptability. There is significant difference between the means in appearance, flavour, taste, tenderness, juiciness and acceptability at 5% level of probability.

Conclusion

Since fish is known as an extremely perishable food item, there is need for good processing measures to give its product an attractive form to the consumers and extended storage life. This study was therefore carried out to compare different processing methods on two species of fish from the wild and homestead pond. It was observed that different nutritional components of fish samples changed at different processing method. Boiled and smoked fish samples improved in the protein quality in terms of location and species. The most important is their general reduction effect on the moisture content which is an index of perishability.

The proximate values revealed that processing methods had a significant effect on the nutrient composition of the fish species which could keep the fish products germs free and extend its shelf-life but smoking was adjudged to be the best due to lower moisture content in the final products.

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