EFFECTS OF OVEN–DRYING AND SMOKE–DRYING ON THE NUTRITIONAL QUALITY OF SNAKEHEAD (*Parachanna obscura*) AND UPSIDE-DOWN-CATFISH (*Synodontis clarias*) IN DELTA STATE

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Abstract: This study examined the effects of smoke drying and oven drying on the nutritional qualities of *Synodontis clarias* and *Parachanna obscura*. Twelve pieces each of both species of same size, weight and source were procured from Mac-Iver market, Warri in Delta State, Nigeria. The fresh samples were divided into two groups, dried using Magbon-Alade and Gas Oven to a constant weight. The proximate and sensory quality of the samples were determined. The proximate composition of the fresh samples results were 66.33 and 64.67 (Moisture), 4.92 and 1.48 (Ash), 19.13 and 25.07 (Protein), 2.73 and 7.90 (Fat), 2.10 and 3.78 (Crude fibre) and 0.51 and 2.57% (Carbohydrate) for *Synodontis clarias* and *Parachanna obsura* respectively while smoke-dried *Synodontis clarias* and oven dried *Synodontis clarias* results were 6.74% and 4.97% (Moisture), 10.77% and 9.41% (Ash), 60.50% and 65.65% (Protein), 15.90% and 13.34% (Fat), 2.99% and 2.89% (Crude fibre) and 3.12% and 3.74% (Carbohydrate), respectively. The proximate composition of oven dried *Parachanna obscura* and smoke dried *Parachanna obscura* results were 5.96% and 6.39% (Moisture), 7.97% and 11.22% (Ash), 61.33% and 55.10% (Protein), 16.10% and 21.19% (Fat), 4.06% and 2.54% (Crude fibre) 4.92% and 4.17% (Carbohydrate). The organoleptic test for smoke-dried and oven-dried samples of both species assessed showed preferences for oven-dried samples in comparison with smoke-dried ones in terms of taste, colour, aroma, appearance. However, the texture of smoke dried *Synodontis clarias* was more preferred to the one oven dried. This study therefore recommends oven drying for processors because it has a positive influence on nutrition and acceptability of the dried fish.

Keywords: Proximate composition, *Parachanna obscura, Synodontis clarias*

Introduction

A fish is a cold blooded aquatic gill breathing oviparous vertebrae whose body is covered by dermal scales. Fish is highly proteinous, has high digestibility and is a rich source of lysine and sulphur containing amino acids. In Africa, over 17.5% of animal protein is gotten from fish while in Nigeria; it constitutes 40% of the animal protein source of the people as well as in many other developing countries (Kabaherda *et al.*, 2009). Fish however is susceptible to damage as soon as it is harvested hence the urgent need for preservative measures. (Akintola *et al.*, 2011) reported a 50% annual loss of fish in Nigeria to post harvest spoilage irrespective of the method of preservation employed. High ambient temperatures and humid tropical conditions speed up spoilage rates in fresh water fishes (Saliu, 2008). According to (Eyabi-Eyabi, 1996), the limited shelf life of dead fish i.e. 16-20 h in Southern part of Nigeria and 20-36 h under conditions in the Northern part are basically due to biochemical changes after death. The speed with which fish spoils depends on hygienic conditions, storage temperature, acidity and the structure of the muscular tissue (Clucas, 1990). Chemical breakdown of protein content, fat content (agent of rancidity and off-flavour) and the water content/water activity contribute to quick spoilage of fish (Daramola *et al.*, 2007). Fish deterioration is a complex process brought about by action of emyzmes, bacteria and chemical constituents.

Spoilage caused before processing takes place can be as a result of inadequate landing facilities, high temperatures of the surrounding or carrying vessels as well as poor hygienic conditions which render some fishes unqualified for processing. During processing, spoilage in fish occurs mostly as a result of poor handling of fish, poor hygienic conditions of the processor and the materials/equipment used in processing and also contamination from insect infestations e.g. blow flies that lay their eggs on moist fish (Getu *et al.*, 2003). Spoilage can also occur after fish has been processed mainly through insect infestation, attack from bacteria and mould and from poor packaging and storage materials (Getu *et al.*, 2003). In order to avoid spoilage which leads inevitably to post harvest losses several methods of preservation can be employed to prolong the shelf life of fish while still maintaining its nutritional, economical and physical content. They include drying, smoking, salting, freezing, canning (Akinola *et al.*, 2006). Smoking and drying is more often desirable due to the ease of procedure, taste, flavour, texture and most times consumer's preference. Based on the above named qualities of dried/smoked fish, there is impeding need to investigate the effect of oven drying and smoke drying on the nutritional value of fish. The aim of this study is to investigate the effects of smoke drying and oven drying on nutritional qualities of Snakehead (*Parachana obscura* and Upside-Down Catfish (*Synodontis clarias*) in Delta state.

Materials and Methods

Collection of samples

Two marketable species; Upside-down Catfish, *Synodontis clarias* and Snakehead, *Parachannaobscura* were bought from Mac-Iver market apopular market in Warri, Delta state. A total of twenty-four (24) fishes were bought, twelve(12) fishes per species. Both samples were of equal sizes, weight (1kg each) and from the same source.

Proximate composition

Crude protein was determined using Kjeldahl method (Foss analytical while %moisture content, %ash content, %crude fibre content and %crude fat were determined using Galyean laboratory procedures in animal nutrition. Total % nitrogen free extract was determined by subtracting %moisture content, %ash content, %crude fibre content and %crude fat from 100.

Drying procedures

Both fish species were dried using Gas oven for oven drying and Magbon-Alade smoking kiln for smoke drying of the Department of Fisheries, University of Benin.

Prior to drying both Magbon-Alade smoking kiln and Gas oven were cleaned thoroughly and their racks oiled properly to avoid samples getting stuck on them during drying. Scales

were completely removed from Snakehead. Both dish species were degutted and eviscerated properly. Charcoal was placed in the Magbon-Alade smoking kiln to get the oven preheated and ready for use. salt was applied for taste. Both fish species were shared equally and one half from both species were placed in Magbon-Alade smoking kiln and the other half of both fish species were place in the Gas oven and left to dry. Temperature was constantly monitored and regulated in the Gas oven dryer. Fish was checked hourly and flipped occasionally to achieve uniform drying and to avoid charring. Drying took six (6) hours for Gas oven dryer and sixteen (16) hours for Magbon-Alade smoking kiln. Samples were dried to constant weight. Samples from both drying facilities were placed on different trays to cool.

Organoleptic assessments

A fifteen (15) man panel was randomly selected consisting of students, lecturers and passers-by and were briefly trained. The panel was tasked to assess the appearance, colour, texture, aroma and taste of each species comparing them based on the type of drying facility. A ten point Hedonistic scale was adopted. (0 - 2 =Poor; 2 - 4 =Fair; 4 - 6 =Good; 6 - 8 =Very Good; 8 - 9 =Excellent) to determine the level of acceptance/likeness or rejection by indicating their preference for each parameter as shown on the hedonistic scale of 0 - 9. With 9 points indicating the highest acceptability and 0 the lowest acceptability. Each judge was giving pure water and cabin biscuits to clean their mouth of any leftovers before testing each sample.

Statistical analysis

Data was subjected to paired samples T-Test at 0.05 significant level. All statistical analysis were performed using IBM SPSS 20.0 software.

Results and Discussion

Effect of drying methods on the sensory qualityOrganoleptic assessment

The mean taste of the *Parachanna obscura* dried with Gas Oven was 7.60 and had significantly higher score than the *Parachanna obscura* dried with Magbon-Alade smoking kiln 6.80. The mean aroma of the *Parachanna obscura* dried with dried Gas oven 7-74 was higher than that dried with Magbon–Alade which was 6-80. *Parachanna obscura* dried with Gas oven had a mean texture of 7.60 which was also higher than that dried with the Magbon-Alade smoking kiln with a mean taste of 6.40. *Parachanna obscura* dried with Gas oven had an appearance of 7.20 was significantly better than the one dried with Magbon–Alade smoking kiln which was 6.26.The *Synodontis clarias* dried with the Gas Oven had a slightly higher mean taste score 7.60 than that dried with Magbon–Alade which was 6.80. Also the mean aroma score of the *Synodontis clarias* dried with Gas Oven was 7.46 which was better than the 6.80 recorded by *Synodontis clarias* dried with Magbon-Alade smoking kiln. *Synodontis clarias* dried with the Magbon–Alade had a mean texture of 6.26 which was slightly higher than that dried with the Gas Oven 6-14. The *Synodontis clarias* dried with Gas Oven with mean appearance score of 6.80 had a slightly higher score than that dried with Magbon–Alade smoking kiln 6.66.

Table 1: Mean hedonic scores (mean ± SD) of *Parachanna obscura* dried with Gas oven and Magbon-Alade smoking kiln

Attributes	Gas oven	Magbon-Alade
Taste	7.60 ± 1.66	6.80 ± 1.22
Aroma	7.74 ± 1.12	6.80 ± 1.78
Texture	7.60 ± 1.36	6.40 ± 3.76
Appearance/colour	7.20 ± 1.48	6.26 ± 1.56

Table 2: Mean hedonic scores (mean ± SD) of *Synodontis clarias* dried with Gas oven and Magbon-Alade smoking kiln

Attributes	Gas Oven	Magbon-Alade
Taste	7.80 ± 1.66	7.20 ± 1.48
Aroma	7.74 ± 1.12	6.66 ± 0.82
Texture	7.60 ± 1.36	6.26 ± 1.66
Appearance/colour	7.20 ± 1.48	6.66 ± 1.80

The objectives of modern smoking procedures should be to impart the desired sensory characteristics to the product uniformly, without undue variation from batch to batch and to extend product shelf life (Oyero *et al.*, 2012). The results of the sensory evaluation showed that there were differences in the acceptability of the smoked *Parachanna obscura* and *Synodontis clarias* from the different smoking kilns. According to (Karim *et al.*, 2007), flavour is an important factor in consumer's acceptability. There are lots of factors that influence the quality of smoked fish products, and these include the properties of fish flesh, maturity, age, sex, seasonal variations and factors involved in the smoking procedure such as wood type, composition of smoke, temperature, humidity, velocity and density of the smoke (Simko, 2005). According to (Safari *et al.*, 2001) the most important contribution of sensory attribute to eating quality was tenderness with flavour and juiciness.

From the result it was observed that the taste of *Parachanna obscura* dried with Gas Oven was distinctively better than that dried with Magbon-Alade smoking kilnand the taste of *Synodontis clarias* dried with Gas Oven had a better taste than that of Magbon-Alade smoking kiln. The improvement in taste couldbe attributed to the difference in fuel source and the controlled drying rate as recorded by (Chukwu and Shabai, 2009) who studied the influences of two different drying methods (Smoking kiln and electric oven).

The mean appearance/colour observed in both species dried with Gas oven was higher than that obtained in the Magbon-Alade smoking kiln. The trend observed in both drying facilities were however similar to the values observed by (Akande *et al.*, 2005) for smoked *Pseudotolithus senegalensis* and (Obande *et al.*, 2012) for *Clarias gariepinus*. The observed better appearance/colour obtained might be due to the quicker drying time observed in time observed using the Gas oven in agreement with (Rozaine and Ng, 2010) who investigated the effects of microwave power and hot air temperature on drying time, dehydration behaviour, energy consumption and colour of dried catfish.

Mean texture for *Parachanna obscura* in the Gas Oven was higher than that observed in the Magbon-Alade smokiing kiln; however, a lower value was observed in the *Synodontis clarias* for Gas Oven as compared to the Magbon-Alade smoking kiln. The mean texture observed in *Synodontis clarias* was observed in both smoking kilns however higher than the values (2.85 and 3.0) observed by (Yola and Timothy, 2012) for *Clarias gariepinus*.

The mean aroma of both *Parachana obscura* and *Synodontis clarias* dried with Gas Oven had a higher value than the value obtained from smoke drying with Magbon-Alade, this difference observed in aroma could be attributed to type of smoke generated by the type of energy source of the smoking kiln (charcoal) which follows the trend observed by (Wu and Mao, 2008) who studied the influence of hot air drying and microwave drying on the nutritional and odorous properties of Grass Carp fillets.

The recorded taste, aroma, texture and appearance 7.60± 0.68, 7.46 ± 0.96, 6.14 ± 0.88 and 6.80 ± 0.83 respectively of *Synodontis clarias* were higher than that obtained *by*

(Abolagba *et al.*, 2015) on *Synodontis clarias* and(yakubu and Ngueku, 2015) on *Clarias* spp. But was however lower than that of *Clarias gariepinus* reported in same work of (Abolagba *et al.*, 2015)

Proximate composition

The measurement of some proximate profiles such as percentage protein, carbohydrates, lipids, moisture contents and ash content is often necessary to ensure that they meet the requirements of food regulations and commercial specifications (Waterman, 2000). The total amount of body water of fish species, depend on morphological and chemical differences, physical properties and the fish storing.

The proximate composition of the fish samples are given in Tables 3, 4 and 5.Table 3 shows that the percentage moisture content of fresh *Synodontis clarias* (66.33%) had a higher value of as compared to fresh *Parachanna obscura* (64.67%) while the percentage crude protein content of fresh *Parachanna obscura* (25.07%) was higher than fresh *Synodontis clarias* (19.13%). As shown in Table 3, the percentage ash content of fresh *Synodontis clarias* (4.92%) ranked higher than fresh *Parachanna obscura* (1.48%) while the percentage crude fat of fresh *Parachanna obscura* (7.90%) had a higher value than fresh *Synodontis clarias* (2.73%). The percentage crude fibre content of the fresh *Parachanna obscura* was 3.78% and was higher than the percentage crude fibre content observed in fresh *Synodontis clarias* (2.10%).

Table 3: Mean proximate composition (mean ± SD) of fresh *Synodontis clarias* and fresh *Parachanna obscura*

Parameters (%)	Fresh *S. clarias* (%)	Fresh *P. obscura* (%)
Moisture	66.33±1.53	64.67±0.58
Crude Protein	19.13±1.76	25.07±0.33
Ash	4.92±0.17	1.48±0.05
Crude Fat	2.73±0.49	7.90±0.09
Crude Fibre	2.10±0.10	3.78±1.92
Nitrogen Free Extract	0.51±0.04	2.57±0.38

The percentage moisture content of fresh *Synodontis clarias* had a higher value of 66.33% as compared to fresh *Parachanna obscura* which had 64.67%. The moisture content observed for *Parachanna obscura* was lower than the value (68.61%) gotten by (Fapohunda and Ogunkoya, 2006). The percentage crude protein of fresh *Parachana obsura* (25.07%) was higher than fresh *Synodontis clarias*, the higher value crude protein recorded for fresh *P. obscura* may be attributed to the fact that the fish species is a piscivore unlike Synodontis which is more of plankton feeder or feed on waste products which may probably not be very rich in protein.

The ash content was higher in the fresh *Synodontis clarias* (4.92%) than in fresh *P. obscura* (1/48%), the difference in ash content could be attributed to the fish species, season, sex, or food availability (Effiong and Mohammed, 2008)A comparison of the fat content of *P. obscura* with that of *Synodontis clarias* indicate that *P. obscura* has a higher fat content. Zuraini *et al.*, (2006) also reported a high fat content in *Channa straitus* and asserted that the genus *Channa* seems to have a high fat content. (Ama-Abasi *et al.*, 2012) in support of the above statement strongly recommended that *P. obscura* should be a major constituent of post natal and recuperating patients.

The percentage crude fibre content of the fresh *Parachanna obscura* was 3.78% and was higher than the content observed in fresh *Synodontis clarias* (2.10%). The values observed for the fresh *Synodontis clarias* were higher than the value (0.20+0.81) obtained by (Kefas *et al.*, 2014) on the species.The carbohydrate values obtained in this study are lower than the values obtained by Imabong (2015) for *C. nigrodigitatus* (3.69), *C. senegalensis* (7.26) and *P. quadrifilis* (5.3). Fish generally have very low levels of carbohydrates because glycogen does not contribute much to the reserves in the fish body tissue (USDA, 2010)

As shown in Table 4, the percentage moisture content of smoke dried *Synodontis clarias* was 6.74% it was higher than that observed in oven dried *Synodontis clarias* (4.97%). Oven dried *Synodontis clarias* had a crude protein of 65.65% which was higher than that observed in smoke dried *Synodontis clarias* (60.50%). The percentage crude fibre content of smoke dried *Synodontis clarias* followed similar pattern with ash content of 2.99% and oven dried *Synodontis clarias* 2.89%. It can also be seen in Table 4 shows that the percentage ash content of smoke dried *Synodontis clarias* with a value of 10.77% ranked higher than that of oven dried *Synodontis clarias* (9.41%). Smoke dried *Synodontis clarias* with a percentage crude fat value of 15.90% ranked higher than the value observed in oven dried *Synodontis clarias* (13.34%). The percentage nitrogen free extract observed in both samples varied slightly with oven dried *Synodontis clarias* having a value of 3.74% and smoke dried *Synodontis clarias* a value of 3.12%.

Table 4: Mean proximate composition (mean ± SD) of oven dried *Synodontis clarias* and smoke dried *Synodontis clarias*

Parameters (%)	Oven Dried (%)	Smoke-Dried (%)
Moisture	4.97±0.21	6.74±0.25
Crude Protein	65.65±5.19	60.50±0.70
Ash	9.41±1.12	10/77±0.25
Crude Fat	13.34±0.81	15.90±0.30
Crude Fibre	2.89±0.19	2.99±0.15
Nitrogen Free Extract	3.74±0.25	3.12±0.03

The percentage moisture content of oven dried *Synodontis clarias* (4.97%) was lower than that observed in smoke dried *Synodontis clarias* (6.74%) which is similar to the work of Puwestian *et al.*, (1999) and (Tao and Linchun, 2008). (Oyero *et al.*, 2012) also reported significantly lower moisture content on *Clarias gariepinus* oven dried over that smoked dried.

The quality of fish protein is superior to that which could be obtained from milk, meat and eggs. It is reported in literature that fish has well balanced amino acid profile, needed minerals as well as fatty acids (Ashrafi *et al.*, 2011). From the result obtained, the crude protein of smoked dried *Synodontis clarias* (60.50%) was significantly lower than the crude protein of oven dried *Synodontis clarias* (65.65%). Similar trend was reported by (Ogbonnaya, 2009) on *Oreochromis niloticus.* The protein composition of fish is affected by a diversity of factors such as size, sexual maturation, temperature, salinity, exercise, ration, time and frequency of feeding, starvation, type and amount of dietary ingredients (Shearer, 1994).

Ash is the inorganic residue that remains after the organic matter has been burnt off which was found in little non-significant traces in the fish sampled. The ash content of smoke dried *Synodontis clarias* (10.77%) was significantly different from the ash content of oven dried *Synodontis clarias* (9.41%). This was similar with the works of (Akinneye *et al.*, 2010) on *Bonga spp., Sardinella spp. and Heterotis niloticus.* The concentrations of minerals and trace elements that contribute to the total ash contents are known to vary in fish depending on their feeding behaviour, environment, ecosystem and migration even within the same area ((Andresi *et al.*, 2000); (Canli and Atli, 2003)).

The percentage crude fat of smoke dried *Synodontis clarias* with a value of 15.90% ranked higher than that of oven dried *Synodontis clarias* (13.34%). This is in accordance to work of (Akinneye *et al.,* 2010) on *Sardinella spp*. Smoke dried *Synodontis clarias* with a crude fibre value of 2.99% ranked higher than the value observed in oven dried *Synodontis clarias* (2.89%). Similar trend was reported by (Ogbonnaya, 2009) on *Oreochromis niloticus*; (Ogbonnaya and Ibrahim 2009) on *Clarias gariepinus.* The relatively low values of carbohydrates could be due to higher values of moisture and relatively high value of protein contents. The low carbohydrate values could be due to the fact that glycogen does not contribute much to the reserves in the fish body tissue (Das and Sahu, 2001). Oven dried *Synodontis clarias* had a slightly higher value (3.74%) as compared to smoke dried *Synodontis clarias* (3.12%)

It can be observed in Table 5 that the percentage moisture content of smoke dried *Parachanna obscura* (6.39%) ranked higher than the observed value of oven dried *Parachanna obscura* (5.96%). The percentage crude protein value on the other hand was lower in smoke dried *Parachanna obscura* (55.10%) as compared to the oven dried *Parachanna obscura* (61.33%). Table 5 also indicated that smoke dried *Parachanna obscura* had percentage ash value of 11.22% which was higher than the (7.97%) observed in oven dried *Parachanna obscura* while the percentage crude fat value was higher in smoke dried *Parachanna obscura* (21.19%) when compared to oven dried *Parachanna obscura* (16.10%). Percentage crude fibre values observed in oven dried *Parachanna obscura* (4.10%) ranked higher than the value observed in smoke dried *Parachanna obscura* (2.54%). Percentage nitrogen free extract value of both samples varied slightly with oven dried *Parachanna obscura* having a value of 4.92% and smoke dried *Parachanna obscura* a value of 4.17%.

Table 5: Mean proximate composition (mean ± SD) of oven dried *Parachanna obscura* and smoke dried *Parachanna obscura*

Parameter (%)	Oven dried (%)	Smoke dried (%)
Moisture	5.96±0.28	6.39±0.6.
Crude Protein	61.33±1.04	55.10±1.78
Ash	7.97±0.19	11.22±0.58
Crude Fat	16.10±0.25	21.19±0.38
Crude Fibre	4.06±0.29	2.54±0.12
Nitrogen Free Extract	4.92±0.65	4.17±0.20

The percentage moisture content of smoke dried *Parachanna obscura* (6.39%) was lower than that observed in oven dried and *Parachanna obscura* (5.96%). This trend is similar to what was observed by (Gokoglu *et al.,* 2004); (Adewumi *et al.,* 2015) in *Clarias gariepinus*.

(Abolagba *et al.,* 2015) stated that high level of protein in fish is as a result of the high quality diet with protein rich ingredient such as fish meal, soya bean cake, groundnut cake. Fish protein is a high quality protein that is easily digestible and fish diets reduce levels of cholesterol in the blood, thereby reducing risk of heart disease. From the result obtained, the crude protein of oven dried *Parachanna obscura* (61.33%) significantly lower than the crude protein of smoke dried *Parachanna obscura* (55.10%). (Akinneye *et al.,* 2010) reported similar trend on *Bonga spp., Sardinella spp. and Heterotis niloticus.* The protein composition of fish is affected by a diversity of factors such as size, sexual maturation, temperature, salinity, exercise, ration, time and frequency of feeding, starvation, type and amount of dietary ingredients (Shearer, 1994).

Ash is a measure of the mineral content of any food including fish (Omotosho *et al.,* 2011). Majority of the fishes (87%) contain<2% ash contents. Smoke dried *Parachanna obscura* had ash value of 10.61% which was higher than the observed value of oven dried *Parachanna obscura* (7.97%) and was similar to the work reported by (Ogbonnaya, 2009) that higher ash content value was recorded for *Oreochromis niloticus* when smoked dried than when oven dried.

The percentage crude fat of smoke dried *Parachanna obscura* (21.19%) ranked higher than that of oven dried *Parachanna obscura* (16.10%). This trend observed in this study is in contrast with what was observed by (Adewumi *et al.,* 2015) on *Clarias gariepinus.*The percentage crude fibre content of oven dried *Parachanna obscura* (4.10%) ranked higher than the value observed in smoke dried *Parachanna obscura* (2.54%). This however, is contrary to what was observed by (Adewumi *et al.,* 2015) for *Clarias gariepinus.*

A good source of instant energy that comes to the mind is the carbohydrates. It also helps in the body development and growth. The carbohydrates content in the fish is small and practically considered zero (Osibiona *et al.,* 2009). It was observed that the carbohydrate value of oven dried *Parachanna obscura* (4.92%) ranked higher than the smoke dried *Parachanna obscura* (4.17).

Conclusion

There were positive significant influences of oven drying on the proximate compositions of Upside-down Catfish and Snakehead making it nutritionally suitable for all. The organoleptic test result showed that oven drying was more acceptable by the consumers for taste, aroma, colour/appearance in both species although the texture of smoke dried *Synodontis clarias* was more preferred than the one that was oven dried. The texture of oven dried *Parachanna obscura* was more preferred to the smoke dried one. Generally, fish can be grouped into four categories according to their fat content: lean fish (<2%), low fat (2 to 4%), medium fat (4 to 8%) and high fat (>8%). From the proximate composition result, fresh *Synodontis clarias* and *Parachannaobscura* are lean fish and medium fat respectively, they both have a moderately high protein level while the oven-dried samples contain higher crude protein than the smoke-dried sample.

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