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The Effect of Pretreatment and Packaging Material on the quality of Stored Dried Catfish (*Clarias gariepinus*)

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Abstract: The study was conducted to determine effects of pretreatment and locally available packaging materials on the quality of dried and stored catfish (*Clarias gariepinus*). The freshly obtained catfish was cut into pieces measuring 20×5×6mm. The treatment group was pre-treated with lemon juice, while the control was prepared without pretreatment. Both the treatment and control were dried using hot air at 80 ℃ to constant weight. The dried sample was then stored using three packaging materials (aluminum foil, unbleached paper and low-density polyethylene bag) in triplicate and stored in iron basket in the laboratory for observation at 25 °C and 55 % relative humidity. Samples were then taken out from storage for further analysis after every week and finally concluded at six weeks. The analysis done was proximate composition, moisture content, total volatile basic nitrogen (TVBN), bacterial and fungal count. The fresh sample had the following data: 72.49%, 19.72, 5.6, 1.04, 1.15 % for moisture content, protein, fat, crude fibre respectively. That of the pre-treated sample obtained was 72.80% moisture content, 17.01% protein content, 3.37% fat content,0.53% ash content and 1.16% crude fibre content. The moisture content for lemon treated dried cat fish ranged between 28-30% $_{(wb).}$ The result showed that the higher the moisture content, the lower the protein content, ash content and fibre. Therefore, as the moisture content decreased, the protein content, crude fibre, fat and oil content increased. The total volatile basic nitrogen (TVBN) of the fresh sample was higher than that of the lemon treated sample due to its chemical compositions with the mean value of 5.60% for the fresh sample and 2.80% for the lemon treated sample. Bacterial and fungal counts on the fresh samples were more than that of the treated samples. After drying, the only microorganisms that survived the heat were thermophilic microorganisms (Bacillus furinus, Pseudomonas aureginosa and Aspergillus terraus) and they weren't significantly influenced during storage. The results of the analysis of variance (ANOVA) showed that the most suitable packaging material was aluminum foil and the organic acid added to the fish also helped to prolong shelf life. This is because the aluminum foil preserved the quality of the fish hence the proximate compositions of the fish was better than the fish kept in polyethylene and the paper.

Keywords: Catfish, packaging, aluminum foil, unbleached paper, low-density polyethylene bag, lemon juice.

I. Introduction

Fish are a component of seafood that provide food for human consumption. Seafood provides a balanced nutritional content which include low fat, high protein, and a variety of micronutrients including various vitamins and minerals, and a dietary source of long chain polyunsaturated fatty acids which have a lot of health benefits (Hassoun et al., 2022).

Fish is an excellent source of protein in the diet of many people in the world. The quality of fish protein is as good as that of beef, milk, pork and poultry. Some cultural and religious beliefs are associated with fish consumption.

Fresh fish as any other agricultural product deteriorates quickly as a result of intrinsic and extrinsic factors. However, the gap between the demand and supply of fish is widening due to increase in population, and its health benefits since many people are more health conscious but post-harvest losses are high. High ambient temperature hastens the spoilage of fish by accelerating the activities of bacteria, enzymes and chemical oxidation of fat in fish flesh (Ikrang & Umani, 2019).

Drying involves the removal of water from the food, to prevent the survival of food microbes such as bacteria, fungi and yeast thus prolonging the shelf-life of food (Olalusi et al., 2014). There are various drying methods for fish, they vary between different countries and within the same country depending on the type of fish species used and the type and quality of product desired. For instance fish may be dehydrated to various levels of moisture content in the final product ranging from 10 to 60%wb (Ikrang et al., 2014).

It has been observed that different processing and drying methods have varying effects on nutritional compositions of fish. The issue of heating, freezing and exposure to high concentration of salt alongside other pretreatments can predispose fish to chemical and physical changes and consequently affects digestibility, as a result of protein denaturation, but the content of thermolabile compounds and polyunsaturated fatty acids is often decreased. (Tao and Linchun, 2008). It is imperative to note that the quality of

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fish dried by different methods differ from one another. Oven drying is the simplest and faster way of drying foods. It is an efficient drying process for agricultural products and has been used for drying for several decades.

A properly dried fish product may undergo spoilage if not well packaged because of the hygroscopic nature and its ability to lose oil when exposed to the atmosphere. Appropriate packaging is necessary to maintain the quality of fishery products enhancing consumer satisfaction. A proper fish packaging material should provide reduced oxidation and further dehydration of product, provide less bacterial and chemical spoilage, prevent odor permeation and protect the product from physical damage (Olayemi et al, 2013).

Packaging materials are important to maintain the qualities established by processing and deliver same to the consumer. Adequate packaging materials cannot therefore be over emphasized since processing agricultural products is expensive in terms of resources needed for processing such as energy demands, time and other inputs required for processing. These resources differ from product to product and from process to process. Therefore, if any product is worth processing, then that product is worth packaging well. Therefore, the aim of this work is to examine the effects of aluminum foil, low density polyethylene bag and paper from unbleached pulp as packaging material on oven dried flat head catfish with a view to selecting a suitable one and the effects of lemon juice pretreatment on the proximate analysis, Total volatile basic Nitrogen (TVBN) and the total microbial load of fresh catfish (Clarias gariepinus).

II. Materials and Method

Sample Collection and Treatment.

The flathead catfish (*Clarias gariepinus)* obtained from Domita Farms in Nsukara Offot, Uyo,Akwa Ibom State, Nigeria were used for the work. Fresh fish samples were collected and processed same day. Two sets of samples were prepared: one was pretreated with fresh lemon juice immediately after cutting while the second set had no pretreatment. Samples were cut into size measuring 20 mm x 5mm x 6 mm and dried in an electric oven to constant weight at temperature of 80°C. The equilibrium moisture content of the sample varied between 28-30% wet basis.

The dried samples were then put in equally in each of the packaging material (aluminum foil, Low density polyethylene bag and unbleached paper) they were well wrapped and covered and kept for storage in a room with storage conditions averaging 25 °C and 75 % relative humidity. Temperature was measured with a mercury in glass thermometer in the laboratory whereas the relative humidity was measure with a wet and dry bulb hygrometer in the laboratory

The packaging materials were aluminum foil, LDPE (low density polyethylene) bag, and paper (from unbleached pulp) wide enough to cover the fish totally. The packaging materials were obtained from the supermarket.

Proximate Analysis

The proximate analysis of processed samples was carried out according to. standard methods of analysis described by the Association of Official Analytical chemist (A.O.A.C, 2002). The parameters determined were moisture content, protein content, fat and oil, crude fibre and ash content.

Total Volatile Basic–Nitrogen (TVBN)

The fish sample was macerated with 100 ml of tap water and washed into the distillation flask with 200ml tap water, followed by addition of 2.0 grams of magnesium oxide (MgO) and few anti bumping agent added to the 500ml recurring flask followed by addition of two drops of screened methyl-red indicator. The apparatus was connected up with receiving tube dipping below the boric acid solution. The distillation flask was then heated with gas flame from Bunsen burner to enable the mixture to boil for 10minutes (before distillation was carried out) for another 25minutes. The distillate was titrated with 0.1N Sulphuric acid (H_2SO4).

The titre value was multiplied by 14 to obtain total volatile base nitrogen in mg N/100gm sample.

Bacterial Assessment of the Fish Sample

A specified quantity (1 grams) of fish sample was suspended in 100ml of sterile distilled water. The mixture was properly shaken and 1.0ml of this was pipetted using a sterile pipette into another sterile universal bottle containing 9.0ml of distilled water. This process is prepared for the other sterile bottle so that at the end of the serial dilution 10^{-1}, 10^{-2}, $10^{-3}10^{-4}$, and 10^{-5} folds are obtained in respective bottle. Each was then plated by spread plating techniques on the plate count Agar (PCA). Fish sample (0.1ml aliquots) were transferred using sterile pipette on the surface of the plate count Agar composing of 5.0gm yeast extract, 5.0gm tryptone,1.0gm Dextrose,15.0gm Agar volume/litre of distilled water and yeast Extract peptone dextrose Agar (YEPA) consisting of 3.0gm yeast extract powder,5.0gm peptone, 15.0gm Agar, 10.0gm dextrose, 0.05gm Streptomycin sulphate in/ litre of distilled water. The above constituent of each medium is weighed and dispensed into a conical flask, plugged with cotton wool and covered with aluminium

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foil. These were boiled to ensure homogenous suspension and then sterilized in the autoclave for 15 minutes at 121^0c. The sterilized medium was left to cool and then poured into sterile Petri-dishes and allowed to solidify. After solidification, the Petri dishes are inverted and incubated in that form to prevent contamination from water droppings. A sterile glass spreader was then used to spread the sample quickly. The plate were then incubated at 15^0C for 24 hours and observed for the growth of micro-organism.

Microbial Count

The pure culture of each colony was obtained by using a sterile wire loop. A sterile wire loop was used to streak each separated colony into a new solidify plate count agar (PCA) and yeast extract peptone. Dextrose agar (YEPA) plaster was incubated at 15^0 C for 24 hours. Stock culture of each organism was made and kept on agar plate at 4^oc and then sub cultured from time to time

Packaging and Storage of Fish

Various types of packaging made up of different materials design and sizes are used all over the world during processing, transportation, storage, retail and display. Packaging materials available in Nigeria for dried fish include jute bags, mat bags, baskets, sacks, paper cartons, wooden rackets, cane, basket, earthen pots, polyethylene, aluminum foil.

The packaging materials used for this study include paper, polyethylene and aluminum foil. After drying, the oven dried catfish were removed from the oven, cooled in a desiccator and packed in each of the three packaging materials in three replicates. The samples were then stored in an iron basket away from the floor and under ambient condition for six weeks.

III. Results and Discussion

The results of the various experiments conducted on catfish under highly controlled conditions showed a proximate composition as shown in Table 1. The average moisture content for fresh cat fish had a mean value (mean ±standard deviation) of 72.49±0.388 %, Protein 19.72 ±0.204%, Fat and oil 5.6±0.011%, ash 1.04±0.174, and crude fibre 1.15±0.100%. Result showed that the higher averages in moisture were probably due to the size and environment from which the fish was caught with high tendency of retaining moisture in its flesh. The high average in the crude protein and fat extract is due to the fact that, fat and protein had not condensed due to the high moisture content. Similar results were obtained by Kumolu-Johnson et al; (2010) who worked on *Clarias gariepinus.*

On the other hand, the lemon juice pretreated catfish had average moisture content of 72.80± 1.457%., protein 17.01±2.788%, fat extract was 3.37±0.018%, ash content was 0.53±0. 012% and crude fibre was 1.16 ± 0.178%. The reduction in fat extract is due to the acidic nature of the lemon juice that was used to pretreat the fish, thereby reducing the fat and oil of the treated fish. Similarly, the crude protein and crude fibre recorded for the fresh catfish were also higher than that of the lemon treated catfish. A similar finding was reported by Ogbonnaya (2009) that the decrease of moisture content increases the protein, lipids, vitamin A, potassium and phosphorus content. Therefore, the increased moisture content of the fish yields a decrease in the protein, lipids, vitamin A, potassium and phosphorus content.

Table 1: Proximate analysis of fresh and lemon treated catfish

Fresh catfish					
Parameter %	1st	2nd	3rd	Mean	Standard deviation
Moisture content	71.98	72.41	73.07	72.49	± 0.388
Protein content	19.80	19.96	19.40	19.72	± 0.204
Fat and oil	5.62	5.60	5.59	5.60	± 0.011
Ash content	1.3	1.01	0.81	1.040	± 0.174
Crude fibre	1.2	1,02	1.13	1.15	± 0.100
Lemon Treated catfish					
Moisture content	73.72	70.44	74.24	72.80	± 1.457
Protein content	21.42	13.82	15.80	17.01	± 2.788
Fat and oil	3.37	3.34	3.39	3.37	± 0.018
Ash content	0.51	0.54	0.54	0.53	± 0.012
Crude fibre	0.98	1.45	1.06	1.16	± 0.178

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This pretreatment is useful in drying and helps to preserve the quality as the moisture content is reduced prior to drying thereby reducing the actual drying time.

The total volatile basic nitrogen (TVNB) of catfish for both the fresh and lemon juice treated samples were obtained as follows: fresh cat fish had the highest average value of 5.60mgN/100gm $\pm$ 1.255, whereas lemon juice pretreated sample had a value of 2.80gmN/100gm $\pm$ 0.108. Huss (1995) reported that the chemical composition of fish vary depending on many factors such as, geographical location of the harvest area, seasons, duration of rigor mortis, intrinsic conditions of the fish as well as how it was captured and handled. This therefore shows that the pretreatment affected the composition of the fish thus causing the chemical composition to vary.

Total Volatile basic nitrogen (TVBN) content and microbial counts have been used for the evaluation of meat freshness (Vinci and Antonelli, 2002). The TVBN content of meat increases as putrefaction progresses since ammonia is produced during storage as a result of the deamination of amino acids. Accordingly, the total amount of TVBN is one of the best indices of the decomposition of fresh meat and poultry (Byun et al., 2003)

Microbial Count for Fresh and lemon treated Catfish

The total viable counts (TVC), the bacterial species as well as the fungal species were also studied. The result revealed that the fresh sample had a total microbial load of 1x 10^4. Connel (1985), stated that the maximum total plate count for fish to be consumed safely was $10^7 - 10^8$ this implies that the fresh samples were microbiologically acceptable for consumption. Gram (1989) stated that the population of bacterial flora on newly harvested fish be it in the wild or in the fish farm is a function of the environment, in which it was caught rather than on the fish species being studied. It was found that that the TVC remained the same in the second week but in the third week it started to increase. This is because the fresh sample still had enough moisture which encouraged growth of the bacteria.

Also, a total of three bacteria and one fungus were found in the fresh sample in the first week. The organisms found were *Bacillus furinus, Proteus vulfaricus, Escherichia coli* and *Aspergillus terraus.* In the second week, the organisms grew to six in total and in the third week it increased to ten. This was due to the deterioration of the fish and the continuous enzymatic changes in the fish.

In the lemon pretreated sample, production of both microorganisms were inhibited significantly compared with those of the fresh sample. Although lemon juice was added as a preservative, it also adds flavor to the fish and also reduced the water activity in the fish and thereby indirectly prevents microbial growth (Rarishankar and Juneja, 2000). The pretreatment caused a decrease in the total microbial count. This is because lemon juice like lactic acid, acetic acid, propionic acid and formic acid are highly effective in decontaminating surfaces and they are safe, simple, efficient, and cheap modality of fish decontamination which can be highly recommended for industrial scale. Lemon is an essential pretreatment as it lowers the pH of fish which consequently significantly reduces the risk of food-borne diseases (Yang and Lee, 2009).

Proximate analysis for stored lemon pretreated Catfish

The storage of the catfish was mainly carried out for the samples treated with lemon juice. From the results values of the percentage moisture, protein, fat and oil, ash and the crude fibre contents during the storage period were found. From the result the protein content of the stored fish generally decreased with storage time but there was not much loss in the protein content for all the packaging materials. The protein content ranged from 26.00% to 35.07%. in all the samples tested. The mean of protein content for storage materials with a standard deviation varied as follows 28.55 % $\pm$ 1.65 for aluminum foil, 34.11% $\pm$ 0.745 for polyethylene material and 30.26% $\pm$ 1.36 for paper material. The mean and standard deviation of the fat and oil content for the various storage materials varied as follows 13.18 % $\pm$ 0.147 for aluminum,12.33% $\pm$ 0.536 for polyethylene and 13.14% $\pm$ 0.592 for paper material. In the like manner the ash content generally decreased with storage period. The mean and standard deviation for ash content in the various storage material varied as follows 3.12% $\pm$ 0.085 for aluminum foil, 2.47% $\pm$ 0.332 for polyethylene and 3.09% $\pm$ 0.142 for paper material. Crude fibre increased with storage period having a mean and standard deviation of 1.88% $\pm$ 0.097 for aluminum foil, 2.60% $\pm$ 0.415 for polyethylene, and 2.067 % $\pm$ 0.592 for paper material. The moisture contents of the dried catfish stored in the polyethylene and paper materials increased due to the interaction of the environment with the packaging materials while that of aluminum foil did not increase because aluminum foil has a good barrier property against moisture and air. The mean moisture content in the work varied as follows 29.39 % $\pm$ 0.017 for aluminum foil,30.77% $\pm$ 0.522 for polyethylene and 31.35 % $\pm$ 0.77 for paper material. The increase in moisture is due largely to environmental effect which is in line with the findings of Daramola *et al* (2007). It was found that most of the packaging material behaves differently because of their peculiar characteristics with respect to the environment in which they were exposed. Since moisture absorption is major determinant of growth of microorganism which can cause spoilage, it was used to assess their performance. From the analysis it was found that

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aluminum foil had the least amount of moisture absorption whereas paper had the highest amount of moisture absorption, as shown on Table 2, nhence aluminum foil was adjudged as a better storage material for dried catfish given the prevailing condition of the storage environment.

Table 2: Proximate composition and its interaction with packaging materials

Packaging materials	Storage period	Proximate composition				
	(weeks)	Moisture (%)	Protein (%)	Fat and Oil (%)	Ash(%)	Crude fibre(%)
Aluminium foil	0	29.42	32.30	13.50	3.22	1.65
	2	29.40	29.20	13.27	3.18	1.88
	4	29.39	26.00	13.00	3.09	1.97
	6	29.35	26.70	12.95	3.00	2.02
Mean value		29.39	28.55	13.18	3.12	1.88
Standard deviation		± 0.017	± .65	± 0.147	± 0.085	± 0.097
Polyethylene	0	29.42	32.30	13.50	3.22	1.65
	2	31.22	35.00	11.80	2.62	2.45
	4	31.23	35.07	11.40	2.02	3.25
	6	31.24	34.07	12.60	2.02	3.05
Mean value		30.77	34.11	12.33	2.47	2.60
Standard deviation		± 0.522	± 0.745	± 0.536	± 0.332	± 0.415
Paper	0	29.42	32.30	13.50	3.22	1.65
	2	32.02	32.28	12.30	3.19	2.64
	4	32.42	27.88	12.33	3.22	2.94
	6	31.52	28.58	14.43	.2.72	3.44
Mean value		31.35	30.26	13.14	3.09	2.67
Standard deviation		± 0.771	± 1.36	± 0.592	± 0.142	± 0.592

IV. Conclusion

From the results, the aluminum foil has been found to be the best packaging material for storage of oven dried cat fish and can keep fish in good quality over a period of 5 weeks. The total volatile basic nitrogen (TVNB) of catfish for both the fresh and lemon juice treated samples were obtained as follows: fresh cat fish had the highest average value of 5.60mgN/100gm ± 1.255, whereas lemon juice pretreated sample had a value of 2.80gmN/100gm ± 0.18. Lemon juice pretreatment inhibited the growth of microorganism on the fresh fish unlike the control, the Total viable count kept increasing. Lemon Juice pretreated catfish therefore showed better keeping quality than the non-pretreated counterpart.

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