CHANGES IN PROXIMATE COMPOSITION AND MICROBIAL QUALITY OF CLUB MACKEREL (*Scomber japonicus*) UNDER LOCAL MARKET CONDITIONS IN ADO-EKITI, NIGERIA

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ABSTRACT

The present study evaluated changes occurring in the proximate composition and microbial quality of Club Mackerel (*Scomber japonicus*) that were displayed for sale under local market conditions in Ado Ekiti, Nigeria. Fish were collected from the market, firstly at the time they were removed from the carton in the morning (0 hour), and subsequently from those displayed for sale at four hour intervals (4, 8 and 12 hours). Proximate and microbial analyses of collected fish samples were done in the laboratory following standard procedures. The results revealed that protein contents of the fish were significantly ($P<0.05$) reduced at the 12 hour than at 0 hour of sampling, while the moisture contents were significantly higher at the 12 hour than at 0 hour of sampling. Significant differences were not observed in the values for crude fat and ash contents at all sampling times. In terms of microbial quality, both *Salmonella* and Fungi were not detected at all sampling times. Fish samples at 12 hours had significantly ($P<0.05$) highest total bacterial and Staphylococci counts than samples collected at 0, 4 and 8 hours, while significant differences were not observed in both Coliform and *E. coli* counts. The present study therefore revealed remarkable loss in quality in terms of protein contents and increased total bacterial and *Staphylococci* counts after 12 hours of thawing and displaying Club Mackerel (*S. japonicus*) in open markets.

Keywords: Club mackerel, open markets, Staphylococci, sampling time, raw fish

INTRODUCTION

Fish and other seafood remains an important food commodity worldwide. According to reports, fish contributes more than half of the world supply of protein while 60% of the developing world reportedly derives more than 30% of their animal protein from fish (Adeleke *et al*., 2021). In Nigeria, inadequacy of domestic fish production has led to dependency on imports to bridge the widening gap between fish supply and demand (WorldFish, 2018). These imported fish, which include herring, horse mackerel, club mackerel, croakers, sardines, blue whiting etc., are brought into the country and preserved in frozen form. Thus, frozen fish constitutes the major category of fish widely distributed in the country, through a network of privately owned cold stores located in towns and cities. The fish finally get to the end users through the activities of fish retailers who purchased one or few cartoons of frozen fish from nearby cold store and sell the de-frozen or processed (smoked or dried) fish in open markets or through hawking in the neighbourhood.

In local markets or during hawking process, both sellers and buyers may contaminate the fish in the process of pricing and selection, during which there is no limit as to what portion or amount of fish that can be touched or fiddled with (Oyelese and Opatokun, 2007). Raw fish in fresh or frozen forms are usually displayed openly in some markets to attract customers during the day under varying environmental conditions until the fish becomes flabby and unattractive. This method of marketing may pose a health hazard to final consumers. It is unknown at what point the nutritional and microbiological qualities of most frozen fish products become unsuitable and unfit for human consumption.

Consumers are nowadays becoming increasingly conscious of quality and safety of fish and fishery products, as cases of diseases due to consumption of fish and shellfish have been reported, and some of these diseases have been specifically associated with pathogens, which are resistant to antibiotics (Adebayo-Tayo *et al*., 2012). It should be noted that although frozen fish are checked and certified by appropriate governmental agencies before they are imported into the country; their qualities may still be compromised during distribution through human and other animate and inanimate contacts before the fish get to the final consumers. Thus, fish quality should be monitored to prevent distribution of unwholesome fish and its associated risks (Pal, 2012). The aim of this paper is therefore to examine changes in proximate composition and microbial quality of Chub Mackerel (*Scomber japonicas*) during sale under local market conditions.

MATERIALS AND METHODS

Raw Chub Mackerel (*Scomber japonicus*) samples (average weight of 350 g) were obtained from three randomly selected fish vendors at the popular local Oja Oba Market in Ado-Ekiti metropolis. Three fishes were collected per sampling. The first sample collections were made at 6:30 a.m. when the sellers had just opened the fish cartons and the fish were still in frozen form, and this was taken to be 0 hour of the experiment. Further collections were made from the fish displayed for sale at intervals of four hours and were recorded as 4 hours, 8 hours and 12 hours of experiment respectively. Each fish was wrapped in sterile nylon and transferred to the laboratory in ice box within 30 minutes of collection for both microbiological and proximate analysis.

Fish muscles were obtained for proximate analysis at the same time samples were taken for microbial analysis, and these samples were analysed following the methods described by AOAC (2003). Briefly, moisture was determined by oven drying the ingredients at 105 ºC for 24 h. Crude protein (N X 6.25) was determined by the Kjeldahl method after digestion with concentrated H_2SO_4. Ash content was determined by incineration in a muffle furnace at 600 ºC for 16 h. Crude fat was determined by the Soxhlet method using petroleum ether while crude fibre was determined by digestion with 1.25% NaOH and 1.25% H_2SO_4. Nitrogen free extract (NFE) was calculated by subtracting the sum of moisture, protein, oil, fibre and ash from 100.

Microbial analysis of fish samples were carried out in the laboratory using standard microbiological techniques. 10 cm^2 of skin in each sample were swabbed using sterile stick swab, and washed in 10 ml sterile saline solution. One millilitre of the stock was serially diluted to 10^{-5}, and 0.1 ml of aliquot was plated using pour plating method. Nutrient agar (NA), Mac-Conkey agar (MCA), Eosine Methylene Blue (EMB) agar, Salmonella-Shigela agar (SSA) and Manitol salt agar (MSA) were employed for the enumerations of total viable counts, total coliform counts, *Escherichia coli* counts, *Salmonella* and Staphylococci counts respectively. The inoculated plates were incubated aerobically in at 37^0C for 48 hours. After incubation, the plates having well spaced colonies (30–300) were counted and recorded.

The data obtained were recorded as mean ± standard deviation. Data were subjected to one-way analysis of variance (ANOVA) to determine whether significant differences occurred among their means, using SPSS version 20.

RESULTS

The results of the proximate composition of raw Club Mackerel (*S. japonicus*) at different sampling times under local market conditions are presented in Table 2. No significant ($p>0.05$) change was observed in crude fat at different sampling time. Ash contents were also observed to be similar and insignificantly differed among different sampling times. Protein content was found to be lowest at 12 hour than at the 0, 4 and 8 hours of sampling, while moisture content at 12 hours was significantly highest among the sampling times.

The results of the fish borne bacteria isolated from raw club mackerel during sale under local market conditions are presented in Table 1. Bacterial growth in the fish at 0 hour (i.e. when the fish were first removed from the carton and remained frozen) was below detection. Similarly, pathogenic Salmonella was not detected in all the tested sampling times. However, significant variations were observed in total viable counts and staphylococci counts at 4, 8 and 12 hours, with bacterial counts recovered at 12 hours having significantly ($p<0.05$) highest values. Coliform counts and *E. coli* counts were higher in 12 hours of sale than in 4 hours and 8 hours, but the values were insignificantly ($p>0.05$) differed. All recovered bacterial counts at 4 and 8 hours of sale were below the recommended acceptable limits of 10^5 cfu/g. Fungi growth was not detected in fish samples at all sampling times

Table 1: Proximate composition of raw Club Mackerel (*S. japonicus*) under local market condition

Nutrient categorie	Percentage composition (%) at different sampling times			
	0 hour	**8 hours**	**8 hours**	**12 hours**
Crude Protein	$17.92\pm2\ 31^a$	17.10 ± 1.82^a	16.14 ± 3.59^a	14.6 ± 2.62^b
Crude fat	9.36 ± 1.19^a	9.38 ± 1.05^a	9.28 ± 1.11^a	9.31 ± 1.27^a
Ash Content	4.55 ± 0.31^a	4.42 ± 0.73^a	4.50 ± 0.75^a	4.46 ± 0.00^a
Moisture Content	68.17 ± 5.22^a	69.1 ± 7.44^a	$70.08\pm5.12^{a,b}$	71.63 ± 8.74^b

Values with different superscripts on a row are significantly different ($P < 0.05$)

Table 2. Bacterial counts from raw Club Mackerel (*S. japonicus*) under local market condition

Sampling time	Total viable counts (cfu/cm^2)	Coliform counts (cfu/cm^2)	*E. Coli* counts (cfu/cm^2)	*Salmonella* counts (cfu/cm^2)	Staphylococci counts (cfu/cm^2)	Fungi counts (cfu/cm^2)
0 hour	BD	BD	BD	BD	BD	BD
4 hours	$4.6\pm0.7x10^{3a}$	$4.1\pm0.5x10^{3a}$	$1.9\pm0.1x10^{3a}$	BD	$1.1\pm0.4x10^{3a}$	BD
8 hours	$7.0\pm0.4x10^{4a}$	$5.0\pm0.1x10^{3a}$	$2.2\pm0.1x10^{3a}$	BD	$9.4\pm2.1x10^{3b}$	BD
12 hours	$5.7\pm1.3x10^{5b}$	$7.8\pm0.5x10^{3a}$	$4.3\pm2.4x10^{3a}$	BD	$6.2\pm1.5x10^{4c}$	BD

BD – below detection. Values with different superscripts on a column are significantly different ($P<0.05$)

DISCUSSION

The Chub Mackerel (*Scomber japonicus* family Scombridae) is a coastal pelagic fish species and one of the mostly preferred imported fish in Nigeria due to its attractive appearance and sweet taste after cooking. Like other imported fishes, *S. japonicus* is prone to rapid spoilage under room temperature, so the fish must remain frozen to prevent spoilage. It is unknown whether the fish quality remains intact during sale in the local markets where, after de-frozen, they are exposed to varying environmental conditions.

In this study, protein content of *S. japonicas* was significantly reduced at 12 hours of being displayed in the market, while crude fat and ash contents were not significantly affected. The reason for the observed reduction might be associated with the activation of some enzymes (whose activities were previously suppressed by freezing) in the fish muscles due to increased ambient temperature, as earlier reported by Yetunde (2016). According to Lakshmanan *et al* (2003), these enzymes are responsible for degrading trymethylamine oxide to dimethylamine and formaldehyde. Dimethylamine production results in changes in colour and flavour of the fish, while the cross-linking of proteins induced by formaldehyde, thus protein denaturation and toughening texture often occur in thawed fish, as observed in this study. As a result, proteins become more prone to damage and essential amino acids are more susceptible to loss (Pourshamsian *et al*., 2012). The results of this study pinpoint the need to keep fish in frozen state, or in low ambient temperature, during sale under local market condition to prevent loss of vital nutrients and even complete spoilage.

It was observed that significantly higher total bacterial and Staphylococci counts were recorded at 12 hour than at other sampling time. Similarly, *E. coli* and Coliform counts were also recorded at 4, 8 and 12 hours of sampling. The values recorded at 12 hours were slightly higher than 10^5cfu as proposed by the International Commission on Microbiological Specifications for Foods (ICMSF). Since no bacteria/fungi were observed in the sampled fish at 0 hour, it could be inferred that these bacteria were not inside the fish, but they contaminated it during prising. According to Birgen *et al*. (2020), the presence of flies and pests, dirty storing places, vending environments littered with garbage, filthy clothes, and lack of hygienic knowledge, are responsible for microbial contamination of most raw foods (including fish) displayed for sale in the open markets. These microorganisms especially *E. coli* and *Staphylococcus* have been previously linked with foodborne illnesses with serious fatality (Dalgaard *et al.*, 2006; Rahman *et al*., 2017).. Proper hygiene and sanitation must therefore be maintained in the local markets, while practises involving touching of fish with bare hands during sale must be eliminated to avoid contamination with foodborne pathogens. Proper cooking of raw fish before consumption should also be done to reduce or eliminate risk of fish borne bacterial diseases.

REFERENCES

Adebayo-Tayo B.C,, Odu, N.N., Igiwiloh, N.J.P.N., Okonko, J.O (2012). Microbiological and Physicochemical Level of Fresh Catfish (*Arius hendelotic*) From Different Markets in Akwa Ibom State, Nigeria. *New York Science Journal* 5(4): 1 – 7

Adeleke, B., Robertson-Andersson, D., Moodley, G. and Taylor, S. (2021) Aquaculture in Africa: A Comparative Review of Egypt, Nigeria, and Uganda Vis-À-Vis South Africa. *Reviews in Fisheries Science and Aquaculture* 29 (2): 167 – 197. DOI: 10.1080/23308249.2020.1795615

AOAC. (2003) Official Methods of Analysis. Vol.I.17th ed. Association of Analytical Chemistry, Washington, DC, USA

Birgen, B. J., Njue, L. G., Kaindi, D. M., Ogutu, F. O., and Owade, J. O. (2020). Determinants of microbial contamination of street-vended chicken products sold in Nairobi county, Kenya. *International journal of food science*. https://doi.org/ 10.1155/2020/2746492

Dalgaard, P, Madsen, H.L, Samieian, N and Emborg, J (2006). Biogenic amine formation and microbial spoilage in chilled garfish (*Belone belone belone*) – effect of modified atmosphere packaging and previous frozen storage. *Journal of Applied Microbiology* 101 (1): 80-95

Lakshmanan R., Piggott JR, Paterson A. Potential applications of high pressure for improvement in salmon quality. *Trends in Food Science & Technology*. 2003;14(9):354–363.

Oyelese, O.A. and Opatokun, M.O (2007) Exposure time on bacteria flora/count and shelf life of canned sardine (*Sardinella pilchardus*) under ambient and cold storage conditions. *Journal of Food Processing and Preservation* 31 (5): 517 – 530

Pal, M. (2012). Food spoilage. *Ph.D. Lecture Notes*. Addis Ababa University, College of Veterinary Medicine, Debre Zeit, Ethiopia. Pp.1-8.

Pourshamsian K, Ghomi MR, Nikoo M. (2012) Fatty Acid and Proximate Composition of Farmed Great Sturgeon (*Huso huso*) Affected by Thawing Methods, Frying Oils and Chill Storage. *Advanced Studies in Biology* 4(2):67–76.

Rahman, M. A., Rahman, A. K. M. A., Islam, M. A. and Alam, M. M. (2017). Antimicrobial resistance of *Escherichia coli* isolated from milk, beef and chicken meat in Bangladesh. *Bangladesh Journal of Veterinary Medicine*, 15(2): 141-146. https://doi.org/10.3329/bjvm.v15i2.35525

WorldFish (2018) WorldFish Nigeria Strategy: 2018-2022. http://pubs.iclarm.net/resource_centre/2018-09.pdf

Yetunde K.O. (2016). Biochemical composition of Micromesistus poutassou from agbalata market, Badagry Lagos West, Nigeria. *Food and Applied Bioscience Journal* 4(1):12–14.