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Organoleptic and Chemical Studies on the Storage Characteristict of the Skip Jack Tuna (*Katsuwonus pelamis*)

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Abstract: Sixteen samples of Skip Jack Tuna (*Katswonus pelamis*) with a size range of 9.58-1.62 gm werecollected at the Lagos Jetty of the Nigerian Institute for Oceanography and Marine research, Victoria Island, Lagos and stored at a cold storage temperature of-21°C for a period of 13 weeks. Samples were kept in the cold room for 6 weeks before the commencement of the experiment using one piece of fish per week for both organoleptic and chemical studies (Trimethy lamine (TMA), Total Volatile Bases (TVB) and Free Fatty Acids (FFA). This is in a bid to determining the level of spoilage and limit of acceptability (Shelf life) of the fish. Organoleptic assessments of a five-man panel, showed the general conditions (appearance, taste and odour) of the fish was unsatisfactory at the end of the 12th week of storage, with an average score of 3.9±0.30. However the uncooked fish was still acceptable (4.5±0.33) up till the 11th week of storage. Also for the cooked specimen the general conditions (texture, odour and taste) of the fish were unsatisfactory at the and of 12th week, with an average score of (4.6±0.38). The chemical assessment results were significant ($p<0.05$) and there was a strong positive linear correlation (TMA = 0.9823, TVB = 0.9855 and FFA = 0.9847) between the chemical indices and the length of storage. For the TMA and TVB, the limit of acceptability was the 8th week of storage with values of 4.0 mg 100 g^{-1} fish and 3.75 mg 100 g^{-1} fish, respectively. With FFA as a chemical index of spoilage, (a less sensitive index) acceptability limit of 1.07% was recorded at the 11th week of cold storage. The limit of acceptability (shelf life) for the cold storage of Tuna (*Katsuwonus* pelamis) as shown in this study is between the 8th and 11th week of storage at-21°C using the chemical assessment (as the lower limit) and organoleptic assessment results (as the upper limit) as indicators. However using Least Significant Difference (LSD) to test, the shelf life of Tuna under cold storage of-21°C is 2 months.

Key words: Skip jack tuna (*Katsuwonus pelamis*), organoleptic/chemical assessment, limit of acceptability, shelf life

INTRODUCTION

Tuna belongs to the family *Scombridae*. Members of this family are pelagic marine fish of large or medium size which are related to the Mackerel and to some extent, to *schilbeidae* in structure. They differ from these fishes in having a well-developed network of blood vessels in the dermis that are connected with the vascular system. This is apparently a thermoregulatory adaptation which keeps the body temperature of Tuna fish (unlike in other fishes) some what higher than the surrounding waters.

Ajayi[1] reported that three sp. Yellow fin (*Thunnus albacore*), Bigeye (*Thunnus obesus*) and the Skip Jack Tuna (*Katsuwonus pelamis*) are common in Nigerian coastal waters. However the latter is usually caught in abundance off the Nigerian coast.

Tuna fish has a skeleton that provides support for the body. The edible part (muscles) account for most of the weight of the fish. The skin forms a cover and secretes slimy mucus, which lubricates the fish and seals the surface.

Dewberry[2] stated that the composition of Tuna varies from species to species due to variation in the amount and quality of food that the species eats and the amount of movement they make.

Tuna fish are of great commercial importance and are caught both in the Pacific and Atlantic oceans. The main countries engaged in the catching of Tuna are the U.S.A, Japan and Australia. Tuna are caught with various fishing gears, among them are pelagic hook and lines that may be several dozen kilometers long and rods baited with artificial bait are cast from fast-sailing chippers after first luring the Tunas with small fish thrown overboard. The small Tunas are caught with purse seines and gill nets.

The principal components of the fish muscle are water, fat, protein and other minerals and vitamins compounds. The protein content is usually in the region of 15-20% of the total body composition and this varies depending on the species. For instance Skip Jack Tuna have a protein content as high as 25% or more Chicas[3].

The primary aim of fish quality control according to Borgstrom[4], is to find some methods by which deteriorative changes could be accurately and

quantitatively measured. Quality assessment describes the suitability or excellence of fish for processing oreating and it embraces intrinsic composition, degree of contamination with undesirable materials, nutritive value, degree of spoilage, storage, sale and presentation to consumer.

During storage, the Free Fatty Acid (FFA) of oils and fats usually increases steadily. The rate is however, inhibited as the temperature is lowered. In general, the breakdown and rancidity of oils and fats is accelerated by heat, light and the presence of moisture or traces of metals such as copper and iron[5]. According to Shewan[6] depending on the area of capture, spoilage of fish appears to be the result of a combinedeffect of autolysis and microbial action and the differences in surface slime. Microorganisms contribute to spoilage either directly by their growth or indirectly by excreting enzymes which exert a disintegrating action on the host tissues.

Spinnelli[7] reported that spoilage in fish refers to those undesirable and irreversible changes in fish quality due to autolytic changes coupled with bacterial attack in the entire fish body and chemical changes due to the presence of fat. The ultimate aim of fish production either through culture or capture fisheries is to provide the fish to its final consumers in an acceptable form. Prior to long distance between the landing site and the market, there is need to preserve the fish to increase its shelf life. To achieve this aim of production storage characteristics of fish species which controls fish quality and its deteriorative changes should be accurately and quantitatively measured.

This study is therefore designed to

- Determine the shelf life at cold storage of the skip Jack Tuna (*Katsuwonus* pelamis) using some chemical and organoleptic parameters as indices.
- Establish the limit of acceptability of this species stored under frozen conditions.
- To determine if the length of storage as effects on the rate of deterioration.

MATERIALS AND METHODS

Tuna for this study were caught by Sakin Barka (NIOMR Tuna fishing boat) vessel off Lagos Coastal waters using pole and line and anchovy as baits. They were stored at the fish technology cold room at storage temperature of -21°C. The duration of the study was 13 weeks (3 months and 1 week). 16 pieces of the Skip jack Tuna (*Katsuwonus pelamis*) of size range 9.58-1.62 gm in weight were stored for the initial Six weeks before the actual commencement of the study. Apart from the first and 13th week of the study that involved proximate (initial and final) analysis of the fish, subsequent studies embraced only the organoleptic and chemical (Trinethylamine (TMA), Total volatile bases (TVB) and Free Fatty Acids (FFA) assessments which were carried out on manually filleted samples weekly for an 8 week period (that is the 6th, 7th, 8th, 9th, 10th, 11th, 12th, and 13th week of cold storage) at -21°C.

Organoleptic assessment: A five man strong panel was briefly trained on the organoleptic assessment of the fish. The panel were made of 4 staffs of the fish technology department of the Institute and 1 student on industrial attachment in the Institute. Samples from the stored fish were then assessed as follows:-

For the cooked fish, this was done by steaming for 25 min. the already cut fillets, which were then presented to the tasters on white flat plates. Before tasting; panel members were given clean water to wash their mouth to avoid any carry over of taste. Panel members based their scores on the following characteristics.

- Texture
- Odour and
- Taste

Scores were on numerical scales of 1 (extremely unacceptable) to 8 (extremely acceptable or very good). As for the uncooked fish, a whole round fish was placed on a clean table for grading Parameters employed by the judges were as follows:-

- Appearance or external characteristics. This include skin mucus, shape of the eyes, colour of the gill and rigidity of the abdominal wall.
- Texture refers to the degree of loss of elasticity of the flesh.
- Odour scores for each characteristics were also on numerical scales of 1 (extremely unacceptable), to 8 (extremely acceptable/very good).

Chemical assessment: Samples of fish were withdrawn from the cold room weekly as from the 6th week of cold storage to the 13th week of storage for the chemical assessment studies. Filleted samples were all well macerated and were used for the following analysis. Protein nitrogen was determined by the Microkjeldah distillation method A.O.A.C.[8]. Total lipid was determined by chloroform methanol method, Bligh and Dyer[9].

Free Fatty Acid (FFA) were determined by Pearson method,[10]. Moisture and Ash determination was by A.O.A.C[8] methods. Determination of Total Volatile Base (TVB) and Trienethylamine (TMA) was done by Conway microdiffusion techniques. Analysis were carried out on triplicate samples.

Statistical analysis of data:

- Analysis of variance (ANOVA) for TMA, TVB and FFA measured parameters were carried out for the storage period to test for significant differences between the weekly values. The design is complete randomized block design (CRBD) in the 3 cases.
- Correlation coefficient (r) between the TMA, TVB and FFA values and the length of storage was also carried out.

RESULTS

The final proximate composition of the stored Tuna showed a drop in the moisture content from 73.00 (initial) to 70.62%. While crude protein of the final (at end of experiment) stored .Tuna increased from 24.43 to 25.01% lipid from 0.57 to 0.91% and Ash from 2.00 to 3.46% at the end of the experiment.

Fairly good qualities of uncooked Tuna (5.0-6.0) in the first 9 weeks of storage. However noticeable deteriorations were recorded in the 10th,11th, 12th and 13th week of storage with an organoleptic score range of 3.6-4,5 as shown in Table 2.

A similar pattern for the organoleptic assessmentof the cooked fillets of Tuna was also recorded with good qualities recorded for the first 9weeks of storage with a range 5.8-6.6.However noticeable deteriorations were recorded as from the 10th-13th week with a score range of 3.8-4.8 as shown in Table 3.

A steady increase was recorded for the TMA, TVB and FFA values from the 6th-13th week with the TMA values ranging from 0.00-22.47 mg/100 gmN of fish, TVB values from 0.00-21.87 mg/100 gmN of fish and FFA% values from 0.14%-1.55%, respectively shown in Table 4.

Strong linear correlations exist for all the measured parameters (TMA, TVB, FFA) with increasing length of storage. Also significant differences ($p<0.05$) exist between the TMA, TVB and FFA values with increasing length of storage.

DISCUSSION

Comparison of the initial proximate composition of the Tuna fish (*Katsuwonus pelamis)* before storage in week 1 and final proximate composition in the 13th week of storage shows a decrease in the value of moisture contents Table 1, this is probably an indication of dehydration due to freezing. Thus resulting in the condensation of the crude protein, lipid and ash as shown in their increased values in the final proximate composition. It is inferred that the inverse relationship that exist between moisture and lipid contents is dependent on the circumstances of freezing. Results of organoleptic assessment presented in Table 2 and 3 indicated that length of storage has effect on the shelf life of the fish. The five man panel agreed that the general appearance of the fish was still fairly acceptable at the end of the 13th week ofstudy with a score of 4.2 although rapid deterioration might have started between the 12th and 13th week of storage with organoleptic scores of 4.4 and 4.2, respectively.

Also in the uncooked fish the texture (score 4.0) was still fairly acceptable at the 10th week of storage; while in terms of odour, there was a general consensus among the panelists that the odour was unsatisfactory (3.0) at the end of the 13th week. Though trend of the odour from the table shows fluctuations, based on average score the uncooked fish was unsatisfactory (3.9±0.30) at the 12th week of storage and its limits of acceptability is the 11th week of storage with average score of (4.5±0.33).

In the cooked fillets, odour and taste were unsatisfactory (3.7 and 3.8, respectively) at the 12th week

Table 1: Proximate composition of stored tuna (*Katsuwonus pelamis*)

	Moisture	Crude protein	Lipid	Ash
Initial	73.00	24.43	0.57	2.00
Final	70.62	25.01	0.91	3.46

Table 2: Taste panel score of uncooked (round fish) of tuna (*Katsuwonus pelamis*) stored at coldroom temperature of -21°C

Weeks of Storage	Appearance	Texture	Odour	Averagescore
6	6.2	5.8	6.2	6.0±0.15
7	6.4	5.8	5.6	5.9±0.27
8	5.4	5.2	4.6	5.0±0.27
9	5.0	4.3	5.7	5.0±0.46
10	4.7	4.0	4.3	4.3±0.23
11	4.5	4.0	5.0	4.5±0.33
12	4.4	3.5	4.0	3.9±0.30
13	4.2	3.8	3.0	3.6±0.40

Key: 8-excellent 5-fairly good 2-Very poor 7-very good 4-Just fair 1-highly unacceptable 6-good 3-Poor

Table 3: Taste panel score of cooked (fillets) of tuna (*Katsuwonus pelamis*) stored at coldroom temperature of -21°C

Weeks of Storage	Appearance	Texture	Odour	Averagescore
6	6.0	6.8	7.0	6.6±0.35
7	7.2	7.0	6.0	6.7±0.43
8	5.8	6.2	5.6	5.8±0.20
9	5.3	6.3	5.8	5.8±0.33
10	4.0	4.7	5.7	4.8±0.57
11	5.0	4.0	5.0	4.6±0.38
12	4.3	3.7	3.8	3.9±0.21
13	4.0	3.7	3.8	3.8±0.10

Table 4: Changes in trimethyamine (TMA), Total Volatile Bases (TVB) and Free Fatty Acid (FFA) of fillets of tuna (*Katsuwonus pelamis*) stored at-21°C

	Weeks							
Chemical indice	6	7	8	9	10	11	12	13
Trinethylamine (TMA) mg/100 gm N of fish	0.00	3.20	4.00	7.23	14.97	17.73	21.50	22.47
Total Volatile base mg/100 gm N of fish	0.00	3.13	3.75	8.60	14.57	16.67	20.83	21.87
Free fatty acid (FFA) % of Extracted lipid	0.14	0.31	0.62	0.97	0.95	1.07	1.14	1.55

Table 5: Correlation coefficient (R) for tma, tvb, ffa and storage weeks

Constituents	Coefficient (r)
TMA	0.9823
`TVB	0.9855
FFA	0.9847

of storage and at the 13th week of storage, rate of deterioration fasten with average score of (3.8±0.10). Considering the general conditions (Texture odour and Taste) of the fish the limits of acceptability is the 11th week of storage with average score of (4.6±0.38) from the organoleptic assessment.

Chemical assessment of Tuna (*Katsuwonus pelamis*) Table 4 showed that there was a general increase in TMA, TVB and FFA values throughout the 13th week storage period (as shown by the weekly steady increase in this values from the 6th to 13th week experimental period). Such changes in TMA, TVB and FFA values can be attributed mainly to the action of bacteria and somatic enzymes digesting the fish tissue after death[11].

TMA and TVB as an index of storage showed a marked increase from 0 mg/100 gmN in the 6th week of storage to 22.47 mg/100 gmN at the 13th week of storage for TMA. While for TVB from 0 mg/100 gmN of fish to 21.87 mg/100 gmN. These findings are in line with the work of Borgstrom[4] and Faber which showed that TMA and TVB could serve as good indices for the determination of spoilage in raw fish.

However, Pearson[5] recommended the limit of acceptability (shell life) of raw fish stored under cold storage conditions to be 20-30 mg/100 gmN of fish when TVB is used as an index of spoilage. With an FFA value of 0.14 to 1.55 from the 6th-13th week of storage a steady increase in the fish rancidity is implicated since FFA formation is always accompanied with increasing rancidity levels of the fish[5].

Therefore as shown the limit of acceptability using. TMA and TVB as indices is the 8th week of storage, that is 2 months with values 4.00 and 3.75 mg 100 $gm^{-1}N$, respectively (using Least Significant Difference (LSD) to test it). This implies there is an accelerated rate of spoilage as from the end of 8th week of storage of Tuna (*Katsuwonus pelamis*) hence the shelf life of Tuna under cold storage conditions of-21°C is 2 months. However lower temperatures of-30°C or below could prolong the shelf life. The TMA and TVB chemical indices are more sensitive indicators of spoilage than FFA, since LSD indicates a value of 1.07 for FFA at the 11th week of storage; however, this could be taken as the upper limit of acceptability for the Tuna fish under cold storage conditions of-21°C.

The analysis of variance (ANOVA) shows that significant differences ($p<0.05$) exist between each of the values for each of the (TMA, TVB and FFA) chemical test carried out in the study as length of storage increased. Also the relationship between the measured parameters and the storage periods are positively linear (TMA-0.9823, TVB-0.9855 and FFA-0.9847).

CONCLUSION

It is concluded that as length of storage increases, the spoilage rate of Tuna (*Katsuwonus pelamis*) increases, based on organoleptic and chemical parameters result under cold storage of-21°C. Also the measuredparameters (TMA, TVB and FFA) results were significant at ($p<0.05$) and strong positive linear correlation exists between the chemical indices (TMA-0.9823, TVB-0.9855 and FFA-0.9847) and the increasing length of storage. The Least Significant Difference (LSD) test carried out on the weekly values of the chemical result showed the limit of acceptability of the Tuna fish to be the 8th week of storage for TMA and TVB values and the 11th week of storage for FFA values.

Therefore, it can be suggested from the results of the study, that the 8th week of storage, 2 months shelf life (or limit of acceptability) obtained when chemical indices (TMA and TVB) were used to represent the lower limit of acceptability, while the 11th week of storage obtained when considering organoleptic assessment results is taken as the upper limit of shelf life of Tuna (*Katsuwonus pelamis*). Therefore the limit of acceptability or shelf life for Tuna under cold storage at-21°C is between the 8th and 11th week of storage. However, using Least Significant Difference (LSD) to test, the shelf life of Tuna under cold storage of -21°C is 2 months.

In comparing the two methods used for the determination of spoilage rates (organoleptic and chemical assessment) used in this study for Tuna, the chemical method is more accurate and precise than the organoleptic method which is highly subjective and depends on the experience of the taste panel where biases might even arise.

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