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Quality Characteristics of Brined Deep Frozen Common Carp (*Cyprinus carpio)*

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Abstract: The effect of brining on the keeping quality of gutted, ungutted, gutted common Carp (*Cyprinus carpio)* were monitored under low storage (deep frozen) conditions of-21°c for 8 weeks. Three treatments were used for the study viz: Treatment 1- Normal brined Carp (saturated) Treatment 2-superbrined Carp (super saturated) and treatment 3- control- (carp with no brine treatment). These were monitored through organoleptic (cooked and uncooked) and chemical tests (TVB) to indicate extent of spoilage. Weekly variations in mean weights and initial and final proximate composition of fish in each treatment were also monitored. A concurrent loss in weight was recorded form 1st- 3rd week in all the brining treatments employed and equally affects the fillets, gutted and ungutted samples. This suggests displacement of locked up water which could have accelerated spoilage in the tissue of the fish (*Cypriuns corpio)* by salt crystals, hence the corresponding loss in weight of the fish, weight loss was negligible in Treatment 3, the control fish without brining. The correlation efficient (r) for TVB values with length of storage were positive in all cases for gutted, ungutted, and fillttetted samples (super brine -0.80, 0.84 and 0.87), (Normal brining -0.86, 0.90 and 0.44) and (control -0.98, 0.94 and 0.62 respectively) which implies TVB values increases with the spoilage rate/ length of experimental period. However delayed production of TVB were experienced in Treatments 1 and 2 (Normal and superbrined fish) up to the end of the 5th week which suggests that brining in whatever form causes delayed responses to spoilage in deep frozer *Cypriuns carpio.* The much lower crude protein (6.59-15.42% (Super brine) and 9.62-13.22% (Normal brine) and higher ash content 16.85-18.78% ash (super brining) and 12.08-16.77% ash (normal brine) on proximate analysis of the final fish products for normal and supper brined fish suggests salt protein denaturation coupled with cell (tissue) damage by the frozen salt crystals. The larger surface of exposure of the fillets in Treatments 1 and 2 and there thinness compared to gulled and ungutted samples makes it a better preserved product and it is also responsible for the higher degree of saltiness. All measured parameters the organoleptic assessment (cooked and uncooked), weight loss and TVB values followed a similar pattern of variation. However, there was no delayed response in the TVB production for the control fish which commenced at the 2nd week for fillet control (4.89-24.49 mg 100 gm^{-1} fish), ungutted control (9.79-26.93 mg 100 gm^{-1} fish) compared to much lower values recorded for normal and superbrined products from the 6th-8th week. Normal brining should be done to deep frozen *Cyprinus carpio* to reduce the degree of saltiness to taste. However, if a more permanent product form/preparation) is desired, like it is the case if further processing to Carpfish meal, cake or paste superbrining is recommended in the fillet form to enhance a better keeping (shelflife) quality. If superbrined fish is desired for cooking immediately it should be soaked in water for at least 3 h to desalt it or if used directly little or no salt should be added.

Key word: *Cyprinus carpio*, deep frozen, normal and superbrining, loss in weight/tissue damage, delayed spoilage, filleting

INTRODUCTION

The mode of handling and preservation of fish immediately after catch determines the final quality characteristics of the fish. In recent years, a number of preservation and processing techniques have been developed. However, the viability of any method used is largely determined by the specie of fish concerned, its size and the chemical composition as reported by Mills (1975), Krone (1970) and Lover (1964).

Cyprinus carpio belongs to the family Cyprinidae. The family includes important species of food fish as well as ornamental fishes. They are found in freshwater and brackish water systems and of wide distribution between tropical and temperate zones, although generally prefers warm climate with water temperature 15°C-30°C. Carp is demersal with moderately compressed body. It is a bottom feeder, possessing oblique mouth and feeding on insects, larvae and other food items on the pond bottom.

The common Carp like other Carp species though an exotic fish prior to 1944 in Panyam fish farm, but since its introduction, it has been found to be highly vulnerable to culture and is now a delicacy in Nigeria. This gives an insight to the necessity for its proper processing or preservation in order to satisfy consumers.

There are four main factors contributing to the quality of product reaching the final consumer which the producer cannot ignore. They are

- Quality of the initial raw material, its selection, processing, preservation and packaging
- The way fish is stored, frozen and storage conditions, the rates of freezing, refreezing times and the storage temperatures
- Handling-Handling conditions during trawling, transportation to market areas for distribution and during processing
- Preparation for cooking or processing, including thawing and cooking methods/other methods of processing as reported by Disney *et al.* (1971) and Dugal (1967).

Bacteria believed to be chiefly responsible for spoilage in fish has different tolerance level for salt. Shewan (1977) reported 3 groups of bacteria with respect to salt tolerance.

The halophobic type: This includes mostly pathogens and putrefactive types such as *Pseudomonas* and *Achromobacter* species. They fail to grow in salt concentration greater than 6%, though they may remain viable for long periods, even in the most favourable substrates.

The halotolerant type: It includes spore-bearers, the micrococci, some anaerobes, and in particular *Clostridium botilinum*. They grow in concentration greater than 6%, even up to salt saturation, although more slowly with increasing concentration of salt. The halotolerant property of *Staphylococcus aureaus* have been used to isolate it from, mixed culture on clinical, foods and other materials as reported by (Chapman *et al*., 01961).

The halophic type: Grow best in the presence of salt, requiring concentration usually greater than 2%. It may be pointed out that, most bacteria are stimulated by small amount of salt much less than 2%, hence are in a sense halophic for practical purposes. However, it is probably best to define halophiles as organisms failing to grow in absence of salt and whose salt concentrations of optimum growth lies beyond 2% as reported by Ernest *et al.* (1942) and Shewan (1977).

Many of the types from marine environment fail to grow on primary isolation, on ordinary media growing best in 3- 6% Sodium chloride and can grow even in media saturated with salt. The microorganisms causing pink and dun in salted fish are important members of the halophic group. The name pink and dun is coined from the appearance of the spores of the bacteria flora formed on the fish (substrate). However as reported by Subramanian (1985) the growth of bacteria on fish was strongly affected by salt concentration ranging from 2.5-10%. Also fields and Tylor (1953) reported that partial freezing, as a result of mixing ice and salt preserves the fish better. Slightly better quality of fish is obtainable with salt water ice (brine ice) than with conventional ice.

It is therefore the aim of this study to achieve the following objectives:

- Organoleptic and chemical assessment of brined *Cyprinus carpio* in order to establish the effect of brining on its keeping qualities.
- To determine whether brining fish for a long period under cold storage cause a loss or gain in weight.
- To establish if brining causes drastic changes in the composition of *Cyprinus carpio*.

MATERIALS AND METHODS

The *Cyprinus carpio* were caught in Oyo State fish farm in Oshogbo and were deep frozen fresh immediately at a cold room temperature of-21°C after brining. The brining of the fish was done immediately and the study which lasted 8 weeks was carried out under 3 treatments:- Treatment 1-Normal Brining of gutted, ungutted and filleted *Cyprinus carpio*. was carried out before cold storage at-21°C The brine in this treatment was prepared by dissolving common salt Nacl in water until no more salt will dissolve. The clear salt solution was separated from the mixture after allowing the undissolved salt to settle after 1 h. This is termed saturated solution or 100% Normal Brine and contains 254 gm of salt per litre of water. Treatment 2-Super brining was carried out on gutted, ungutted and filleted *Cyprinus carpio* was carried out before cold storage at-21°C. This was prepared by dissolving common salt (Nacl) in hot boiled water at 100°C until supersaturated. This method is a slight modification of Fields and (Tylor, 1953) using salt water ice (brined ice) to produce a slightly better quality of fish. The superbrined solution contained 320 gm of salt per litre of water. Treatment 3-Control (without brining). Gutted, ungutted and filleted *Cyprinus capio* were stored in water before cold storage at- 21°C. All the 3 treatments were deep frozen and stored under cold storage at- 21°C. A total of Eighty specimen of fresh *Cyprinus carpio* with average weight of 450 + 20gms were used for the study.

Samples of the *Cyprinus carpio* were withdrawn from each treatment on a weekly basis for organoleptic and chemical assessment. Also the initial (on fresh *Cyprinus*

capio) and final proximate analysis were carried out, in order to determine how much change has been effected and compare each level with the length of storage.

Handling and preparation of fish

Gutted preparation: The fish samples were cut open with a sharp knife on the abdominal part carefully to avoid damage to the fish. The visceral parts were all removed and the fish washed thoroughly in clean water to allow the blood drain away.

The fish were carefully packed inside the brine solutions (Saturated Normal Brine (Treatment 1), Supersaturated Superbrine (Treatment 2) and the control kept in normal good quality water. The fish samples were deep frozen immediately at a temperature of- 21°C.

Ungutted preparation: The *Cyprinus carpio* samples were washed in clean water and kept inside the saturated brine, superbrine and clean water (Control). The samples were frozen immediately at a temperature of-21°C.

Fillet preparation: The fish were held at the head and was carefully cut into fillets from the portion slightly below the head to the tail region giving 2 + 0.2cm thickness of fillet.

The fillets were kept in saturated brine, superbrine and clean water (control). The samples were frozen immediately at a temperature of-21°C.

Precautions and safety measures taken:-

- Fish (*Cyprinus carpio*) were carefully handled to prevent fish from being bruised or contaminated.
- Fish was descaled to allow for salt penetration.
- Use of gloves, wearing of cap, laboratory coat and rubber soled shoes.
- Use of clean and rust-free knife.
- All processes were carried out under the best hygienic manner and condition.

Proximate analysis on *cyprinus carpio*: The proximate analysis was done on a dry matter basis for *Cyprinus carpio*, a general proximate analysis was carried out initially, before brining is done and at the end of the study (i.e. the final proximate analysis).

The proximate analysis (protein, moisture, ash and lipid content) were determined according to(A.O.A.C. methods, 1990).

Organoleptic assessment: A four man panel was set up and trained on the organoleptic assessment of brined iced fish and unbrined iced fish. Samples were taken from the coldroom randomly. Two pieces were withdrawn for each week's work (8 cooked, 8 uncooked) in all.

After thawing and washing in clean water the cooked specimen were prepared by steaming whole in a closed dish over boiling water for 30 min. The sample were served in clean white plates.

The uncooked samples were placed in a bowl numbered US; GS, FS, FSS, GSS, USS, GC, FC and UC. FS-Fillet Saturated, FSS-Fillet supersaturated, US-Ungutted supersaturated, GS-Gutted saturated, GSS-Gutted Supersaturated, GC-Gutted control, FC-Fillet control, UC-Ungutted control.

The parameters used by the judges were as follows:

Characteristics of uncooked *Cyprinus carpio*

- The appearance or external feature-whether slime is present on flesh or not, shape of the eyes, colours of the gills.
- Texture
- Odour

Characteristics of cookd *Cyprinus carpio*

- Texture
- Odour
- Flavour
- Taste

Scores on each characteristics were on a numerical basis ranging from 1-4.

Score pattern

- Flavour/Texture/Appearance
  Very good4
  Good3
  Fair2
  Bad1
- Taste

Very Salty	4
Salty	3
Moderate	2
Salt to taste	1

- Odour

Excellent	4
Good	3
Bad	2
Strongly Bad Odour	1

Chemical assessment: After the initial base line chemical analysis of the fresh *Cyprinus carpio,* 1-2 samples were withdrawn from the cold room subsequently every week for chemical analysis. Samples in each treatment were minced and used for the following analysis:- Protein nitrogen was determined by the microkjedahl distillation method (A.O.A.C., 1990), Total lipid was determined by the method of Bligh and (Dyer, 1959), Determination of Total Volatile Bases (TVB) was carried out using Conway Microdiffusion techniques. Analysis were carried out in triplicates.

Statistical analysis: The following statistical analysis were carried out:

- ANOVA-Analysis of variance to test the variability between the chemical indices according to Steel and Torrie.
- Least Significant Difference (LSD of the parameters)
- Correlation Coefficients of the parameters with length of storage.
- Split plot design to jointly analyse the variability of all the measured parameters (TVB, weight differences, organoletpic assessment) for all the 3 treatments in the study.

RESULTS

where USS-Ungutted Super Saturated (Superbrine), GSS Gutted Supersaturated, FSS-Filleted Supersaturated, US-Ungutted saturated (Normal brine), GS-Gutted Saturated, FS-Filleted Saturated, UC-Ungutted Control (No brine), GC-Gutted Control, FC-Filleted Control.

As shown in Table 1, the moisture content of the initial fish (77.00%) is much higher than in any of the components of the 3 treatments in this study. However, Treatment 1 products is worst hit because of the much lower moisture range of (65.06-73.10) while the control fish-Treatment 3 has a closer moisture content range of 71.60-75.00%.

Also while there is a general decline in the crude protein levels in all 3 treatments from the initial 19.44%, the Gutted Superbrine (GSS) and gutted normal brined fish (GS) had much lower values of 6.59 and 9.62% respectively. This is possibly due to their larger surface area for the salt to penetrate the tissues and react with the crude protein content of the fish tissues.

However, for the control unbrined fish frozen in ordinary water the decrease in moisture content is compensated for by an increase in crude protein ranging from (21.53-24.97%). Ash content of the superbrined fish (16.85-18.78%) and normal brined fish (12.08-16.77%) far exceeded the initial ash content of the fresh fish (2.13%) while much lower values of (1.68-1.82%) were recorded for the control unbrined fish.

Brining effect on weight and proximate composition of frozen *Cyprinus carpio*

As shown in Table 2, there is an appreciable drop in weight generally from the 1st to 3rd week in all cases, compared to a gradual drop in weight from the 4th-8th week. Also observed is that the weight drop in superbrined fish (Treatment 2) is greater than what is observed in Normal brined fish (Treatment 1) while the latter loss in weight is greater than in the Control-no brine (Treatment 3).

This observation is due to rapid effective penetration of salt into the Carp tissues thereby causing reduction in moisture as a result of brine denaturation of protein (Table 1 and 2). This is accompanied by loss of water binding capacity, causing reduction in moisture protein, minimal effect on fat and considerable increase in ash (Table 1). The observation is in line with Bligh (1970) findings.

Table 1: Initial and final proximate composition of common carp (*cyprinus carpio*)

Readings	Moisture %	Crude protein %	Ash %	Lipid %	NFE %
Initial					
Initial fresh fish	77.00	19.44	2.13	0.25	1.18
Fiinal					
Superbrining					
USS	65.06	15.42	17.30	0.32	1.90
GSS	73.10	6.59	18.78	0.45	1.08
FSS	67.70	13.89	16.85	0.54	1.02
Normal brining					
US	68.62	13.32	16.77	0.29	1.00
GS	75.50	9.62	13.44	0.40	1.04
FS	74.50	11.99	12.08	0.30	1.12
No brining control					
UC	75.00	21053	1.68	0.26	1.53
GC	72.90	24.06	1.72	0.30	1.02
FC	71.60	24.97	1.82	0.33	1.28

Table 2: Mean weekly weight reading of *cyprinus carpio*

	Superbrining			Normal brining			Control/no brine		
Weeks	GSS_1	FSS_1	USS_1	GS	FS	US_1	OC_1	CC	UC
Initial mean weight	460	265	450	435	280	470	465	270	465
1st Week	456	256	447	433	273	468	465	270	465
2nd Week	452	251	444	433	270	466	464/10	268	464
3rd Week	449	247	441	429	266	463	463	267	464
4th Week	449	247	441	429	266	463	462.30	265	463
5th Week	449	247	439	429	266	463	462.10	265	462
6th Week	449	246	435	429	265	463	462	264	461
7th Week	448	245	420	428	265	462	460.20	263	461
8th Week	447	243	424	426	264.50	461	460	261	460

The superbrined cooked fish (Treatment 2) had the best quality of fish with an organoleptic score range of 3.0 (gutted)-2.95 (fillet)-2.75 (Ungutted) at the end of the 8th week which corresponds to good flavour/texture/appearance, salty to taste with good odour as shown in Table 3. The next best quality is the cooked normal brined fish (Treatment 1) while the least quality was recorded in Treatment 3, the cooked control fish without brining.

Also as shown in Table 4 the organoleptic assessment of uncooked common carp followed the same pattern with the cooked samples (Table 3) with the best quality recorded in the superbrined samples (Table 4) although with slightly lower scores although with the freshness of the samples still maintained.

CHEMICAL ASSESSMENT RESULT

Hergbord *et al.* (1975), stated changes in TMA (Trimethylamine), TVB (Total Volatile Bases) and FFA

Table 3: Organoleptic assessment result of cooked samples

	Control			Saturated			Super brine		
Weeks	Gutted	Ungutted	Fillet	Gutted	Ungutted	Fillet	Gutted	Ungutted	Fillet
1	4.00	4	4	4.00	4.00	4	4	4.00	4.00
2	3.60	3.2	3.5	3.67	3.50	3.65	3.67	3.50	3.80
3	3.20	3	3.1	3.60	3.25	3.42	3.55	3.48	3.50
4	3.00	2.9	2.9	3.52	3.00	3.16	3.5	3.30	3.33
5	2.90	2.8	2.8	3.25	2.80	2.9	3.3	3.10	3.00
6	2.90	2.7	2.6	3.10	2.80	2.9	3.38	3.00	3.25
7	2.50	2.5	2.4	2.82	2.70	2.6	3.26	2.90	3.15
8	2.10	2.2	2	2.60	2.54	2.47	3	2.75	2.95

N.B:Indices recorded weekly are means of scores for colour, texture, flavour and taste

Table 4: Organoleptic assessment of uncooked samples

	Control			Saturated			Super brine		
Weeks	Gutted	Ungutted	Fillet	Gutted	Ungutted	Fillet	Gutted	Ungutted	Fillet
1	4.00	4	4	4.00	4.00	4	4	4.00	4.00
2	3.50	3	3.3	3.50	3.40	3.45	3.6	3.40	3.60
3	3.10	2.9	3	3.40	3.10	3.4	3.5	3.35	3.40
4	2.90	2.8	2.9	3.42	2.90	3.1	3.45	3.25	3.20
5	2.80	2.5	2.6	3.10	2.70	2.8	3.25	3.02	3.00
6	2.82	2.32	2.52	3.05	2.65	2.75	3.14	2.82	3.00
7	2.40	2.3	2.3	2.72	2.55	2.5	3.94	2.62	2.84
8	2.10	1.92	1.92	2.40	2.42	2.35	2.74	2.50	2.72

N.B:The indices recorded for Table 4 are means of scores of odour, appearance and texture.

Table 5: Changes in Total Volatile Bases (TVB) of samples of *cyprinus carpio* (common carp) brined/no brining and stored at-21°C

Levels of treatment for superbrining, normal brine/control	Changes in total volatile bases weekly (TVB mg 100 gm^{-1} fish under different levels of brine/no brine treatment							
	1	2	3	4	5	6	7	8
Normal brining								
Gutted saturated	0	0	0	0	0	10.38	12.50	20.21
Fillet saturated	0	0	0	0	0	9.44	22.06	24.52
Ungutted saturated	0	0	0	0	0	4.93	7.35	17.17
Superbrining								
Gutted saturated	0	0	0	0	0	5.03	9.86	14.80
Fillet saturated	0	0	0	0	0	9.49	9.86	14.80
Ungutted saturated	0	0	0	0	0	14.86	17.42	17.53
Control (No brining)								
Gutted control	0	0	0	4.90	4.90	9.35	12.35	14.69
Fillet control	0	4.89	4.89	12.24	14.69	17.14	18.12	24.49
Ungutted control	0	9.79	9.79	17.14	22.04	22.64	22.64	24.93

(Free Fatty Acid) can be attributed mainly to the action of bacteria and somatic enzymes as evident in superbrined and normal brined *Cyprinus carpio* used in this study from 6^{th}-8^{th} week in both cases and 2^{nd}-8^{th} week in the Control fish with no brining preservation. Although a delayed response to spoilage was experienced in the gutted control fish with TVB production (indicating spoilage) commencing from the 4^{th} week of the study as shown in Table 5.

The strong positive correlations (r) (Table 6) for all levels of treatment further buttresses the fact that whatever the extent of delay experienced before spoilage commences; spoilage (which means increasing TVB values in this study) increases with length of storage. Although progressive but delayed spoilage were experienced at all levels as a result of the brine treatment especially with Treatments 1 and 2 (Normal brining and superbrining (Table 5 and 6).

DISCUSSION

A concurrent loss in weight was recorded from 1^{st}-3^{rd} week in all the brining treatment methods employed, and equally affects the fillets, gutted and ungutted samples which further confirms the assertion that the salt crystals displaces water in the tissues of *Cyprinus carpio* this corresponds to(Bligh, 1970) findings.

The table of correlation 'r' (Table 6) shows all the values of all the treatment levels to be positive which simply means the TVB values are increasing progressively with the spoilage rate/length of the experimental period (storage period). Although delayed production of TVB were experienced in Treatments 1 and 2, up to the end of the 5^{th} week (Normal and superbrined fish (*Cyprinus carpio*) which simply suggests that brining in whatever form causes delayed responses to spoilage in deep frozen *Cyprinus carpio*.

Table 6: Correlation coefficient 'r' for gutted, filleted and ungutted (superbrined, normal brined and no brining (control) *cyprinus cazrpio* with length of storage

Level of treatment	Coefficient (r)
Superbrining	
Superbrined gutted	0.80
Superbrined ungutted	0.84
Superbrined fillet	0.87
Normal brining	
Saturated gutted	0.86
Saturated ungutted	0.90
Saturated fillet	0.44
Control (No brining)	
Fillet control	0.98
Ungutted control	0.94
Gutted control	0.62

It is also envisaged that spoilage could still be further delayed if freezing is still done at much lower temperatures than-21°C coupled with brining. This is further confirmed since the main treatment effects (that is of the 3 treatments) in each case were not significantly ($p>0.05$) different in their pattern of variation in the freezing medium (as shown in the split plot design which superimposed all the measured factors TVB, mean weight changes, organoleptic assessment (cooked and uncooked) for the (gutted, ungutted and fillet) which followed a similar pattern of variation for the 3 treatments. It is also suggestive that the delayed responses to spoilage was as a result of the salt penetrating the cells to displace the locked up water that could accelerate spoilage. However this development could be accompanied with salt protein denaturation coupled with cell (tissue) damage by the frozen salt crystals. The consequence of this is the much lower values of crude protein (Table 1) experienced by the normal brined and superbrined final fish products, also resulting in higher ash content values for these treatments (Treatment 1 and 2) (Table 1).

However the tendency for saltiness of the final fish product is highest in the fillet, followed by gutted fish and least in the ungutted fish (among the brined fish) compared to the control products without brining. The larger surface of exposure and thinness of the fillets compared to others is responsible for the higher degree of saltiness.

CONCLUSION

It is advised that normal brining should be done to deep frozen *Cyprinus carpio* in order to reduce the degree of saltiness to taste. However, if a more permanent product form (i.e., preparation) is desired, like it is the case for further processing into Carp fish meal cake or paste super brining is recommended in fillet form to enhance a better keeping (shelf life) quality.

If the superbrined fish is desired for cooking immediately, little or no salt should be added or in the alternative the fish is allowed to desalt and thaw in ordinary water for at least 3 h before use for cooking.

The loss of moisture and possibility of replacement of salt penetrating the fish tissue is further confirmed by a gradual drop in the weekly weight readings recorded for each sample treated in brine.

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