

# Effect of varying proportions of salt to fish on the quality of salted and dried Trigger fish (*Balistes capriscus*)

GLADYS NERQUAYE-TETTEH (MRS)

Food Research Institute, P. O. Box M-20, Accra, Ghana

## SUMMARY

Traditionally, Trigger fish (*Balistes capriscus*) is salted and sun-dried to preserve it. Previous studies by the author revealed that there is the need for standardization of the methods of processing Trigger fish in order to guarantee a product with uniform quality. The present investigation was carried out to study the effect of varying proportions of salt to fish on the quality of the salted fish. From the various results obtained, ratios of salt to fish of 1 : 7 and 1 : 8 were found to be the best levels of salting for a period of 18 h and these have been recommended for use.

Original scientific paper. Received 28 Jul 77; revised 8 Jun 78.

## Introduction

Trigger fish (*Balistes capriscus*) is of increasing importance in Ghana especially when salted and dried. Previous studies on the traditional processing of Trigger fish have shown the need for standardization of the processing methods in order to guarantee a uniform product (Nerquaye-Tetteh, 1970; 1978).

Lahiry, Sen & Visweswariah (1961) studied the effect of varying proportions of salt to fish on the quality of sun-dried mackerel (*Rastrelliger canagurta* Cuv). There is, however, very little information on how the quality is affected by different levels of salting. This work was, therefore, carried out to study the effect of varying proportions of salt to fish on the quality of the salted and sun-dried Trigger fish. It is hoped that from the results it will be possible to recommend one or two

## RÉSUMÉ

NERQUAYE-TETTEH, GLADYS: *Effet de l'adjonction de différentes proportions de sel sur la qualité du poisson Trigger (Balistes capriscus) salé et séché.* Traditionnellement, le poisson Trigger (*Balistes capriscus*) est salé et séché au soleil pour sa conservation. Des études précédentes par divers auteurs ont montré qu'il est nécessaire de standardiser les méthodes de préparation du Trigger de manière à garantir un produit de qualité uniforme. Dans le présent travail, l'auteur se propose d'étudier l'effet de l'utilisation de différentes proportions de sel sur la qualité du poisson salé. Les résultats obtenus ont montré que les proportions de sel par rapport au poisson, de 1/7 à 1/8 étaient les meilleures, appliquées pendant une période de 18 heures; ces indications sont recommandées aux usagers.

ratios to be used by the traditional processors for salting Trigger fish.

## Materials and methods

The fresh Trigger fish was purchased from Elmina, in the Central Region of Ghana immediately after landing in the early hours of the morning. It was immediately gutted at the beach by making a cut in the belly and pulling the entrails out, washed and transported on ice to Food Research Institute, Accra. At the Institute, the fish was frozen at -24 to -28 °C for 18 h till the next day when it was used in the trials. To begin the trials, the whole batch was thawed at room temperature (28-30 °C) for 2-3 h. Crude solar salt was used throughout the investigations. The salt used was analysed with respect to (a) moisture (b) insoluble matter (c) calcium (d) magnesium and (e)

sodium chloride contents.

The salting was done in broad plastic bowls (of about 15 dm<sup>3</sup> capacity) with various proportions of salt to fish ranging from 1:3 to 1:12. For each ratio, 30 gutted Trigger fish whose individual weights were in the range of 69.1 - 74.6 g and the length ranging from 16 to 18 cm were used. The total weight of each lot was recorded and the quantity of solar salt required was calculated on the basis of the weight of the fish.

The actual salting was done by filling the belly of each fish with salt and the rest of the salt was sprinkled on the packed fish. The bowls of the salted fish were kept in a fly proof room at 28-30 °C. The laboratory methods employed were similar to the commercial practice in the preparation of salted Trigger fish except that the salting was done in plastic bowls instead of wooden barrels.

#### Chemical analysis

At intervals of 0, 6, 12, 18, 24 and 48 h, five fish were randomly picked from each of the 10 bowls for analyses. In all cases, any salt left in the belly and the proportionate quantity of salt on the fish were removed. The fish was then skinned and the flesh minced together before samples were taken for salt, moisture and total volatile bases (TVB) analyses.

Moisture was determined on a 5 g well minced sample in a ventilated drying oven at 105 ± 1 °C to a constant weight.

Salt was determined according to the method described by Schonherz (1955).

For the determination of TVB, a perchloric acid extract was prepared from 3 g of the minced sample according to the method of Jones, Murray & Burt (1965) and TVB was estimated from this extract by a procedure based on Conway micro-diffusion method as described by Beatty & Gibbons (1937).

In another set of experiments, leached out fluid was measured for samples salted at the 10 different ratios for 6 and 18 h, using a measuring cylinder.

To study the change in texture with different proportions of salt to fish 1:5, 1:8 and 1:11 were sun-dried for 3 days. At the end of each day, samples were taken for salt and moisture determinations. Five fish were also boiled for 15 min in about 850 dm<sup>3</sup> water and the texture determined

by chewing.

The drying was carried out from 9 a.m. to 3 p.m. each day, with the temperature being recorded every 2 h. It was not possible to record both the humidity and wind speed due to lack of the necessary equipment. The fish to be dried was spread on wooden framed nylon mesh which were placed on a raised platform. Each fish was tagged to help in monitoring the weight at 2-h intervals in the three ratios (1:5, 1:8, 1:11).

The salt was analysed according to AOAC (1970) to determine the moisture, insoluble matter, calcium, magnesium and sodium chloride levels.

#### Results and discussion

The method followed in the actual salting of the fish was the same as that used by the traditional processors. The quality of the salt used is shown in Table 1.

TABLE 1

*Quality of Crude Solar Salt Used for the Salting*

<i>Content</i>	<i>Percent</i>
Moisture	5.7
Insoluble matter	0.2
Calcium	0.84
Magnesium	0.42
Sodium chloride	94.6

The salt was 94.6 per cent pure and of varying granular sizes. The moisture content of the fish salted with different proportions of salt to fish is given in Table 2. The results show that as the proportion of salt to fish was decreased from 1:3 to 1:12, the moisture content generally increased. The moisture content at each ratio also decreased with time. The values are, however, slightly higher than those obtained by Lahiry, Sen & Visweswariah (1961) when they worked with mackerel. The moisture contents differ probably because of different fat contents in the two species. The fat content of Trigger fish is in the range of 0.3-1.0 per cent whereas that for mackerel is 2.4-9.7 per cent (Eyeson & Ankrah, 1975). The tough skin of Trig-

TABLE 2

Change in Moisture Content of Trigger Fish Flesh Salted with Different Proportions of Salt to Fish

Proportion of salt to fish	Percent moisture at					
	0 h	6 h	12 h	18 h	24 h	48 h
1:3	79.1	71.5	66.0	66.8	62.4	58.5
1:4	79.1	71.3	71.2	68.1	62.9	57.7
1:5	79.1	70.8	67.5	66.6	65.0	58.2
1:6	79.1	72.2	71.0	70.2	65.7	61.5
1:7	79.1	71.7	68.5	67.2	66.9	59.7
1:8	79.1	72.2	71.0	68.2	68.7	62.5
1:9	79.1	72.7	70.8	69.9	68.4	65.5
1:10	79.1	72.6	71.8	68.1	67.9	68.0
1:11	79.1	73.0	70.0	69.8	67.3	65.8
1:12	79.1	74.5	69.5	70.3	71.5	68.7

ger fish might also have acted to some extent as a barrier to moisture.

Table 3 shows the changes in sodium chloride content of Trigger fish flesh during the salting process. Throughout the 10 different proportions of salt to fish, the results show a general decrease in salt content as the proportion of salt to fish was decreased from 1:3 to 1:12. The salt content at each ratio also increased with time.

It was also observed that after 18 h of salting, the salt level continued to increase at ratios 1:3, 1:4, 1:5 and 1:7 in a decreasing order whereas the salt content levelled off at ratio 1:8.

The TVB levels obtained during the salting process are presented in Table 4. The results do not show any significant differences in the values obtained. This probably proves the fact that TVB as a means of determining the degree of spoilage cannot be applied to all types of fish (Farber, 1965).

Table 5 gives the volume of fluid leached out at different proportions of salt to fish after salting for 6 and 18 h. There is a gradual decrease in the volume of fluid leached out with decrease in proportion of salt to fish; and more fluid was leached out with time so that the 1 cm<sup>3</sup> of fluid leached out per gram weight of dressed fish obtained after 18

TABLE 3

Change in Sodium Chloride Content of Flesh of Trigger Fish Salted with Different Proportions of Salt to Fish (Expressed in percentage of wet weight)

Proportion of salt to fish	Percent sodium chloride in flesh after salting for					
	0 h	6 h	12 h	18 h	24 h	48 h
1:3	0.2	4.8	6.2	7.6	12.9	13.7
1:4	0.2	3.9	8.8	7.1	11.7	12.7
1:5	0.2	3.7	6.8	6.2	9.6	12.4
1:6	0.2	3.4	6.7	6.1	10.1	10.7
1:7	0.2	4.6	7.1	6.2	8.4	9.5
1:8	0.2	3.3	5.4	7.6	7.6	7.6
1:9	0.2	4.1	4.8	4.9	8.8	7.1
1:10	0.2	3.1	5.2	5.4	5.3	5.1
1:11	0.2	3.4	5.5	5.8	6.2	6.0
1:12	0.2	3.2	5.4	5.6	5.6	5.2

h salting were more than those for 6 h.

The rate of drying of Trigger fish salted for 18 h at 1:5, 1:8 and 1:11 proportions of salt to fish are shown in Table 6. The rate was calculated on the basis of initial weight of the fish on first day of drying. The results show that more moisture was removed from the fish samples as the ratio of salting decreased from 1:5 to 1:11. The high drying rates of the samples with lower levels of salting compensated for the initial higher moisture contents (Table 2). This confirms the findings of Lahiry, Sen & Visweswariah (1961) that the total drying time needed to dry a product to a definite moisture content is practically unaffected by the degree of salting.

Table 7 gives the results of the texture of Trigger fish samples salted and dried for different periods before they were cooked. The texture of the heavily salted samples, i.e. 1:5, was found to be hard after a day's drying. After 2 day's drying, the texture of samples salted at 1:5 and 1:8 were hard but samples from ratio 1:11 were still soft. After the 3rd day, all the samples were hard but samples from ratio 1:11 were not as hard as those from 1:5 and 1:8. This shows that both the degree of salt-

TABLE 4

*Total Volatile Bases (TVB) at Various Times after Salting*

Proportion of salt to fish	TVB (mg N/100g flesh on dry weight basis) after salting for					
	0 h	6 h	12 h	18 h	24 h	48 h
	1:3	29.9	25.2	29.0	21.6	31.6
1:4	29.9	24.0	27.0	20.0	33.1	-
1:5	29.9	32.2	-	24.5	38.8	29.6
1:6	29.9	21.5	-	26.8	40.8	-
1:7	29.9	27.9	24.1	20.5	35.0	23.5
1:8	29.9	-	31.0	25.1	38.3	20.2
1:9	29.9	27.4	-	30.2	37.9	29.2
1:10	29.9	33.5	26.9	29.4	35.8	36.2
1:11	29.9	24.8	26.6	22.8	36.0	39.7
1:12	29.9	27.4	27.5	23.5	44.0	40.9

ing and the extent of drying affect the texture of the final or dried product.

The following general observations were also made during the salting and drying processes. It was noted that up to 24 h of salting, salt crystals were still present in samples salted at ratios 1:3, 1:4, 1:5 and 1:6 in a decreasing order of quantity of salt and after 48 h of salting, salt crystals were only in ratios 1:3, 1:4 and 1:5.

From the point of view of economy in the use of salt, it would be deduced that between 18 and 48 h of salting time, the ratios of salt to fish above 1:6 would be recommended.

It was, however, observed that maggots appeared after 48 h salting in samples which were salted with very low concentrations of salt as expressed in the ratios of salt to fish 1:9, 1:10, 1:11 and 1:12. The appearance of maggots is indicative of too low a concentration of salt for efficient preservation.

It was also observed that when the samples were left overnight in the laboratory, after the first 2 days of drying, the samples picked up moisture from the atmosphere but this did not happen on samples which had been dried for 3 days.

All the salted and dried Trigger fish samples had the characteristic strong odour and flavour of

TABLE 5

*Volume of Fluid Leached out at Intervals during Salting with Different Proportions of Salt to Fish*

Proportion of salt to fish	1 cm <sup>3</sup> of fluid / g weight of dressed fish leached out after salting for	
	6 h	18 h
	1:3	0.09
1:4	0.09	0.12
1:5	0.09	0.12
1:6	0.08	0.10
1:7	0.08	0.10
1:8	0.08	0.10
1:9	0.07	0.09
1:10	-	0.09
1:11	0.06	0.09
1:12	0.06	0.07

TABLE 6

*Rate of Drying of Trigger Fish Salted for 18 h at Different Proportions of Salt to Fish (Rate calculated on the basis of initial weight of the fish on day 1)*

Proportion of salt to fish	Day	Initial weight in gram	Percent moisture loss on basis of initial weight on day 1
1:5	1	87	35.5
	2	65	
	3	56	
1:8	1	80	43.7
	2	54	
	3	45	
1:11	1	80	46.2
	2	52	
	3	43	

salted and dried fish. These characteristic cured flavours which most consumers like, probably developed because the curing process was carried out

TABLE 7

Texture of Cooked Trigger Fish Salted and Dried to Different Extents

Proportion of salt to fish	Texture		
	1 day dried Trigger fish (6 h)	2 days dried Trigger fish (6 h)	3 days dried Trigger fish (6 h)
1 : 5	Hard +	Hard ++	Hard +++
1 : 8	Soft +	Hard +	Hard +++
1 : 11	Soft ++	Soft ++	Hard ++

at room temperature which for most part of the year was in the range of 28-30 °C.

From the various results obtained and the general observations made, the ratios of salt to fish of 1:7 and 1:8 were recommended as the best levels of concentration of salt for salting Trigger fish due to the following reasons: These ratios

- (i) do not provide excessive and wasteful use of salt,
- (ii) provide a continued absorption of salt in the fish between 18 and 48 h of salting time,
- (iii) provide a level that is able to prevent the growth and survival of maggots, thus making the product more hygienic.

In the traditional salting process, the unit of measure is the "basin" which can contain 100-200 fish pieces. The amount of salt to be used will, therefore, be calculated based on this unit. It was recorded during the experiment that the difference in weight of salt between ratios 1:7 and 1:8 is of the order of 1g per fish, thereby making a difference of about 200 g maximum per basin of fish. For purposes of the practical handling of salting along the beach by the traditional processors, the

difference between ratios 1:7 and 1:8 can be considered insignificant.

#### Acknowledgement

The author is grateful to Messrs J. Tete-Ogah and E. Opong (Chemistry Section), M. Amekudi and E. A. Agbetor (Fish Processing Section) for their assistance in this work. She also wishes to thank Messrs K. K. Eyeson and J. K. B. A. Ata (Food Research Institute) for commenting on the draft.

#### REFERENCES

- AOAC (1970) *Official methods of analysis*, 11th ed. pp. 294-310, 571-574. Washington, D.C.: Association of Official Analytical Chemists.
- Beatty, S. A. & Gibbons, N. E. (1937) The measurement of spoilage in fish. *J. biol. Bd Can.* **3** (1), 77-91.
- Eyeson, K. K. & Ankras, E. K. (1975) *Composition of foods commonly used in Ghana*. Accra: Food Research Institute. (Mimeo.)
- Farber, L. (1965) *Freshness tests in fish as food* (ed. George Borgstrom), **4**, 73-75. New York: Academic Press.
- Lahiry, N. L., Sen, D. P. & Visweswariah, K. (1961) Studies on dry salting and sun-drying of mackerel (*Rastrelliger canagurta* Cuv.). *Fd Sci.* **5**, 139-143.
- Jones, N. R., Murray, J. & Burt, J. R. (1965) Automated analysis of hypoxanthine. *J. Fd Sci.* **30**, 791-794.
- Nerquaye-Tetteh, Gladys (1976) *Traditional methods of salting fish in Ghana*. Accra: Food Research Institute. (Mimeo.)
- Nerquaye-Tetteh, Gladys (1978) Trigger fish (*Balistes capricus*). 1. Studies on traditional processing. *Ghana Jnl agric. Sci.* **11**.
- Shonherz, Z. (1955) Determination of salt based on titration with mercuric nitrate. *Fd Manuf.* **30**, 460.

#### Introduction

In Ghana, *bambusa granados* (Poaceae subtribe) grows wild only to be used in production and consumption (Doku & Nantso, 1971), yet there are no definite recommendations as regards plant densities and fertilizer treatments

(Doku, 1967; Amon (1972) has suggested that the higher potential yields made possible by favourable water regimes and high soil fertility could be realized only at the appropriate plant population. Douglas (1983) indicated that maximum yields of species in any particular environment can be