Retail Prices and Market Quality of Unsalted-Grilled and Salted-Dried Tilapia from Volta Lake, Ghana*¹

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With an aim to reveal the actual quality of dried freshwater fish on the Ghanaian market, chemical, bacteriological and organoleptic examinations were carried out on 42 unsalted-grilled and 73 salted-dried tilapia. Retail prices per kg of the products were also recorded. There was no significant difference between the average retail prices of the two products. For both dried fish, there existed negative and significant correlation ($P < 0.001$) between fish weight and the retail prices. No significant correlation was found between the retail prices and organoleptic scores. Average water content of unsalted-grilled fish was 58% and that of salted-dried ones, 45% with 16% salt. Average appearance and odor scores of both products fell between fair and good. For grilled fish, taste panel scores significantly correlated with appearance and odor scores ($P < 0.05$), and log (total viable counts) ($P < 0.02$). But salted tilapia demonstrated no significant correlation of the taste panel scores to these two variables. The data suggest that in drafting the quality standards of these two products, different criteria should be adopted.

Tilapia has commercially been the most important fish species harvested from Volta Lake. It was estimated in 1969-70 that the percentage of this species varied between 20 to 60 of the total annual catch of 40 to 60 thousand tons¹⁾. 85 to 90% of this tilapia catch was sold in dried forms of either unsalted-grilled or salted-sundried. The former, however, composed only 0.3% of the total product weight of processed tilapia in 1972.*⁴

On the market quality of the products only fragmentary information has so far been collected.*^{5,2)} The objective of this paper is to reveal the actual quality of the dried tilapia on the market as determined by chemical, bacteriological and organoleptic examinations. This forms a ground work for future development of quality standards for the dried fish, based strictly on local requirements. Simultaneously the data will point out the defects on the present products which should be eliminated for an improved quality.

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*⁴ Statistical data, Fisheries Department, The Government of Ghana, Accra, Ghana, personal communication.

*⁵ J. McAlister: Proposal for development of landing, marketing and supply facilities. Internal Report, Volta Lake Research Project, Akosombo, Ghana (1970).

E. M. Mensah: Methods used in fish processing on Volta Lake, Internal Report, Volta Lake Research Project, Akosombo, Ghana (1970).

Pricing system of the products has also not been well understood. Thus, fluctuation in retail prices per unit weight of the dried fish were discussed in order to sort out factors responsible for local price mechanism.

Material and Methods

Locally prepared unsalted-grilled and salted-dried tilapia (*Tilapia galilae* and *nilotica*) were purchased at Akosombo and Agormenha market in southern Ghana, for the period August 1971 to November 1972.

The traditional methods of usual processing are described briefly in the following:

Unsalted-grilled fish; After scaling, fish are cutted sideways starting from anus to upper end of pectoral fin base showing somewhat a logarithmic curve, then gutted by pulling out entrails by fingers through the opening. After gutting, the fish are placed on the shelves of ovens and covered by metal sheetings. Ovens are normally made of clay, metal drum or sometimes of simple pit, with one layer of the shelf directly over fire-place.²⁾ Grilling of fish are carried out at 60°C to 125°C and lasts from overnight to 7 days depending on the size of fish and season. Dead submerged trees which are abundant on the lake because of the inundation caused by the construction of Akosombo Dam, are used as fire-wood.

Salted-dried fish; After being scaled and cutted open the abdominal cavity, fish are gutted, as described for the unsalted-grilled fish. Then, coarse salt is stuffed in the belly cavity and fish are piled up in a basin or bucket and left there normally overnight up to 3 days. The amount of salt added is not well controlled but about 20 to 30% of fresh fish weight is added. Occasionally fish are pressed by stones and kept submerged in the brine formed by the water squeezed out from the fish (pickling). After salting, remaining salt is taken off and the fish are sundried on brushwood platform for one to several days.

The sampling of the products was done by local staff of the Volta Lake Research Project (VLRP). The samplers were instructed to behave as ordinary shoppers.

It was planned to collect at least 2 samples weekly for each product. Each sample comprised 2 fish. Due to acute shortage of the products during this survey, however, the sampling schedule became irregular. The resulted distribution of the samples by month is shown in Table 1.

Fish retailers from whom the samples were taken were selected as randomly as possible. Overall, a total of collected samples was 115, of which 42 were the unsalted-grilled and 73 the salted-dried.

The commodity has traditionally been traded not by weight but by fish. After being brought back to the VLRP laboratory at Akosombo, the samples were weighed to 0.5 g and price per kg of the dried fish was calculated.

Table 1. Number of samples* by month

Year	Month	Unsalted-grilled tilapia	Salted-dried tilapia
1971	August	4	4
	September	8	9
	October	2	6
	November	2	6
	December	4	8
1972	January	3	8
	February	—	2
	March	1	6
	April	—	2
	May	—	—
	June	—	—
	July	9	6
	August	2	2
	September	2	2
	October	4	8
	November	1	4
	December	—	—
Total		42	73

* Each sample comprised 2 dried fish.

The fish were then sensorily examined for appearance and odor by a modified method of WATANABE and DZEKEDZEKE's scheme³⁾ as adapted to the Ghanaian products. The products were scored into a 10 point hedonic scale (excellent-10, good-8, fair-6, poor-4, half spoiled-2, spoiled-0). After this examination, total viable counts on skin surface were determined by the method as described by WATANABE and ULSTRUP⁴⁾.

The meat of the fish was then separated from bones and skin, and subjected to chemical and taste panel tests.

Water content was determined by drying it overnight at 105°C and salt content by the method of GREIG and SEAGRN⁵⁾. A glass electrode pH meter was used for pH measurements. 4 members of the VLRP laboratory staff formed taste panels to score the eating quality of the dried tilapia into the same 10 point hedonic scale as described above for the appearance and odor scoring.

Results and Discussion

Average values and monthly changes of retail prices Table 2 shows the averages of the retail prices, together with the results of statistical analysis of the data.

The prices of the salted-dried tilapia was 50% over the prices in April–May 1970 when THIELE^{*1} surveyed on the samples in various towns of Ghana. The average price of ₵1.10 (US \$0.96)*² per kg of the grilled products in Ghana was much cheaper than

*1 E. THIELE: Fish price survey of salted tilapia. Internal Report, Volta Lake Research Project, Akosombo, Ghana (1970).

*2 US\$1.00 = ₵ (Ghanaian Cedi) 1.15 in 1972.

Table 2. Average retail prices of unsalted-grilled and salted-dried tilapia at Akosombo and Agormenha market, Ghana, in 1971-72

	Unsalted-grilled tilapia	Salted-dried tilapia	Student's ^{*2} <i>t</i>
Average price /kg ¢, Ghanaian Cedi (US\$)	1.10 (0.96)	1.12 (0.97)	0.241 ^{*1}
Standard derivation	0.414	0.438	
Number of samples	42	73	

^{*1} Not significant.

$$^{*2} \text{ Student's } t = \frac{\bar{x}_1 - \bar{x}_2}{s \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where $\bar{x}_1$: mean of the prices of unsalted-grilled tilapia

$\bar{x}_2$: mean of the prices of salted-dried tilapia

N_1 : Number of the samples of unsalted-grilled tilapia

N_2 : Number of the samples of salted-dried tilapia

s : standard deviation of the whole samples

that (K^{*3} 1.16, US\$ 2.25) of similar products in Zambia in 1968-69⁶). This may be due to the competition from marine catch in this country which represented about two third of the dried fish sold at retail^{*1}. Another factor could be a higher salary scale in the larger towns of Zambia.

Contrary to the previous estimate^{*4} that grilled fish were 15 to 20% more expensive than salted fish, no significant difference in the retail prices was found between the two types of the products.

Monthly, the prices of unsalted-dried fish increased, though including a wide

Fig. 1. Monthly changes of retail prices per kg of unsalted-grilled and salted-dried tilapia. Each point is the average of 1 to 9 samples.

^{*3} K (Zambian Kwacha) 1.00=US\$ 1.40 in 1970.

^{*4} G. TAYLOR and J. McALISTER: A proposal for fisheries development at Kpandu Tokor, Volta Lake. Internal Report, Volta Lake Research Project, Akosombo, Ghana (1970).

fluctuation, from ¢0.80 per kg in August 1971 to ¢1.20 per kg in November 1972, while the increase trend was less pronounced (10%) in that of salted dried fish (Fig. 1).

Prices of both products were relatively higher in December 1971 to January 1972 than in previous months. Larger demand at the end and the beginning of the year might have pulled up the price.

Another factor which most possibly affects the price would be fish catch which in turn might be affected by rainfall. Fig. 2 shows meteorological conditions on Volta Lake. It is generally noted that fish catch from the lake is good at the beginning of high water level on the assumption that fish can not see nets well due to high water turbidity. The high water level generally starts in August after the onset of major rainy season in May–June. Then follows a period of settling and clearing of the water, through minor rainy season in September–October and in the following dry months, which correspond with a period of reduced catch.

The sudden drop in the price of unsalted-grilled tilapia in August 1972 corresponds to the season of good catch. This price decrease, however, was not observed in that of salted-dried fish. This may be that tilapia are primarily transformed into the salted-dried regardless of season because of easier processing. Only when fishermen find difficult to handle glut catch to be sun-dried in high relative humidity and salt is scarce because of difficulty in transportation, e.g. in the rainy season, grilled form of tilapia is prepared in larger quantity. As a result, the price of salted-dried fish are relatively stable due to uniform supply whereas the price of grilled fish are pressed down in August due to increased production.

In order to discuss the above relationships between seasonal price changes and fish supply in less assumptive way, detailed monthly data on tilapia catch from the lake should be essential. Unfortunately, such an information is unavailable at the moment.

Fig. 2. Meteorological conditions on Volta Lake.
Source: Meteorological Services, The Government of Ghana, Accra, Ghana.

Relation of price to fish size and organoleptic scores For both unsalted-grilled and salted-dried fish, the correlation between fish weight and retail price was negative and significant ($P < 0.001$). The smaller the fish, the more expensive in terms of price per unit weight. No significant correlation was found between the retail prices and organoleptic scores (Tables 3 and 4). The products of better quality would not necessarily enjoy higher prices.

Table 3. Regression analysis of the relationship of retail prices to other variables, for salted-dried tilapia

Variables	D.F.* ¹	a^{*2}	Regression coefficient b	Correlation coefficient r	Significance level P
Fish weight (g)	71	1.552	-0.002	-0.466	0.001
Appearance and odor score	71	0.902	0.027	0.110	NS* ³
Taste panel score	71	0.705	0.067	0.202	NS

*¹ Degree of freedom.

*² a of fitted regression function $y = a + bx$ where y is retail price.

*³ Not significant.

Table 4. Regression analysis of the relationship of retail prices to other variables, for unsalted-grilled tilapia

Variables	D.F.* ¹	a^{*2}	Regression coefficient b	Correlation coefficient r	Significance level P
Fish weight (g)	40	1.620	-0.002	-0.505	0.001
Appearance and odor score	40	0.881	0.030	0.133	NS* ³
Taste panel score	40	0.834	0.037	0.107	NS

*¹ Degree of freedom.

*² a of fitted regression function $y = a + bx$ where y is retail price.

*³ Not significant.

These results are similar to those observed on smoked tilapia on the market in Zambia.⁷⁾ This may indicate that the consumers in this West African country are, as in East Africa, not yet economically well-off to be able to be choosy for quality. Rather, the purchase pattern is controlled by available cash of the consumers.

Defect features in appearance and odor Of the appearance factors examined, all the samples of both products were neither infested with blow fly larvae nor contaminated by moulds (Fig. 3). In Ghana, any fish products with maggots are considered unfit for human consumption and it seems that strong quality control in this respect is voluntarily practiced by fish retailers. The grilled fish are generally brought into the Akosombo and Agormenha market mostly in 1 to 3 days after processing. If the storage and transportation from the processing site prolongs further, every night regrilling are usually done at stop-overs, so that no mould and insect larvae should be on the products on market days. Even with this precautions, the dried fish heavily infested by

Fig. 3. Distribution in the degrees of the defects of discoloration, bruise, brittleness, cleaning defects, fly larvae, moulds and off-odor for unsalted-grilled and salted-dried tilapia.

maggots were often observed at the wholesale level. The spoiled fish are however sorted out and either cleaned off the larvae or discarded if too heavily infested prior to retail. Losses as much as 30% of the dried products have been reported.⁸⁾ As for salted-dried fish, the salt content seemed to be high enough not to allow this defect become apparent.

On the grilled fish, bruise on skin was the most frequently noticed defects, having affected 20% of the samples. 10% of the samples showed moderate to significant degree of cleaning defects. 3% were excessively brittled and bruised.

Nearly 10% of the salted fish smelled significantly to excessively poor with fermented off-odor, particularly in abdominal cavity, accompanied by brown discoloration and meat softening seemingly caused by enzymatic actions. The characteristics of off-odor in the grilled fish were featured more by mushy to sweaty smell and quite different from that of the salted.

Average values of chemical, bacteriological and organoleptic variables and fish weight
Chemical, bacteriological and organoleptic values and fish weights of the two commodities are compared in Table 5.

Water percentage of the grilled fish averaged 57.6, which was significantly ($P < 0.001$) higher than that of salted fish. This high moisture content in the grilled fish should be the major cause of their fast deterioration once stored, although in the present practice the short shelf life is likely overcome by efficient marketing combined with tedious regrilling in order to maintain the quality down to retail. It appears difficult and, even if possible, time-consuming to reduce the moisture content lower than this level

Table 5. Comparison in chemical, bacteriological and organoleptic variables between unsalted-grilled and salted-dried tilapia

Variables	*1	Unsalted-grilled tilapia	N1*2	Salted dried tilapia	N2*3	<i>t</i> *4	Significance level <i>P</i>
Water content (%)	A SD	57.6 11.98	42	45.3 3.205	73	8.340	0.001
Salt content, wet basis (%)	A SD	— —	—	15.8 2.799	72	—	—
pH	A SD	6.92 0.276	22	6.58 1.526	40	1.032	NS*5
log (total viable counts/cm ² skin)	A SD	4.02 0.837	35	4.10 1.082	64	0.365	NS
Fish weight (g)	A SD	216.6 86.10	42	227.2 107.1	73	0.241	NS
Appearance and odor score*6	A SD	7.3 1.805	42	8.1 1.791	73	2.279	0.05
Taste panel score *6	A SD	7.2 1.198	42	6.2 1.314	73	21.76	0.001

*1 A: Average. SD: Standard deviation.

*2 N1 Number of samples of unsalted-grilled tilapia.

*3 N2: Number of samples of salted-dried tilapia.

*4 Student's *t*.

*5 Not significant.

*6 Excellent-10, good-8, fair-6, poor-4, half spoiled-2, spoiled-0.

by the present local processing methods.

The water content of the grilled fish in Ghana is about 3 times more than that in Zambian smoked products.⁷⁾ This higher water content might account for the absence of the infestation of dermestid beetles which prefer to feed on dried products like Zambian dried fish.* Higher relative humidity in Ghana should be responsible for the higher moisture content.

The salted fish were fairly strongly salted at 15.8% wet basis at 45.3% water. pH varied between 6.5 and 7.0. The value in the grilled fish was somewhat higher than that in the salted fish but the difference was insignificant.

Total viable counts per square centimeter of skin surface of both products were similar and about one twentieth of those of the smoked dried fish in Zambia. This hygienic situation of the grilled fish would have again been the result of the aforementioned efficient transport system and consequent short lapse between processors and retailers. As for the salted fish the high salt content would have kept the bacterial counts low.

Appearance and odor of the grilled fish were significantly ($P < 0.05$) inferior to that of salted fish but taste panel scores of the former was significantly ($P < 0.01$) higher by one point than the latter. The data suggest that an improved product should maintain the line of flavor feature of the present grilled fish, but with an appearance similar to

* D. L. PROCTOR: Tropical Stored Products Centre, Slough, Bucks, England, personal communication.

that of the salted tilapia. In any way, the average scores of both products fell within the range of fair to good.

The average weights of the two types of the dried fish samples resembled each other at around 220 g, although the standard deviations were large. Considering that the yield of the local products is about 50%, the average weight of the fresh fish processed into these dried samples should be about 500 g, which is generally regarded as normal individual weight of commercially captured tilapia from the lake.

Monthly changes in chemical, bacteriological and organoleptic variables Fig. 4 shows the monthly changes of water content, pH and total viable counts of the fish products. Water percentage of the grilled fish in September of both 1971 and 72 was about 20% lower than in other months. In this period, the relative humidity is just about the highest in the year. Accordingly, higher moisture content in the fish was expected if we follow the examples of the dried fish in Zambia⁷⁾. The present data contradict this expectation. Fishermen might have grilled fish for longer time to dry

Fig. 4. Monthly changes of water content, pH and total viable counts of unsalted-grilled and salted-dried tilapia. Each point is the average of 1 to 9 samples.

them to the extent that the products should stand with transport time under the unfavorable humid condition.

Water content of the salted fish remained fairly constant relative to that of grilled fish, within the range of 35 to 50%. The dry season of November to March little affected the water content of the products.

The seasonal changes of salt content in the salted fish are graphed in Fig. 5. The lowest salt content was recorded in February when the relative humidity is lowest, and the highest in September when the relative humidity highest. Several fishermen confirmed that in the rainy season they use more salt because of longer drying time and reduce the amount in the dry season when fish can be dried without difficulty, to economize salt.

Fig. 5. Monthly changes of salt content in salted-dried tilapia. Each point is the average of 2 to 9 samples.

Total viable counts of the grilled fish showed the lowest point in September and those of the salted in August. This period corresponds to the highest relative humidity (Fig. 2), which is a condition unfavorable to prepare dried fish with low bacterial counts. Fish traders might handle fish more carefully with frequent regrilling so that fish would not spoil before sale in this wet season.

pH of the grilled fish was fairly constant, while the value of the salted tilapia fluctuated widely.

Both appearance and odor, and taste panel scores of the grilled tilapia dropped to the

lowest in October 1971. This coincides with the highest in bacterial counts. The scores then increased till December and remained almost constant for the rest of the survey period.

As for the salted fish, appearance and odor scores showed a tendency of gradual increase while taste panel scores oscillated widely throughout (Fig. 6).

Fig. 6. Monthly changes of appearance and odor scores of unsalted-grilled and salted-dried tilapia. Each point is the average of 1 to 9 samples.

Overall, in August to October these variables most often showed either peaks or bottoms. This period is generally defined as highest in the relative humidity (Fig. 2), in lake water level and catch, and lowest in lake water temperature.* These factors might have influenced in one way or another physical conditions of processing fish as well as the fish themselves.

Relation of taste panel scores to other variables For the grilled fish, taste panel scores correlated significantly to appearance and odor scores ($P < 0.001$) and log (total viable counts) ($P < 0.01$). Water content, pH and fish size were uncorrelated with the taste panel scores (Table 6). Compared with the data obtained for split, dried, smoked tilapia on the market in Zambia⁷¹, the Ghanaian grilled fish has higher correlation between taste panel scores and appearance and odor scores. The Zambian data also revealed, on the products in that country, non-significant correlation between taste panel scores and bacterial counts, but significant ones of taste panel scores to fish size ($P < 0.05$), and to meat percentage ($P < 0.1$).

In contrast to the grilled fish, the salted tilapia demonstrated no significant correlation

* S. Biswas: Volta Basin Research Project, University of Ghana, Legon, Ghana, personal communication.

Table 6. Regression analysis of the relationship of taste panel scores to other variables, for unsalted-grilled tilapia

Variables	D.F.* ¹	<i>a</i> * ²	Regression coefficient <i>b</i>	Correlation coefficient <i>r</i>	Significance level <i>P</i>
Water content (%)	40	6.693	0.009	0.089	NS* ³
pH	20	6.220	0.580	0.181	NS
log (total viable counts)	33	9.449	-0.578	-0.430	0.01
Fish weight (g)	40	6.983	0.001	0.076	NS
Appearance and odor score	40	4.496	0.370	0.564	0.001

*¹ Degree of freedom.*² *a* of fitted regression function $y=a+bx$ where *y* is taste panel score.*³ Not significant.**Table 7.** Regression analysis of the relationship of taste panel scores to other variables, for salted-dried tilapia

Variables	D.F.* ¹	<i>a</i> * ²	Regression coefficient <i>b</i>	Correlation coefficient <i>r</i>	Significance level <i>P</i>
Water content (%)	71	6.357	-0.186	-0.455	0.001
Salt content (%)	70	7.260	-0.069	-0.147	NS* ³
pH	38	3.091	0.459	0.469	0.01
log (total viable counts)	62	7.864	-0.384	-0.249	NS
Fish weight (g)	71	5.505	0.003	0.238	0.05
Appearance and odor score	71	6.357	-0.234	-0.032	NS

*¹ Degree of freedom.*² *a* of fitted regression function $y=a+bx$ where *y* is taste panel score.*³ Not significant.

between taste panel scores and appearance and odor scores, and log (total viable counts). The taste panel scores, however, significantly correlated with water content ($P<0.001$), pH ($P<0.01$) and fish size ($P<0.05$) (Table 7). The results suggest that, to draft quality standards of these two products, different criteria should be adopted.

The reason why bacterial counts are useful indicator of eating quality for grilled fish but not for salted fish would be: Since the meat of the grilled fish are already cooked and fairly wet, it might be more susceptible to the contaminating bacteria, hence the good correlation. The meat of salted fish are more resistant to the bacterial attack, because not only the meat is uncooked and tough but also salt retards bacterial growth. Thus, even if there are high number of viable bacteria, they would not have been actively engaged in deteriorating fish meat, resulting in no correlation.

Although grilled fish are highly brittle and shows poor appearance, the grilled taste are generally preferred to salted fish. This might explain the non-correlation between taste panel scores and appearance and odor scores of the grilled fish.

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