UNDERUTILIZATION OF FOOD TECHNOLOGY RESULTING LOSSES OF AVAILABLE FOOD IN WEST AFRICA

Part 1.

A State-of-the-Art Paper

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PREFACE

A state of the art paper should strictly be an analytical review of existing data accummulated by research and practice on a given problem which sets forth established principles, indicates how and where they can be used and at the same time pointing out gaps in existing knowledge and how to close them. If these are the criteria to judge this paper then this is a special state-of-the-art paper.

It is special in the sense that there was very little or no accummulated research data on artisanal processing technology which we could review. The data had to be gathered first hand; but we shall still call this work a state-of-the-art paper because out of the collection we can identify deficiencies in local technologies about which we have humbly offered suggestions for future study.

It was originally planned to conduct this survey to cover a number of West African states but this could not materialize and methods and principles recorded here have emphasized the Ghanaian environment. This is not an unjustifiable emphasis however, because it is the technologies developed by Ghanaian fishermen which through their enterprise have spread all along the coastlands of the Gulf Coast of West Africa and therefore what is recorded about Ghana should invariably apply to other sister West African countries.

In a work like this it should have been natural to translate all the local fish names recorded into English or Latin equivalents. This has not been possible due clearly to gaps in our knowledge of the Ghanaian, if not in all West African, fisheries technology. We have as far as possible used English or Latin names names along with local names which are underlined in parenthesis but where a translation from local to English is not possible the local name has been used alone and underlined.

A problem that nearly ruined the start of this project was the fear of a possible duplication of local efforts. The time it took to resolve this problem cost us the best part of the fishing season which lasts from June to October. However, if after reading through this report the reader finds new sources of information not currently available in the published literature on Ghanaian artisanal fisheries technology then our efforts have been justified and we hope that more opportunities

will arise for more fruitful cooperation in the future.

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I. INTRODUCTION

Meat and fish are important sources of protein in the diet. Of the two fish is more important to the average West African because it is more available and cheaper than meat. The present supply of fish in Ghana is unable to meet demand for fish and fishery products and for this reason every effort is being made to avoid waste in the supply lines.

Artisanal fisheries in Ghana are responsible for up to 70% of local marine fresh fish supplies and in the absence of refrigeration facilities the Ghanaian women have developed certain simple processing technologies which have served to extend the shelf life and therefore the distribution base of fish supplies. Irrespective of their successes a cursory look at their operations reveals that there is considerable room for improvement to meet future challenges.

To do this requires that the traditional technologies presently in use be exposed to modern food science and engineering ideas to identify areas requiring upgrading and or innovation. This exposure is very much needed because not much has been done or written about these technologies. The little that is claimed to have been done may be found to have either no supportive documents or descriptions of procedures are woefully inadequate to their understanding to enable work to be initiated aimed at improving them.

Technologically Ghanaian fishermen have had a dominant influence on West African fisheries and fish processing for centuries; they are found all along the Central West African coast from Senegal to the Cameroons exporting their fishing techniques and fish processing technologies. Up to 1954 the bulk of the catch of marine fish in Liberia was landed by migratory Fanti fishermen from Ghana (van Pel, 1964) while fish smoking there was in the hands of Fanti women. A similar situation exists in Guinea, Sierra Leone, Togo, Benin, and the Ivory Coast (van Pel, 1964; Bonsu, 1976; Dykhuizen and Zei, 1970; Kagan, 1970). Indeed certain fish preservation techniques practiced for centuries in Ghana are just beginning to dawn in Nigeria (Bonsu, 1976).

Thus fish processing methods in use in Ghana are a good reflection of the situation in most West African countries. For this reason

it was decided to investigate the state of the art of Ghanaian fisheries and processing technologies to gather fundamental data on various operations and processes as a prelude to identifying constraints in the trade for future specialized study. These studies were conducted through direct observation and personal interviews with persons directly involved in the trade with on site verification in conjunction with limited microbiological and chemical assessments, in the laboratory, of the fish at appropriate points in the distribution lines.

II. STATE OF ARTISANAL FISHING IN GHANA

A. Fishing Operations

Along the Ghana seaboard fishing is carried out on all days except Tuesdays in most areas of the coast and on Thursdays for other areas especially in the Western sector of the coast. These days are considered rest days and neither fishing nor fresh fish marketing, by custom, is permitted. The days however are used to repair broken nets etc.

Traditionally the boats used in fishing are dug out wooden canoes (Fig.1) constructed from Odum and Kusia trees of various sizes. At sea they are traditionally manually paddled aided by sails but of late an increasing number of such canoes are being fitted with outboard motors. In addition there are also the larger motorized inshore wooden vessels that are built locally. These motorized canoes and vessels have a greater operational range than the paddled canoes and therefore have relatively better catch.

Fishing operations are mainly carried out during the night and early morning. The artisanal canoe fishermen usually set out to sea in the mornings at 7:00 am and return in the late afternoon between 3:00pm and 4:00 pm. To cast their net they depend on visual spotting of the shoals of fish in the surface waters. The nets used vary from gil-, ali-, poli to watsa nets. Line fishing is also carried out in areas where the sea is rocky or under conditions where the fishermen do not have sufficient money to buy a fishing net or where the boats are not large enough.

Long range operators using motorized canoes or wooden inshore vessels start their fishing expeditions in the evenings around 4:00pm equipped onboard with wooden packing boxes or crates of 30 kg. capacity with or without ice in their holds. One trip may last over night and thus return in the morning between 5:00am and 8:00am. or they may stay on for up to 3 or more days before landing. When an expedition is prolonged and no ice or insufficient ice is taken aboard the early caught fish may start deteriorating before landing.

B. Supply Pattern

Statistics on daily volume of canoe fishery landings could not be obtained because there was no satisfactory means of weighing the landings. More reliable figures about monthly landings of inshore motorized fishing vessels were available from the Fisheries Department and these were projected to obtain an idea of the probable canoe fishery landings (Table 2, Appendix 2). These data show an increasing volume of monthly landings up to 12,000 metric tons from July to October-which represents the main fishing season and thereafter dropping to a more or less uniform level of 4,500 metric tons through the harmattan months to the next season.

The landings were of mixed species and the quantity of each species landed varied with time and with location. However some species e.g. herring, buritto and anchovies etc. were landed all year round.

The distribution of fresh and processed fish products is completely dominated by women entrepreneurs. This distribution is centered on three types of markets - open beach markets, open town markets and from cold stores (where available). On the coast most consumers go to the beach to purchase fresh fish because they are not only reliably fresh, but cost much less. Cold stores were the least patronized on the coast. The pattern of patronage changes, however, as one moves inland from the coast in favor of town or public markets.

C. Fresh Fish Handling on the Beach

The long range motorized vessels arrive at the dock or ashore

with their catch either packed in wooden crates or bulked without ice in their holds. The discharging of the unpacked fish at the dock is by shovelling with metal or plastic buckets from the holds and the fish is brought to the surface by means of a human chain whose members pass the bucket from hand to hand with the final person emptying the bucket into empty wooden crates.

In some inshore fishing operations the net containing the catch is pulled ashore manually by a chain of men, women and children (Fig.2). At the shore time is allowed for all the sea water to drain off from the net. After this the net is opened out and all sea weeds and undesirable species like some crabs, jelly fish etc. are removed and thrown away; other edible shell fish (crabs and lobster) are separated from the non-shell fish and sold separately.

At the beach the sale of fish to wholesalers is not measured on weight basis, but by volume. Before the sale the price per unit volume measure is mutually agreed to between the fisherman and the prospective wholesale buyer. When an agreement is reached the fisherman walks over to the center of the heap of fish and shovels out the amount required by the individual wholesale buyers. The amount of fish shovelled out may constitute a part payment of monies advanced to the fisherman for various purposes such as the purchase of outboard motors, nets, etc. These women financiers may sell to other wholesalers or retailers who in turn retail to consumers either at the beach or transport them by lorries and trucks to open-air town or village markets.

Considerable exchange activity occurs on the beach as the wholesale buyers as well as the fishermen themselves sell part of their fish directly to housewives for home consumption. What is left unsold by the fishermen at the beach is carried to processing points, often near the beaches, which are operated by the fishermen's wives and relatives.

By a recent agreement (Bonsu, 1973) operators of inshore fishing vessels may keep their surplus unsold fish in government cold storage depots, where they exist, for a fee but only when the fish is in good condition.

The very large fish e.g. swordfish, eagle ray, etc. which cannot be carried by one person, when sold, are eviscerated and trimmed to remove the tails, fins and gills at the beach (Fig.3) then cut up into small pieces before packing into containers for transportation away from the beach to markets and to processing points to be processed by various methods to be described below.

In all these exchanges and preparations on the beach no special effort is taken to avoid contamination of the fish with beach sand which may carry high bacterial loads (see section II F.).

D. Fresh Fish Handling at the Markets

At small open air markets along the beaches or at larger markets in the towns and villages the fish are normally washed free of sand before offering them for sale. At the markets stocks of washed fish may be packed in wooden crates, aluminum trays or cane baskets covered with jute cloth and polythene sheets. From these bulk stocks are removed samples for display, on raised tables or on wide shallow wooden trays placed on top of cane baskets that contain their stock of fish. These display samples are uncovered and exposed to flies and to direct heat of the sun. From time to time as the skin of the fish dries either sea water or fresh water is sprinkled on the fish to keep the skin moist as well as cool.

Most fishmongers are now aware of the advantages of ice storage and whenever availalbe, and they can afford it, they buy ice flakes and mix into their bulk stock purchase in covered containers. Irrespective of this awareness some fishmongers in the markets do not buy ice flakes for use even when available.

E. Fresh Fish Utilization and Consumption

To get information on fish utilization, consumer preferences and dislikes, a random sample of people with varied social and economic backgrounds were interviewed. Occupationally 43% of the interviewees were marketing, 21% were producers/manufacturers, 24% were servicemen etc. (Table 4, Appendix 2); their marital stata were 70% married, 21% single, 9% divorced or widowed (Table 1, Appendix 2) while 63% of the

respondents were female and 37% were male (Table 1, Appendix 2). They were also from families of varying sizes (Table 3, Appendix 2).

Fish preferences of these people varied from area to area (Table 6, Appendix 2) and was observed to be related to the pattern of fish landings in their respective areas. People tended to prefer what was landed in their area. The most preferred fish species everywhere was the herring (Table 6, Appendix 2) which was landed at all seasons. This was followed by seabream which was preferred from Tema to Axim while Ada and Keta had for second preference tuna and anchovy respectively.

Preference for fishery products varied in descending order: smoked/grilled, fresh, fried, frozen, salted-dried fish (Table 6, Appendix 2). These fish products are used in soups, stews and the cooked ones were used directly with instant foods. It was also observed that a relationship existed between the food preparation and the type of fishery product used; certain fishes being associated with certain food preparations.

Dislikes for certain species of fish, which varied from place to place were mainly on account of poor taste, unpleasant smell and strange looks; other reasons offered were presence of bone and family taboo, etc.(Table 7, Appendix 2).

Due to fish scarcities. certain fish species that were underutilized are now eaten on a massive scale e.g. trigger fish, John Dory etc. The blue shark, eagle ray and the dolphin were not eaten at Axim only 5 years ago, but the people now accept it. The blue shark in particular was considered a taboo. The fisherman who caught one was confined in a sacred room, for 8 days, where certain rites were performed for him. Meanwhile, the blue shark was covered in white cloth to decompose at a safe spot on the beach.

There are however certain fish species whose consumption is very limited because they are not normally landed. For example at Elmina the electric fish (Epusuw) and Po aponkye are currently not landed. Scallops (Pectin Spp) though landed at Elmina, are not consumed much because they "make the stomach run" when consumed in moderate amounts. Large quantities of these scallops are landed, but are thrown away(Fig.4).

By tradition the Anlos in the eastern corner of the Ghana coast consider the octopus (Po sran) a taboo but they sell it to people outside their area. The eel and certain species of crab e.g. Calapa rubroguttata Herklots are similarly not eaten by the Anlos but these are eaten by the Fantis in the central and western areas of the coast. Everywhere the jellyfish is not eaten and thrown away when landed.

F. Quality of Fish Sold as Fresh on Ghanaian Markets

Dibbs (1961) reported of unhygienic handling conditions and contamination of fresh fish at the beach and also observed that without facilities even for short term storage of fish the chances of one being assured of fresh fish in reasonably good condition except in the season of heavy supply depended on timing and arrival at the beach market soon after the boats had landed.

In an experiment to test this microbiologically seabream was bought off the fishermen soon after landing and a further sample from the same batch was bought after passing through the normal beach handling procedures from the fish retailers some forty minutes later. The two samples were put into two separate clean polythene bags and placed in ice cooled flasks and transported to the laboratory. They were examined microbiologically for presumptive Coliform organisms as indicators of pollution on violet red bile agar incubated at 30°C for 48 hours. The results were as follows:

Direct from boat	-	3 presumptive coliform organisms/sq. cm. of skin
From fish retailer	-	532 presumptive coliform organisms/sq. cm. of skin

The disparity between the two estimates allowing for the time lapse of 30 to 40 minutes confirm Dibbs (1964) observations.

Using a freshness index developed in this work (Appendix 3), results quoted below (Table 1) show that the quality of fish sold as fresh on Ghanaian markets is very variable and may be pretty bad as one moves inland from the coast. However organoleptic results (Appendix 3) showed that fresh fish rejected on the basis of smell was, within limits, not necessarily inedible.

Table 1. Quality of seabream sold as fresh at Salaga Market in Accra and at Nsawan Market.

Sample #	Location	Of Transmission at 590 mm	Color Reaction	Bacterial Count/sq.cm. of skin
I	Teshie Beach	35	red	---
II	Accra	40	red	28×10^8
III	Accra	42	red	34.5×10^8
IV	Accra	44	red	15.4×10^8
V	Accra	41	red	4.7×10^8
VI	Nsawan*	51	yellow	---
VII	Nsawan*	49	yellow	---

*25 miles inland from Accra.

III. FISH PRESERVATION AND PROCESSING TECHNOLOGIES IN GHANA

Introduction

Fish is a highly perishable commodity. In countries in West Africa and Ghana in particular where the traditional people who handle fish have no refrigerator or freezer storage facilities, ways have been evolved by which fresh fish in excess of immediate consumption which would otherwise spoil is preserved into other forms of fishery products to extend the supply base. These preservation methods evolved in Ghana, particularly among the Fantis and Ewes, have been adopted by fishermen in other West African countries through the enterprise and industry of the Ghanaian fishermen who have migrated to these countries in search of greener pastures.

Though these preservation methods have been in existence for centuries, some of them have still not been exposed to the search-light of food science and technology. This section of the report is aimed at describing the various methods used in Ghana and by reference in other West African countries to preserve fish.

A. Fish Smoking Technology

Easily the most important method of fish preservation in Ghana is by smoking. Several oven designs are in use and these may be grouped

into open and closed oven designs. Within the open designs the shape of the oven may be cylindrical or rectangular and may be of either mud or metal construction. The closed oven type in use is the Altona oven presently being extended at Elmina by the International Development Research Center of Canada (IDRC). The Adjetey closed oven introduced some time ago is abandoned due to expense and operational difficulties.

(a) Types of Ovens used in Smoking

1. Open ovens

(i) Cylindrical mud ovens

These are the traditional ovens (Fig.5) and measure in diameter from 4 ft. to 6 ft. and about 3 to 4 ft. high. Those built in the central and western areas of the coast of Ghana have vertical erect walls while the eastern sector ovens have negatively sloping walls with the top having a slightly wider diameter than the bottom. The inside of these ovens is divided into two halves by a horizontal layer of evenly spaced out sticks or iron bars about a foot from the top. The ends of these wooden or iron bars may be either buried inside the walls or may rest on a ledge created by reducing from the inside at an appropriate level the thickness of the upper half of the circular wall (Fig.6). The upper half of the oven created by the partition constitutes the smoking compartment while the bottom half is the combustion chamber with a side opening through which firewood is introduced and burnt to generate both heat and smoke.

The cylindrical mud ovens in the eastern sector are generally much smaller in size than those found in the central and western areas and are characteristically covered with a woven conical thatch cover.

(ii) Rectangular mud ovens

These rectangular mud ovens 8' X 5' X 3' high are found at Brewire near Axim, Keta, Senya Bereku and at Chorkor - Accra. At Chorkor-Accra these ovens consist of only the bottom combustion chamber built to fit a rectangular framed wire mesh 8' X 5' X 1/3' high introduced by a UNDP

Fisheries Expert in the early seventies. A number of these framed wire meshes when stacked one on top of the other constitute the upper smoking chamber (Fig.7). The lower mud combustion chamber has two side openings through which firewood is introduced and burnt to generate both heat and smoke.

(iii) Cylindrical metal ovens

These are made from one 1/2 - 44 gallon steel drums or from two opened out 1/2 - 44 gallon drums joined together to form a larger cylinder (Fig.8). Like the mud ovens they are divided into two compartments by a horizontal layer of wooden or iron bars evenly spaced and stuck through the wall a short distance from the top.

(iv) Rectangular metal ovens

These rectangular metal ovens were found only at Tema and are constructed from cut and expanded 44 gallon drums. There are two types (Fig.9) - a type which has both fuel combustion and smoking areas as described above and a type which corresponds to the Chorkor rectangular mud oven and used only for drying fish, and henceforth to be described as a rectangular drying oven.

2. Closed ovens

(i) The Altona oven

The Altona oven (Fig.10) consists of a closed smoking chamber with a top chimney and may be built of bricks or sheets of metal sitting on top of a lower combustion chamber, usually of brick construction. The opposite side walls of the smoking chamber has a number or corresponding wooden or metal rails supporting an equal number of wire mesh frames (shelves) which may be drawn in or out of the smoking chamber from a front door.

(ii) The Adjetey oven (Fig.11)

This oven is similar to the Altona oven except that it is of a heavy metal construction and the combustion chamber is not located directly below the smoking compartment but is located several feet to the side and connected to the latter via a flue. The part of the flue

inside the smoking chamber ends with a baffle plate which spreads out the smoke in the smoking chamber.

(b) Preparation of Fish Before Smoking

Presmoking treatment of fish in Ghana involves scaling, gutting, washing with either fresh or sea water, surface moisture drying and grilling to firm the skin. However different fish species are treated differently at different locations and also according to the conditions of the fish.

The fish to be smoked may or may not be scaled depending on the species and size. Specifically herring and Ilisha africana (Nkanfona) are found to shrink when scaled before smoking and are therefore not scaled. Small fish like anchovies are similarly not scaled. All large fish with scales are usually scaled before smoking.

The fish to be smoked is also generally not gutted except when it is known to have bitter entrails or the latter is developing some foul odor which may spread into the flesh during processing and in these respects Buritto Sp and Kokona are gutted at Axim before smoking. Irrespective of any condition small fish are not gutted.

After scaling and gutting as appropriate the fish is washed and exposed to the atmosphere to dry off surface moisture for one or more hours. After this drying, at Axim, medium sized fish such as Sukwei, Spanish mackerel (Saforo) and Ilisha africana (Nkanfona) are grilled in a single layer on one oven with charcoal fire to firm the skin before subjecting to dense smoke treatment in a second oven. At Apam and other places, however, grilling appears to precede the smoking of all medium to large sized fish.

(c) Smoking Processes in the Various Open Ovens

For small fish smoking the wooden or iron bar base supports of the smoking compartments are first covered with a mesh layer of coconut leaf midribs (Fig.12). Over tis mesh of midribs is arranged a layer of the surface dried small fish. A second mesh of midribs is placed over the first layer of fish to separate the latter from a second layer of fish and so on till the smoking compartment of the oven is full. The top layer is finally covered with coconut palm fronds (Fig. 13). Strong heat and light smoke

are finally applied to the fish from a small heap of burning firewood in the lower combustion section about 3 to 4 ft. below the upper smoking compartment of the oven till the fish is cooked and moderately dried in about ten hours. The burning firewood is at this point removed from the combustion chamber and the fish allowed to cool. When sufficiently cool all the layers of midribs except the bottom layer are removed.

If large fish usually arranged in a single layer, were being smoked this would be the time to also turn them over.

The heap of fish in the oven is next covered with cement paper overlain with coconut palm fronds (at Axim) or with plywood or iron roofing sheets (at New Takoradi) and the fish heated a second time at a moderate heat with high smoke density for a further 10 hours.

This moderate heat is not generated deep inside the combustion chamber, but close to the open entrance where the breeze assists to blow hot air through the heap of fish. When the fire is made inside the combustion chamber it is known that the effect of the breeze is eliminated and there is poor distribution of the heat and only the back lot dries.

At Senya Bereku the use of coconut midribs in the oven is optional since the fish are arranged on a wire mesh in a single layer at a time. After applying heat to cook as described above the cooked and moderately dry fish in the layer is pushed to one side of the smoking chamber. This process is continued till the oven is filled with cooked and moderately dried fish. The top of the oven is next covered with either plywood or iron roofing sheets and a dense smoke and moderate heat generated in the combustion chamber below the heap of fish till from the appearance and feel it is judged to be done in about 24 hours. The smoked fish is generally judged to be dried when no drippings fall into the fire below.

Large fish are not normally arranged in layers for smoking but when they are, which normally does not exceed 2 to 3 layers, small sticks instead of coconut midribs are used to separate the layers of fish. At Tema where two types of rectangular ovens are used small fish are not arranged on coconut midribs but are arranged in a thin layer on unframed one inch wire mesh sheets that are cut to fit the rectangular drying ovens.

On these sheets of wire mesh the fish are initially exposed to the atmosphere to dry surface moisture for about an hour. After this these sheets of unframed wire mesh with fish are piled one on top of the other (Fig.14) up to six sheets deep and separated one from the other by thin sticks. These are heated over a rectangular metal drying oven to grill the fish for two hours. On this drying oven vertical cooking of the fish is uneven due to a considerable waste of heat and therefore after two hours the sheets are rearranged to bring the top sheets down and the bottom sheets up for a further hour to effect uniform cooking. After this the uniformly cooked fish on the wire mesh sheets are poured together into the smoking compartment of a rectangular smoking oven and covered with a dry jute cloth. Dense smoke and moderate heat are then applied from below till the fish is done.

It is claimed that when the fish is left exposed to the atmosphere to surface-dry for much longer than one hour before drying on the oven the resulting smoked product is bad tasting but firm while short periods of exposure for surface drying result in tastier but fragile products. Large fish are similarly smoked but in thin layers according to above procedures following a short period of exposure for surface drying.

The procedure for smoking fish at Chorkor-Accra is basically the same as at Tema. Here the small fish are arranged in a thin layer on a framed wire mesh and a number of these framed wire meshes is stacked one on top of the other (Fig.7) for up to ten frames high to form a chimney over the mud rectangular drying oven. On this oven it is not only heat that runs through the chimney but there is also a unidirectional flow of smoke which because of the wide open top is not retained in the oven long enough to create a dense smoke atmosphere to envelope the fish with the result that the underside of the fish receives much more smoke than the upper side.

Drying throughout the chimney column is also uneven and after two to three hours drying and smoking the wire mesh frames are rearranged so that the top frames with the least dried fish are placed at the bottom and the bottom frames moved up to the top. At the same time opportunity is taken to halvethe number of frames and at the same time turn the fish over

for the less smoked upper part to face downwards. All this is achieved by pouring the contents on two wire mesh frames onto single empty frames (Fig.15) and rearranging the frames on the oven again for a final application of low heat and dense smoke. The reduction of the number of framed wires, or chimney column, by half improves the drying efficiency of the subsequent low heat applied.

Generally, if very dry smoked fish is desired a heap of smoked fish may be left covered on the oven for up to six months with occasional application of low heat.

(d) Smoking in the closed Altona oven

This type of oven is in use only at Elmina where the IDRC is extending it to a local cooperative society. Heat and smoke are generated in the bottom combustion chamber and these rise into the smoking chamber to heat fish arranged on shelves of wire mesh frames.

The oven provides a uniform distribution of smoke but the distribution of heat is uneven. There is found in use a back/front and top/bottom difference in heating necessitating only a rearrangement of the shelves of fish during the smoking process.

(e) Smoking in the closed Adjetey oven

The disadvantage of this oven aside from its high cost is that inadequate heat enters the smoking chamber and the fish does not dry enough by local standards.

(f) Packing and storage

Usually the smoked fish is left on the oven overnight to cool before packing into cane baskets.

After cooling small sized smoked fish may be left on one oven and more from other ovens added to form a heap which is then covered on the sides and top with cement paper followed by a sheet of polythene or tarpaulin (Fig.16). In this way it is claimed the bulk of the fish stores well for months. However, it is found that the top layer is often infested with adult insects (bugs) and their larvae. When upon inspeciton this

condition is noticed the top covers are removed and the heap is left exposed to the heat of the sun which kills the insects; alternatively the heap my be heated from below or smoke from burning red pepper may be passed through the heap for the same killing effect. In other cases of storage the covered fish may be packed in small covered cane baskets; several of these baskets may be collected together in a heap and similarly covered with tarpaulin or polythene in the open.

(g) Fuel used in fish smoking

Hardwoods, e.g. nim, esa, olanta, mbir, are generally used to smoke fish. However, there are special materials that are burnt in the final stages of the cure to impart bright smoke colour to the fish. For the Accra and Central regions of the coast sugar cane pulp, and for the Ada and eastern areas wet grass are burnt to generate smoke for a final touch of bright mellow colour to the smoked fish.

B. Salted and Fermented - Dried Fish Technology

The salting process is fermentative involving halophytic micro-organisms. The fish product resulting from various modifications of the technology is given the general name momone. Momone is mainly used in small amounts as a flavoring sauce in stews and soups.

(a) Containers used for salting

Containers generally used for salting are wooden barrels of various sizes. Recently the range of receptacles used has been extended by lining baskets, steel drums, etc. with cement. The center for this innovation, which is localized, is at Elmina under the auspices of the International Development Research Center of Canada (IDRC). Unlined steel drums are not normally used but at New Takoradi it was found to be used to salt trigger fish which it is claimed is not affected by the rusting of the barrel on account of its tough protective skin. Here open square concrete structures are used to salt fish while at Elmina, IDRC project site, such concrete structures are used only for the cleaning of the fish.

(b) Fish used for salting

Fresh fish from the sea is not used directly to make momone. It has to be left for eight to twenty-four hours to soften depending on the type of fish. Because of the normal need to leave the fish to be salted to soften for so long fish which is left unsold at the end of the day or cannot be processed by other methods naturally constitute good material for making momone. Early caught fish at sea that is landed soft fall in this category and is used immediately to make momone on landing. Not all fish,however, can be processed into momone; at Apam, Daa is not used while at Axim Kokona, Poanoma which is variously called Etuhoo, Apatabiako or Ntere are not used.

(c) Preparation of the fish for salting

After enough time has been allowed to soften the fish is washed in either fresh or sea water in large wooden trays at Apam, in concrete structures at Elmina or in any other suitable container at other places.

Depending on the type of fish scaling may be done while the fish is stiff or delayed till when it is soft. For example Burrito (Boi boi) is scaled while stiff because it becomes too soft to handle later; all other species may be scaled when soft.

Small to medium size fish are generally not gutted but the trigger fish (a medium sized fish) is always gutted because of difficulty with salt penetration through its intact skin; furthermore, if it is not gutted it is found that oils around the gut color the underbelly of the dried fish yellow. Large fish are always gutted and further split into two for better salt penetration.

(d) Salting procedures

The fish as prepared above is next rubbed or covered in dry granular salt. The gills and, in the case of gutted fish, the opening in the underbelly are next stuffed with the dry salt. The bottom of the barrel in which the curing is to be done is next covered with a thin layer of dry salt and the prepared fish arranged neatly in a single layer on it. Dry salt granules are sprinkled over this bottom layer of fish and a second layer of fish arranged on top of it and so on until the barrel is filled. As much as 8 gallons volume measure of dry salt may be used per barrel. The mouth of the filled container or barrel

is next covered tightly with a jute bag or cloth overtopped with baskets or trays at Jamestown-Accra (Fig.17) and other places, or with a small weight of beach sand at Apam, to keep off flies which damage the fermenting fish with their larvae.

Salting is a dehydrating as well as a fermenting process and as the curing proceeds water exudes from the fish by exosmosis into the barrel. Thus the bottom layers of fish may be in this liquid while the upper layers may be dry. If the liquid exudate, which is highly salted, is desired for further curing after the momone is removed, it is protected from external contamination by covering the mouth of the barrel or container tightly with polythene sheet. At Elmina only fish liquid from trigger fish curing is reused a second time before discarding. All other fish liquid exudates are discarded because it is stated that their reuse gives poor cure. At Apam, Winneba and Senya Bereku only the exuded liquid from a twenty-four hour cure is reused several times and discarded when excessive oil and other substances accummulate indicated by the development of malodor.

(e) Duration of salting

The fermenting fish may be left for periods ranging from twenty-four hours to several months depending on:

1. Type of species
2. Size of fish
3. Market demand
4. Quality desired
5. Operator

It is difficult therefore to give a time period characteristic of a given location for salting all types of fish. Generally small fish are salted for shorter periods than large fish. At Elmina fatty fish are salted for more than three days, otherwise ther resulting product is found to be brittle. The trigger fish is salted for two to three days. At Winneba Kookoo and Osorpa are salted for more than three months but can also be removed after twenty-four hours for drying.

The herring is not used to make regular momone. The type of momone resulting from the herring is called saafese or fofose and is cured for any period from three to ten months and is not dried subsequently.

(f) After salting processes and drying

After the curing period it is normally found that the fish is dirtied with fish exudate solids. This dirt described as "red stuff" in Apam and as "oily stuff" in Winneba is scrubbed with a sponge (a piece of netting material) and washed with sea water (Winneba, Apam) or only washed with sea water (Apam, Jamestown-Accra) or with the fish exudate (Jamestown-Accra).

The strong scent of the freshly salted (fermented) fish attracts blowflies which lay eggs in any openings found on the salted fish such as the gills and the opened underbellies. The larvae from the eggs then invade the flesh and this lowers the quality of the momone. To prevent this the gills and the opened underbellies are stuffed again with dry salt before exposing to dry in the open sun.

At Axim the salted fish are dried on a raised flat platform (3 ft. above ground) (Fig.18) and are covered with a netting material to prevent vultures from stealing them. At Winneba the salted fish are dried on either coconut palm fronds or on large beach rocks. At Ada they may be dried on the sloping side of special smoke oven thatch covers or at Elmina on newly introduced IDRC raised platforms similar to those traditionally used at Axim. Drying of the salted fish normally takes 24 to 72 hours. All drying requires regular turning over to effect uniform drying.

(g) Quality determinant of salted fish

The quality of the salted fish, it is claimed, depends on the amount of salt used and the time it takes to cure it as well as on the degree of stiffness of the fish used in the salting. The more salt and the longer it is left in the cure the better the quality. It is here stressed that if the fish is left for long periods in solution the salt concentration must be kept high. Insufficient salt results in a partially putrified product whereas insufficient periods of exposure or the use of fresh relatively stiff fish results in a hard,less tasty product. A good quality momone, it is claimed, should dissolve or break up easily in stews and soups. Hence the quality of momone is associated with softness to the touch which is a property used to indicate the end of a properly cured momone.

(h) Packing and storage of salted dried fish

Momone or salted dried fish is hygroscopic due to its high salt content which varies between 11 and 16% (Nerquaye - Tetteh et al, 1977). Thus it has to be protected from the atmosphere to keep its moisture which normally varies between 49 and 62% (Nerquaye - Tetteh et al, 1977) stable. The small salted fish are normally packed in cane baskets that are covered either individually or in groups with jute cloth over-topped with polythene sheets. In other cases, such as with the trigger fish, the individual fishes are arranged on raised platforms in concentric circles round a central point with the outside circle extending to several feet in diameter. A second layer of concentric cirles is built upon the first and so on to a height of several feet (Fig.19). The top and sides of this stack is then covered round in jute cloth followed by a waterproof cover of polythene sheet and tied. (Fig.20).

Larger, softer and wetter momone is packed in cane baskets with each layer sprinkled with dry salt till the basket is filled. The top of the filled basket is similarly covered with paper followed by a sheet of polythene. This may be described as an aging process. It must be remarked here that all the covered stacks and packages are kept in the open without a roof cover.

C. Non-salted Dried Fish Technology

Fish may also be sun dried without salting. This method of fish preservation applies particularly to small fish, e.g. anchovies, Burrito Spp, etc. These are fishes that can be dried quickly before fermentation or bacterial deterioration sets in. These small fishes are usually spread in thin layers on the beach sand (Fig.21) and normally dry within 24 to 48 hours. The dried products are packed into cane baskets and stored in the same manner as described above. Larger fish require prior partial dehydration by salting using methods already described above before drying in the sun.

D. Fried Fish Technology

Fried fish is usually eaten with ready to eat foods, e.g. Kenkey, in Ghana and because of its high demand value it is not normally found packed in heaps awaiting sale. For this reason its importance as a fish preservation method has been underestimated in Ghana. A survey conducted in the present studies clearly reveals it as a highly important method of fish

preservation in Ghana. (Appendix 2, Section 3.1.2)

Coconut oil and palm kernel oil are the types of oil used to fry fish in Ghana. To fry fish, oil is placed in a medium sized aluminum tray on a coal-pot and heated till hot. The right degree of hotness or temperature is indicated by the charring of slices of fresh onion or pieces of peeled fresh cassava tuber placed in the heating oil.

The fish to be fried is scaled where appropriate and gutted along with the gills and then washed in fresh water. The washed fish is arranged in a single layer on a flat clean surface or on a clean wire mesh for surface moisture to dry. When fully dried both sides of the fish is dusted with wheat flour before placing in the hot oil to fry. The fish is removed from the oil when it is uniformly browned.

IV. DISCUSSION OF GHANAIAN ARTISANAL FISHERIES AND PROCESSING TECHNOLOGY

A. Artisanal Fisheries

Contributing to long search and delays at sea which results in the spoilage of early caught fish, due partly to inadequate use or non-use of ice at sea, is the method used to spot the fish. The artisanal fisherman relies on visual spotting of the upper layers of shoals of fish which may easily elude him. The Fisheries Research Unit - Accra has tested acoustic fish finding and light attraction methods by which fish in deeper waters may either be detected or brought to the surface to be spotted and harvested (Ansa - Emmim, 1973). There are problems however before these new methods may be adopted by the artisanal fisherman because of the need to use a net different from his traditional net (Ankama-Okai, 1973) which may require some external finance or credit.

There is also the problem of canoe paddling which is not only tedious but a slow way to land fish quickly. After harvesting it is essential, if the fish is not to spoil to land it quickly. This again requires heavy investment on motorized equipment which again requires the availability of credit facilities.

There is in Ghana an Agricultural Development Bank from which credit may theoretically be obtained but irrespective of this facility credit is still out of the reach of the poor artisanal fisherman.

An afternoon visitor to a beach fish landing site is likely to see a train of men, women and children slowly pulling a long 1" nylon hauling line attached to a net cast way out at sea (Fig.2). This is a traditional way of hauling fish which has not changed for ages. It is both tedious and slow. A simple way to improve or remove the drudgery and assist with speedier fish landing is to adopt a simple pully mechanism with a good mechanical advantage. Quicker landing of netted fish will reduce the amount of struggling the fish have to endure before death. This is necessary because the greater the struggle the quicker the onset and resolution of rigor mortis and therefore the faster the onset of bacterial deterioration of the fish; fish will suffer bacterial attack only after rigor mortis has been resolved.

B. Fresh Fish Handling

It has been repeatedly stated by various authors (Dibbs, 1964; Kagan, 1970; Amu, 1973; Bonsu, 1976) that fresh fish is not well handled and stored in Ghana. The whole problem is recognized to be centered on the inadequate use of ice. This problem is still unsolved and therefore requires attention. Because of scarcity of ice the little there is is too expensive for the small scale fisherman.

Without ice cooling at sea and with subsequent exposure to the sun at marketing centers the fish temperature, which may be already high (5^{o}-19^{o}C) before it reaches the market, quickly increases to anywhere between 14^{o} and 23^{o}C (Trenning, 1969). Hence some of the fish sold as fresh on Ghanaian markets may be in really bad states before the consumer purchases them (see Table 2, Appendix 3).

Covered sheds are provided in some markets but these are not sufficient. This facility deserves to be expanded and extended to other areas.

It is not sufficient to take ice to sea; it must be adequately protected. The inshore fishing vessels have holds which are well insulated but the artisanal fisherman does not have sufficiently insulated boxes for holding his ice and fish at sea and over the bargaining period at the beach markets. This need deserves attention.

C. Quality Control and Fish Freshness

The need has been expressed (Bonsu, 1973) for an objective method for assessing the quality of fresh fish going into freezer storage and onto the markets. One cannot agree with her better. The current methods of relying on physical examination of the gills, eyes, color of the skin, firmness to touch are not considered reliable methods for assessing fish freshness.

Examination of seabream sold as fresh on Ghanaian markets using a new method developed in this work showed great consistency of data and indicated considerable variation in fresh seabream quality offered for sale to Ghanaian consumers. This new method should provide a simple, inexpensive (in terms of material used), reliable and objective assessment of seabream freshness.

The method may be modified to cover other fish species.

D. Utilization and Consumption

Poor taste, unpleasant smell, strange appearance, presence of bone (Appendix 2, Table 7), taboos and medical problems are some of the reasons listed to be responsible for the underutilization of fish in Ghana. Some of these reasons e.g. taboos, affect larger groups of people and therefore larger markets than others. The organoleptic, physical and religious objections can be removed by the application of food science and technology ideas and this is recommended to extend the consumption base of the underutilized fish.

There are other problems of underutilization due to fishermen not landing the fish for one reason or the other. The electric fish for instance can be conveniently handled by using rubber gloves at sea.

Reasons must be found why the scallop (Pecten Sp) which is considered very good to eat elsewhere in the world gives medical problems in Elmina. Could it be due to the way it is prepared?

Ways must also be found to use trimmings of large fish e.g. fins, tails, gills presently thrown away.

E. Fish Preservation

(a) Fish smoking

1. Smoking ovens

The volume capacity of traditional ovens is small and there is

a need to increase them. This need has largely been satisfied by the use of the Altona and improved rectangular ovens at Chorkor-Accra. Inspite of this improvement, there are other technical difficulties to be overcome. For instance heat distribution is not uniform throughout the Altona oven necessitating a rearrangement of shelves both in the vertical and in the horizontal directions. Similarly the improved rectangular oven in use at Chorkor-Accra appears to suffer from a deficiency in both heat and smoke distribution and requires turning as well as rearrangement of the frame before a uniform cure can be realized.

From these accounts it is clear that improvements are still needed in oven designs to provide for even heat and smoke distribution to take drudgery out of hot smoke fish curing.

2. Fuel used in fish smoking

Fish smokers know in each locality what fuel is good for the trade and these are invariably hardwoods. Kagan (1970) has suggested the use of sawdust and shavings from saw mills to generate smoke; though this suggestion is good some amount of research has to be conducted to find a means of burning the sawdust fast enough in the ovens to generate the desired heat and smoke for the cure.

Investigation may also be required to substantiate the claims given to certain plant materials e.g. sugar pulp to generate special bright smoke colors. If the burning of sugar pulp having high sugar content gives a rich smoke color to smoked fish it might mean that the burning of the sugar produces a lot of phenolic compounds which are known to be responsible for smoked fish color. If this is true then it may be possible to dip other plant materials in crushed juice of chewing sugar cane,which is now wasted,to take advantage of the sugar present in the juice.

It is also pertinent to consider investigations to place new smoked fish products, with modified smoke flavor and taste, on the market. The use of brine has been suggested by Kagan (1970) for this purpose.

3. Packing and storage facilities for smoked fish

The present packing and storage facilities are unsatisifactory. In the first place the smoked fish must be stored under a closed roof

cover to avoid the deleterious effect of diurnal changes in atmospheric conditions. The reason for the frequent infestation with insects noticed in the top layers of a packed heap of smoked fish may be due to the absorption of moisture from the atmosphere and also to a greater supply of oxygen to the top than to the more tightly packed bottom layers. Indeed a close examination of the top layers of a packed heap revealed a fading of the smoked color due possible to oxidation of phenolic compounds responsible for the smoke color. The effect of these atmospheric conditions which clearly lead to a lowering of quality indicate the need to pack and store the smoked fish under greater airtight conditions.

Van Pel (1964) has suggested the storage of smoked fish in the dark but the rationale behind the suggestion was not given. We suspect it may be related to the protection of smoke color. This may be investigated with profit.

(b) Salting and drying of fish

Great concern has been expressed by Kagan (1970) on the use of deteriorated fish for making momone (salted dried fish). This concern can be very real as already indicated, momone processing is based on the resolution of rigor mortis which is a condition which coincides with the beginning of bacterial activity in the fish (Hess, 1950). Technologists should therefore aid momone processors by developing practical methods to determine the right point at which rigor mortis has just been resolved in the fish and therefore good for momone processing. For the present momone processors judge this by softness to the touch which is a method we have already indicated, with respect to freshness, as too variable and therefore unreliable.

A by-product of salting which is largely wasted is the liquid exudate of the process. This is the basis of a product called Nouc-Mam commercialized in the Ivory Coast (Bonsu, 1976). Some preliminary work has been conducted in Ghana with good results (Kagan, 1970). This work deserves to be continued to utilize this by-product which is presently wasted.

Though technology of fish salting is well developed it requires understanding of the mechanisms underlying the various stages in the processing in order to improve on it. For instance, some localities will re-use the liquid exudate from a 24 hour cure and continue to re-use it subsequently in 24 hour cures at a time until the liquid begins to develop malodor usually after 2 to 3 re-uses due to microbial action.

The salting is a homofermentative process involving some micrococci (Nerquaye-Tetteh, et al 1977) which are selected at specific high salt concentrations. During salting the high salt concentration favorable to the micrococci gets diluted for 2 reasons:

(1) dilution by exosmosis of water from the fish and

(2) salt absorption onto the fish.

Without measures to retain the salt concentration high spoilage microbes other than the micrococci, previously excluded are now able to grow in the nutritively rich liquid exudate to develop the observed malodors which derive partly as amines from protein breakdown.

Presently, there is considerable contamination of the exudate by handling during the removal of the salted fish for drying. Methods must therefore be developed to avoid touching the exudate to cut down its contamination and at the same time care taken to maintain its salt concentration high to prolong its useful life.

Efforts must also be made to introduce brine salting more actively in the trade.

Salted fish is very hygroscopic - it readily absorbs moisture from the atmosphere which is detrimental to its shelf life since the absorbed moisture dilutes the preservative effect of salt on which its storage life depends. It will require water activity studies to identify an optimum salt concentration for cured products with minimal hygroscopicity.

Chemical reactions leading to the browning of the salted dried fish as may occur on the underbelly of the salted dried trigger fish may be investigated.

It is realized that not all fish species can be processed into momone. For instance Daa is not used at Apam while Kokona and Poanoma are both not used at Axim and to some extent the herring is not used to make up regular momone. It will be worthwhile to find out why this

is so and to see whether some way could be workout to process them into regular momone.

(c) Sun drying of fish

The practice of drying fish on beach sand or on the ground which we have indicated may be highly contaminated, should be discouraged and the processors be encouraged to dry them on raised platforms as is done in some areas.

(d). Frying fish

Previous reports (Kagan, 1970) and common opinion indicate that fish frying as a method of fish preservation is unimportant. Present results from extensive surveys show that this opinion is not justified. The survey shows that it ranks third in importance behind smoking/grilling and fresh fish (Appendix 2, Section 3.1.2). This method therefore may benefit from exposure to research.

F. The Artisanal Fish Processor and the Reception and Movement of New Ideas

The artisanal fish processor will not readily receive new ideas unless it is within his technical competence or skill, financial means, cultural values or standards and of proven economic advantage among others.

An advanced smoking oven, the Adjetey oven, for instance was rejected by fish smokers in Ghana because it was expensive and could not produce smoked fish which was dry enough to meet their cultural standards.

Similarly the introduction of an Altona oven in the village of Biriwa was not sucessful because unit cost of the oven was too expensive. A thorough investigation did not support Kagan's (1970) report that the rejection was due to processors' preference to bend over their ovens instead of standing upright.

Many instances of good technological ideas are available unshared in scattered isolated areas partly because of a communication gap between

processing sites and partly because of the inability of processors to readily appreciate the technical, and nutritional advantages in other peoples' methods even when these methods are operating in the same locality.

For instance the drying of salted fish on raised platforms is not new to the trade in Ghana; it is the practice in Axim and other places but it required IDRC technical men to locate and extend it to Elmina processors. Similarly it required a trained mind to perceive the potentialities of a rectangular oven and unframed wire mesh as are used by Ewes in fish smoking to suggest a framed wire mesh to Chorkor-Accra fish smokers for use along with their traditional rectangular ovens.

We agree with Kagan (1970) therefore, that it is up to research workers to follow the trade at all levels of production, processing and storage to choose the most useful methods for extension to the trade as a whole.

V. LIST OF RECOMMENDATIONS

A. Fisheries and Fish Handling

(a) To improve upon the seasonal pattern of fishing, artisanal fishermen must be assisted financially to acquire fish detection devices such as echo sounders and light-fishing equipment that are available on the world market.

(b) For speedy delivery of fresh fish in good condition at reasonable cost to the consumer artisanal fishermen must also be assisted to acquire their own outboard motors. In this way they may operate independently of middlemen and thereby sell directly to the consumer at lower prices.

(c) Fish inspection and quality control measures must be instituted to protect the consumer.

(d) Investigations must be conducted to see if a mechanical device could be fabricated to aid human labor used to pull nets to the shore.

(e) Engineering ideas should also be applied to develop containers with good insulating properties, using local materials, to assist with ice storage of fresh fish at sea, on the beach and at the markets.

B. Processing Technology

(a) Under-utilized fish species

1. Extend food science and technology ideas to develop methods that will permit fish that are currently underutilized for a variety of reasons (see Section II, E) to be accepted in staple and novel foods.
2. Steps should also be taken to utilize by-products from processing such as fish gills, tails and fins into useful foods.

(b) Salting

1. Methods should be sought to detect the resolution of rigor mortis and therefore the right time to salt a given species of fish.
2. Investigate and introduce brine salting more actively into the trade.
3. Efforts must be sought to find better use for fish liquid exudates currently thrown away.
4. Investigation must be conducted on brown pigments observed on salted dried fish.
5. Water activity studies should be conducted on salted fish to determine their equilibrium water relations to assist their storage and packaging.
6. Procedures must be developed to enable fish that cannot be traditionally salted to be salted satisfactorily.

(c) Smoking

1. Efforts must be intensified to improve on existing closed oven designs and framed wire mesh ovens (rectangular ovens) to improve upon their heat and smoke distribution.
2. Different fuel sources must be experimented with for smoked flavor and taste improvements.
3. Brine smoked fish trials should be pursued.

(d) Frying

Attention should also be directed to fish frying to see what improvements can be made on existing methods.

VI. SUMMARY OF REPORT

A first hand survey of the state of the art and fish processing technologies in Ghana which it is believed have relevance to other parts of West Africa has been made.

It is revealed that fish supply pattern of the artisanal fishermen is seasonal due to reliance on visual spottings of shoals of fish. The handling of fish before it reaches the consumer is also found to be basically not satisfactory. This state of affairs is caused partly by the fact that not much care is taken to avoid bacterial contamination at the beaches and partly by the non-use of ice for preservation and the excessive exposure to insolation by both the fisherman and the fishmonger.

A method that will enable the quality of the fresh wet fish, offered for sale to the Ghanaian and other consumers, to be assessed was developed in this study.

Underutilization of certain types of fish species occurs in certain localities for various reasons but such underutilized fish are not thrown away but sold to outsiders who accept them. Other fish species however were similarly thrown away either at sea or on the beach.

Four methods of fish preservation were identified - smoking, salting and drying, sun drying and frying. Of these methods smoking is dominant. Frying which is commonly believed to be unimportant is revealed to be even more important as a method of preservation than salting and drying. The various equipment and processes used in these preservation methods have been described in great detail.

Recommendations for future laboratory studies have been listed.

VII. ACKNOWLEDGEMENT

We acknowledge with much thanks the cooperation enjoyed by the Research Associate and the Principal Investigators with the staff and members of the Food Research Institute during the execution of this project.

Our appreciation goes particularly to Dr. Okoso-Amaah and his economic survey team for a superb job done with the contract given to them which forms Appendix 2 to this report.

We finally thank U.S. AID-Washington for providing funds to make this investigation possible.

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APPENDIX I

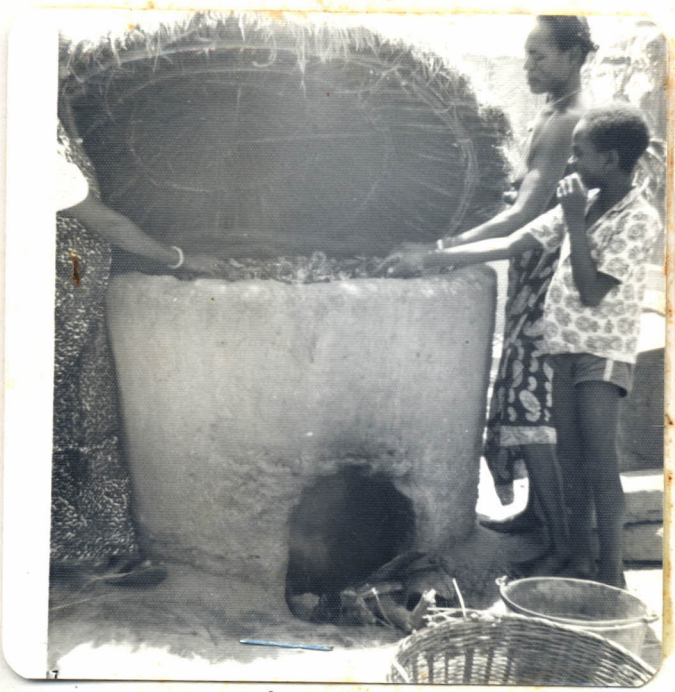
FIGURES CITED IN TEXT

Fig. 1. Dug-out wooden canoes at beach

Fig. 2. Manual dragging of net to shore

Fig. 3. Cutting up large fish at beach

Fig. 4. Scallops thrown away at Elmina inshore-motorized boat landing site



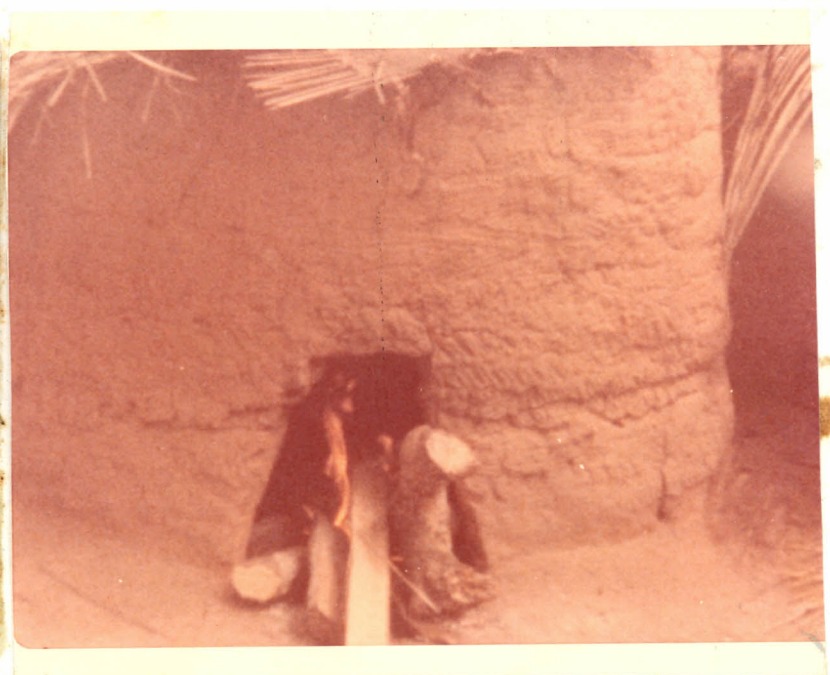


Fig.5. Cylindrical mud ovens (i) vertical (right) and (ii) slopy walled (left)

Fig. 6. Cross section of a slopy mud oven.

Fig.7. Rectangular mud oven with a chimney of framed wires

Fig.8. Cylindrical metal oven

Fig.9. Rectangular metal ovens (i) drying type (center)and (ii) smoking type (left and right)

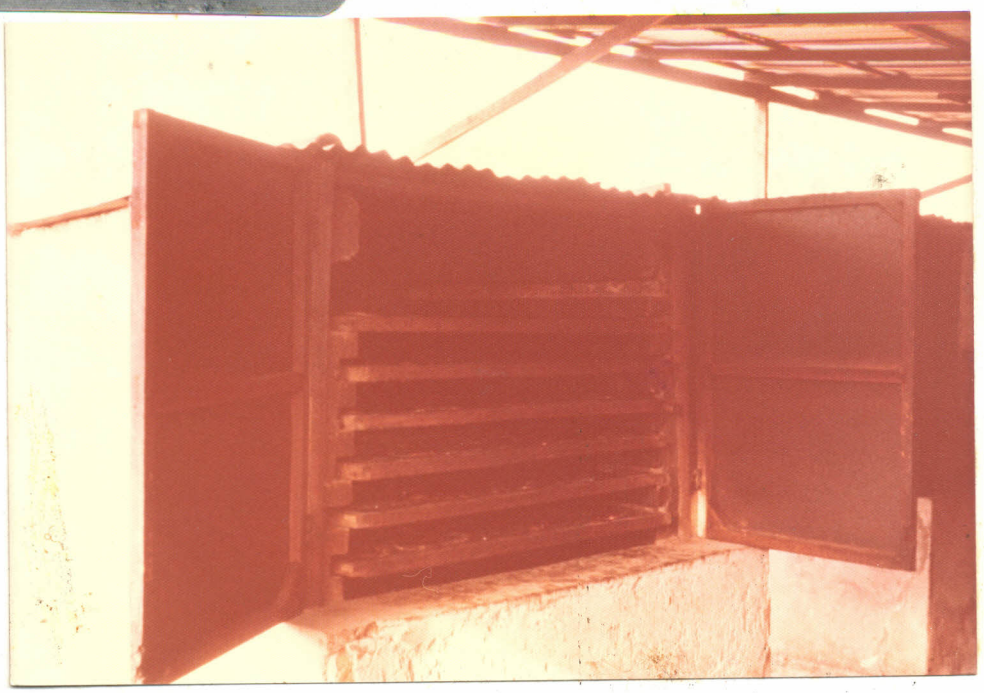


Fig.10. Altona oven

Fig.11. Abandoned Adjetey oven

Fig.12. Smoking compartments of mud oven lined with coconut palm frond mid-ribs

Fig. 13. Covered oven with palm fronds during smoking

Fig.14. A pile of unframed wire mesh (foreground)

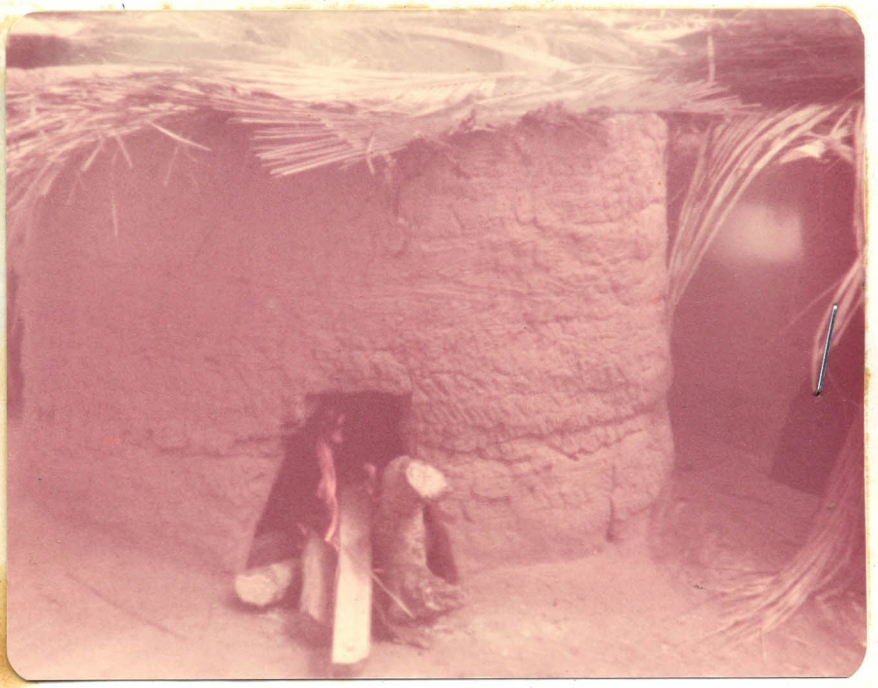


Fig.15. Bulking of partially smoked fish from rectangular mud oven.

Fig. 16. Heaped smoked fish stored on mud oven

Fig. 17. Covered barrel with salted fish in the process of curing

Fig. 18. Drying of salted fish at Axim

Fig. 19. Packed salted dried trigger fish

Fig. 20. Packed salted dried trigger fish in storage

Fig. 21. Anchovies spread on beach sand

Appendix 2

CSIR:FRI / URI:ICMRD FISHERY RESEARCH PROJECT

on

Underutilization of Food Technology
Resulting in Losses of Available Food

A

R E P O R T

on

PATTERNS OF PRODUCTION, UTILIZATION AND CONSUMPTION OF FISH ALONG THE COAST OF GHANA

by

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May 1977

Food Research Institute (CSIR)

(in collaboration with the International Center for Marine Resource Development of the University of Rhode Island, USA).

TABLE OF CONTENTS

1. INTRODUCTION

1.0. Background Information

Malnutrition is one of the important problems associated with food production and consumption in this country. It is believed that it can be alleviated by increased consumption of fish which is relatively cheaper than meat. It is also known that a large proportion of fish landed in Ghana is cured and/or processed before it is used in the various food preparations for consumption.

However, a cursory review of the available reports on fisheries would reveal that efficient utilization of fishery products has not been a major preoccupation of researchers as well as most of the entrepreneurs and officials connected with the industry. It seems that only a few of the species are commercially accepted and that these are being over-exploited. Statistics of catch for the past five years seem to underlie the truth in the diminishing trend in the volume of landings of traditional species. Some species like John Dory and trigger fish have been commercialized and have acquired considerable shares of the markets for smoked and salted dried fishery products in Ghanaian markets. Other groups of fish are less well known. The species involved vary from one fishing area to another along the coast.

The nature of handling techniques employed and the low level of use of the existing preservation technology tend to reduce the volume of fishery products that may be available at any given point in time. Other factors which are equally significant in this respect are dietary patterns and preference schedules, the ability of the market-entrepreneurs to provide the required services associated with its distribution and consumers' demand for other sources of food requirements. All things being unequal, losses in the available food have been considerable, especially during the last decade. The Food Research Institute (CSIR) and the International Center for Marine Resource Development at the University of Rhode Island, USA, have concluded an agreement to undertake fishery research activities under the title "Underutilization of Food Technology Resulting in Losses of Available Food".

It is believed that very often fish reach the processors and/or consumers in bruised or substandard conditions, leading to physical, economic and nutritional losses. The major problem that prompted this study is that data and other relevant information concerning fish supply, handling from the beaches to the processing points, fish consumption and utilization habits are fragmentary and superficial to permit any meaningful action to be taken and to reduce losses. In this respect it is not known how popular fish is in the diet of the average Ghanaian consumer. What species does he patronize most? What factors affect his preference for a given species and fishery products? Which species are less preferred or disliked and why?

1.1. Frame of Reference and relevance of the study

According to the Protocol of the Economics, Marketing and Consumption Division is to provide both statistical and descriptive information on the above-mentioned problems with special regard to the

(a) supply patterns - monthly catch and deliveries by species and fishery products (if possible)

(b) fish consumption habits (including taboos) and utilization patterns and to

(c) recommend preferred species upon which materials would be selected for later laboratory investigations.

While the last point indicates the relevance of the study it is also believed that the report would provide a basis for selecting any species or processing procedures for future detailed work.

1.2 Methodology

This section describes the general methodology used in the preparation and execution of the surveys, tabulation and analysis and the reporting of findings. Details of methods used in obtaining and arriving at other data and results are discussed in full at the appropriate places in the report.

A meeting was held to decide on the coastal towns where the surveys would be conducted. The criteria for the choice of towns were that they should be located at relatively equal intervals from each other and that each center should contribute not less than 10 per cent of the total domestic catch of marine fish. Using some crude estimates of catch statistics we agreed that surveys should be carried out at Keta, Ada (Volta Region), Tema (Accra-Tema Metropolitan Area), Winneba, Elmina (Central Region) and at Axim (Western Region).

We designed questionaires on personal data of interviewees, their food expenditures, motivations for fish preferences and consumptions habits, food preparations with fish, ceremonies for which fish is used, where they purchase fish and why and whether or not they store some fish at home and for how long. We also sought to know about the conditions of the fish after keeping them under domestic conditions.

The questionaires were tested in a pilot survey at Tema. The results were good and therefore we decided not to resurvey Tema but to use the results of the pilot survey for future analysis. After the test 300 copies of quesitonaires were prepared and shared among 6 investigators comprising the team: These are Messrs Sam Nyarko and Nii Anang of FRI, Archibold Thompson, Michael Osae Sackey and Miss Monica Addo-Quaye were temporarily employed for this job. Both the surveys and analysis of the results were supervised by Dr. Kweku Okoso-Amaa, a Research Officer of FRI. In principle 50 questionaires were to be used in each town. However, 93 per cent or 279 of them were completed.

Table 1. Sample Size

Towns	No.	Percentages
Keta	50	17.92
Ada	50	17.92
Tema	38	13.62
Winneba	39	13.98
Elmina	50	17.92
Axim	52	18.64
Total	279	100.00

Table 1 shows the number of questionaires completed in each town and their respective percentage in the total sample size. Fifty questionaires were completed in Keta, Ada and Elmina, 38 and 39 questionaires were completed respectively at Tema and Winneba, while Axim had as much as 52. This gives an average of about 47 questionaires instead of 50 per each town.

The team was instructed on the use of the questionaires to extract as much information as possible from prospective interviewees. The survey started on the 3rd and ended on the 30th of November 1976. There was a break of four days between 12th and 16th to assess the results of surveys in the Volta Region. After the break the team went to the Central and continued the work in the Western Regions.

We have not employed any complicated methods and formulae to analyse and interpret our information. Instead we have used simple observational analysis to interpret the data. The main reason is that the survey objectives do not call for such sophisticated analysis of data and also that an in-depth analysis would probably be out of focus. The report consists of 2 parts: Part I describes supply patterns of fish along the beach where surveys were conducted. Part II deals with consumption, preferences, disliked species and utilization of fish based mainly on the results of the surveys.

I am grateful to all those who helped in making the surveys and the report possible. These include the Technical Assistants of all categories both in Accra and at Elmina, FRI and ICMRD who sponsored financially and technically the research project. I am solely responsible for any incorrect interpretation of the data and information.

Food Research Institute
CSIR, Accra.
20th May 1977

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PART ONE

SUPPLY PATTERN

Chapter 1

1. SUPPLY PATTERNS

1.0. Overview

Records were to be taken on the pattern of daily landings and supply of fish along the coast. However it was pointed out at the start that this would be laborious and practically impossible. But then a monthly supply pattern might be equally useful for our purpose. When we started collecting data on that we realized that even the monthly statistics on supplies per towns surveyed were not readily available. We had to screen a lot of sources to obtain some dubious data for 1974. As to whether they are reliable is anybody's guess. Our only consolation is that they might give a rough description of the supply pattern for 1974. This part of the report relates supply pattern and species composition for 1974.

1.1. Monthly Supplies

Table 2 shows statistics of marine fish supply for January through December at Keta, Ada, Tema, Winneba, Elmina and Axim. Data on supplies at Tema were easily obtained. The fact is that the recordings refer to only one kind of fishing, namely inshore fishing, where vessels are used. The relevance of statistics for planning, management and operation of the business is recognized. And data are available and reasonably reliable. On the other hand, owing to the dependence on recorders who do not have the means to measure the weights of landings, statistics on canoe fishery landings are more observational and subjective. When data are scattered and are not available for a considerable number of months, their reliability and usefulness tend to be marginal. Consequently the writer is compelled to make large amounts of guessings and estimations to obtain figures to fill the gaps.

We have employed such methods to obtain data for some of the monthly supplies at Keta, Ada, Winneba, Elmina and Axim. The most popular method we used is that we found the average rate of growth of

the available data for a number of months of one town. Using the last month's supply as the base, the following month's supply is estimated by multiplying the base figure by the rate of growth. The result is compared to the data of other towns for the same month, making room for some errors, we arrive at a figure that is considered reasonable. Again reasonableness, in this context, is qualified by our observations and information supplied by the fishermen. Data presented in Table 2 are therefore indicative and should therefore be interpreted with caution:

Table 2. Monthly Catch Statistics for 1974 (metric tons)

Months	Keta	Ada	Tema	Winneba	Elmina	Axim	Total
January	73.79	27.61	5187.80	101.09	127.86	118.78	5636.93
February	149.66	54.23	3098.73	311.22	118.64	109.87	3842.35
March	128.76	47.37	4118.12	206.93	103.88	81.82	4686.88
April	297.10	48.65	2824.59	6789.27	124.26	118.24	10202.11
May	138.63	59.95	3892.61	130.05	158.93	158.94	4539.11
June	223.88	73.01	3211.20	106.91	185.78	211.81	4012.59
July	189.88	53.25	4254.65	525.46	246.96	365.46	5635.66
August	238.83	132.45	6710.45	323.44	302.76	407.10	8115.03
September	257.74	141.27	6340.54	215.60	258.97	383.45	7869.57
October	406.90	103.70	10699.88	408.21	350.82	334.08	12304.39
November	625.69	121.45	4226.15	170.00	289.89	202.11	5635.29
December	412.61	81.76	3864.06	125.68	184.26	154.41	4822.78
Total	3143.47	944.70	58468.88	9411.86	2353.01	2646.07	76967.99
Average	261.95	78.72	4872.40	784.32	196.08	220.50	6413.99

Source: Documents of Fisheries Department, Accra.

In general the volume of landings is low during the Harmattan months-December through April. It then begins to rise to a peak period that coincides with the Sardinella season. There are locational and monthly fluctuations of supplies. These are explained by seasonal occurences of species and the type of fishing activities undertaken in one month as opposed to another. This is exemplified by data for

Ada, Elmina and Axim. In Tema, landings in August September and October are exceptionally heavy, otherwise supply for the remaining months are relatively even. The only explanation we can give to this pattern is that the use of vessels seems to immunize inshore fishing against seasonal occurences of different species.

The table shows that the average monthly supplies varied from 78.72 metric tons at Ada to 4872.40 metric tons at Tema in 1974. By extrapolation the pattern of supply would not exhibit any dramatic changes. There would, however, be changes in the quantity supplied.

1.2. Species Composition of Supplies

Many fish species are landed every month. But the quantity and the size of the fish in each species vary tremendously from one place to another and from one month to the other. Some of the species are caught repeatedly for more than a month before they disappear. While some species, like herrings, burrito and anchovy are traditional to the industry as a whole, other species are associated with certain centers, where they are often landed. It is known that vessels land John Dory, mackerel species, (especially scad mackerel) trigger fish at Tema, Elmina and occasionally at Winneba. The supply of anchovies is related more to Keta, Ada, Tema and Winneba than to Elmina.

We made an attempt to collect information on monthly species composition of supply along the coast. While we were successful with Keta, Tema and Elmina, it was difficult to obtain any reasonable information at Ada, Axim and other towns. Another difficulty was that species were caught in such small quantities that a long list would have resulted if we were to include all. We decided therefore that if the volume of supply did not exceed 100 metric tons the species would not be included in the list. Forty three of such species and for which there are statistical information are:

Apapa	Barracuda	Big-eye fish	Bumper
Burrito	Burro	Cassava fish	Cat fish
Chub mackerel	Crabs	Cromics	Cuttle fish
Diagrama	Flat Sardine	Flying fish	Frigate mackerel

Globe fish	Grouper	King fish	Lady fish
Leer fish	Lobster	Long fin herring	Moon fish
R. Runner	Ray	Red mullet	Ribbon fish
Rocador	Round sardine	Scad mackerel	Seabream
Shad	Shark	Shrimps	Snapper
Sole	Spade fish	Surgeon	T. Trachae
Threadfin	Trigger fish		

For this list we had to rely on the information given in the documents of the Fisheries Department. In the survey we noticed however, that the species listed per center was small because not all species were landed.

Since data for other towns, Ada, Axim and partly Winneba, are not available we found it difficult and probably unnecessary to relate the species composition to the volume of supplies as shown in Table 2.

1.3. Supply of Fishery Products

Fishery products refer to fresh fish as landed and/or sold on the markets and cured products, namely grilled, smoked, fried, salted and fermented. We also observed that an appreciable quantities of frozen fish is sold in the markets.

It was not possible to undertake an indepth survey of the supply of fishery products. However, in a concurrent study we asked 118 respondents "What are you going to do with the fish you have bought?". 30 sold their fish fresh, 39 smoked theirs, 40 grilled, and only 9 salted and fermented their fish. Out of the total volume of 6597 kg. of fish, 11.23% was sold fresh, 38.29% was smoked, 21.62% was grilled and 22.63% was salted and fermented.

In all the surveys only production units that employed traditional technology of processing and curing of fish were included in the study. Production technology is simple and may be inexpensive. Yet the quality of the product is challenging.

Fishery products may be sold locally as well as on other markets located outside the landing and processing centers. Women normally are the only entrepreneurs in the supply of fishery products to other populated areas. In the process of distribution entrepreneurship is influenced mostly by the distance to be travelled, availability of

transport charges, prices of fish and allied consumer products and the preference characteristics of the consumers.

1.4. Summary

The supply of fish in the centers surveyed varies in quantity, the composition of species and cured products. The pattern of supply is due also to the seasonal occurences of species and fishing activities of the areas concerned.

P A R T T W O

ANALYSIS OF SURVEY RESULTS

Chapter 2

CHARACTERISTICS OF RESPONDENTS

2.0. Overview

The first part of the questionaire sought information on personal characteristics such as age, sex, marital status, size of family and occupation. We have summarized and discussed the results below.

2.1. Sexual and Marital Composition of Respondents

There were far more females - 176 or about 63 per cent of the sample than males - 103 or about 37 per cent of the sample size.

Table 1. Sexual and Marital Structure of Respondents

	Towns	Sex		Marital Status			
		Male	Female	Married	Divorced	Widow	Single
1.	Keta	24	26	38	-	-	12
2.	Ada	14	36	33	1	10	6
3.	Tema	11	27	26	1	2	9
4.	Winneba	13	26	26	-	2	11
5.	Elmina	21	29	41	1	2	6
6.	Axim	20	32	32	4	1	15
	Total	103	176	196	7	17	59
	Per cent	36.9	63.1	70.3	2.5	6.1	21.1

As indicated in the table above a large proportion of the interviewees are married - 70 per cent, while about 21 per cent are not married. Both widows and divorced constitute only about 9 per cent of the total sample.

2.2. Family Size

The size of the family is taken as comprising a husband and a wife or wives with or without children, which may include also dependents

of either the husband or the wife(s). In order to distribute the interviewees according to family size we had to determine the size range. With an interval of one we obtained 5 groups of family size as presented in Table 3. The first size range corresponds to the number of unmarried persons as in Table 1. But in Tema the only divorced woman had no children. She was therefore considered as single in this table. The family size ranges from 2 to more than 7 members. While size range 6-7 constituted the largest group of families in the sample the smallest size range 2-3 was also the least represented i.e. 15.77% of the sample. The relative difference among the size ranges is more apparent between 2-3 and 4-5 and between 6-7 and over 7 members per family size. Variations of size among surveyed towns are also conspicuous.

Table 3. Size of Family

Size range	Keta	Ada	Tema	Winneba	Elmina	Axim	Total	%
0-1	12	6	10	11	6	15	60	21.50
2-3	7	7	8	5	10	7	44	15.77
4-5	11	13	10	3	14	10	61	21.86
6-7	14	9	2	10	12	15	62	22.22
7+	6	15	8	10	8	5	52	18.65
Total sample	50	50	38	39	50	52	279	100.00

2.3. Occupational Composition

We asked the interviewees as to what they do for a living or what is your occupation? Details of the answers have been indicated in Appendix 1. The answers were grouped under three main categories of profession, as shown in Table 4: Of the 3 categories of profession about 21 per cent of the respondents are producers or manufacturers. There are two types of Servicemen. One group of Servicemen-11.8% is associated with production or manufacturing. The second group of Servicemen-12.5%-is related to administration. A large proportion of the sample-119, being about 42.7 per cent, engage in marketing and general trading. The residual group of respondents-34 or about 12 per cent

of the sample-are housewives, students and unemployed persons.

Chapter 3
PREFERRED AND DISLIKED SPECIES

3.0. Motivation for Fish Consumption

We tried to find out why people eat fish (see question C(i) of App.B-1). The answers to this question are presented in Table 5. In the questionaire 5 possible answers were given, leaving "other reasons" for the interviewee to add what he or she feels should be the case. An interviewee had a chance to give more than one reason for eating fish.

Table 5. Why do people Eat Fish?

	Keta	Ada	Tema	Winneba	Elmina	Axim	Total	% of
	NUMBER OF PERSONS						No.	Sample size
Because of								
1. its food values	43	37	17	36	30	38	201	72.04
2. its taste	26	31	14	29	23	34	157	55.91
3. it is easily obtainable	25	9	6	15	10	21	76	27.24
4. traditionally we eat food with fish	33	41	24	33	37	41	209	74.91
5. its relative cheapness	17	4	12	24	9	6	72	25.80
6. other reasons:								
i. gives more blood	1	1	3	1	-	-	6	2.15
ii. gives strength and good health	-	1	2	2	1	-	6	2.15

The total number of respondents for each reason, for example 209 for "food value", is then related to the sample size with the result expressing the relative importance of each reason as a motivational factor. Of the 5 possible answers the data show that people eat fish because it is traditional or conventional to eat food with fish. And that about 75 per cent of the interviewees attested to this factor. About 72 per cent of them eat fish for its food values, while about 56 per cent patronize it for its taste. Other motivating factors are readily available (27 per cent), and cheaper than meat (26 per cent).

3.1. Consumer Preferences and Disliked Species

Fish species, and even those commercially accepted, are numerous. Only the processed products are eaten as instant food item or as an element of prepared foods. Fresh fish has to be cooked before it is eaten. We wanted to know which of the commercially accepted species are more preferred and the preferences among the fishery products.

3.1.1. Preferred Species

Among the numerous species mentioned by respondents (q.v. Section 1.2. above) we decided to concentrate our analysis on the four most preferred species at each center. This is listed below: q.v. Table 6.

Keta	Ada	Tema	Winneba	Elmina	Axim
Herrings	Herrings	Herrings	Herrings	Herrings	Herrings
Anchovy	Tuna	Seabream	Seabream	Seabream	Seabream
Scarp	Kingfish	Scad Mackerel	Threadfin	Threadfin	Threadfin
Tsuiyi	Gesu	Tsile	Kingfish	Barracuda	Barracuda

It may be noticed that there is only a slight difference in the structure of preferences among the centers. The difference might be explained by the method used in selecting the most preferred species.

TABLE 6 THE FOUR MOST PREFERRED SPECIES AND FISHERY PRODUCTS

Towns	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/Momoni
		NUMBER OF PERSONS RESPONDING						
Keta	Herrings	22	4	5	15	1	14	1
	Anchovy	21	3	11	15	2	11	3
	Scarp	18	2	3	9	10	10	2
	Tsyiyi	5	-	3	4	-	4	-
Ada	Herrings	27	8	12	32	4	25	3
	Tuna	11	2	-	9	-	7	1
	Kingfish	8	5	5	5	2	4	5
	Gesu	17	-	4	14	-	4	-
Tema	Herrings	9	5	-	30	-	7	-
	Seabream	9	8	5	27	-	4	1
	Scad mackerel	1	4	-	5	-	4	-
	Seabream (bigger type)	3	2	-	4	-	1	-
Winneba	Herrings	19	8	6	21	2	13	2
	Seabream	14	5	5	14	2	11	1
	Threadfin	9	3	3	8	2	9	3
	Kingfish	13	6	6	14	3	7	3
Elmina	Seabream	30	8	22	28	8	31	7
	Herrings	22	10	15	21	8	22	9
	Threadfin	6	-	2	9	1	8	4
	Barracuda	7	-	3	8	-	6	1
Axim	Herrings	21	5	16	18	4	15	16
	Seabream	21	6	12	17	5	17	9
	Barracuda	15	-	10	15	1	11	4
	Threadfin	14	1	11	12	-	9	5

The criterion for selection was the number of times the fresh product was mentioned by the respondents. Later on we noticed that this also concurred with the pattern of landings at the centers. Herrings are common to all, Seabream is most preferred at Tema, Winneba, Elmina and Axim and Barracuda-at Elmina and Axim. While threadfin is common to Winneba, Elmina and Axim; Kingfish is patronized mostly at Ada and Winneba. As we mentioned earlier certain types of fish are related to certain centers. Here we can observe that Anchovy, Scarp and Tsuiyi are what consumers prefer most at Keta, consumers at Ada prefer Tuna and Gesu, while at Tema they adore scad mackerel (kpanla) and Tsile.

3.1.2. Preference Structure for Fishery Products

There are considerable differences in the choice of fishery products among consumers at the surveyed centers. Smoked and grilled products together form the products with the highest scores, and in decending order, they are followed by fresh, fried, frozen, salted, fermented and dried.

3.2. Disliked Species

Consumers were asked "which species don't you like and why?". To facilitate analysis we selected four (4) of the species which are disliked and associated them with the reasons given by the respondents. In order to avoid excessive details of describing the reasons for a certain group of consumers disliking a given species we have rounded up some of the respondents as well as the reasons they have given. For example, only 9 of the 50 respondents at Keta dislike Scad Mackerel because it is tasteless (for 5 of them) and that it has not been eaten in the family of the remaining four.

The figures under "No." in Table 7 shows the number of respondents who dislike the species concerned. The percentile values were not estimated because they are not important. The reader may observe that some of the species happen to be some of the most preferred species, even in the same town. For example, anchovy is one of the four most

preferred species at Keta, but it is also a disliked species by some in the same town. One may question the plausibility of such a situation. again our explanation is that it may be due partly to the method of selection, since a disliked species should, by decision, have more than two people to express their dislike before it would be considered for analysis. The rest of the information on disliked species can be found in Table 7.

Chapter 4.
EXPENDITURE AND PURCHASING PATTERN

4.0. Expenditure on Fish

The next question that puzzled our minds is that if people like fish for the reasons given above, Table 5, how much do they spend on food as well as on fish? The answers to this question varied and to make sense out of it all the respondents had to be grouped in relation to the ranges of weekly expenditures on food and on fish per each center, (Table 8).

An interesting revelation is that only 84 people spend between 7 and 21 cedis per week on food, while as many as 235 respondents spend the same amount of money per week on fish. At first this sounded quite incredible. It looks as if some people would subsist soley on fish. We tried to find out why this is so. The only explanation we could find is related to the pattern of supply and proximate location of consumers to their sources of supply. Aprioristically, the information on motivation for fish preferences, namely, food values, tradition, taste and consumers' proximity to the sources of supply, seems to give credence to our explanation.

4.1. Purchasing Pattern

How often do consumers buy their preferred species/fishery products and from which markets/sales points? The answers to this question were related to the four most preferred species. In order to economize

TABLE 7 DISLIKED SPECIES AND REASONS

Towns	Disliked Species	Reasons for Dislike	Sample size	% of Total
Keta	Sead Mackerel	Tasteless; not taken in my family	9	47.4
	Anchovy	Tasteless; not good to my health, too small	4	21.1
	Shark	Unpleasant smell; not nice to look at	3	15.8
	Seabream	Unpleasant scent, costly, and too big	3	15.8
Ada	Cassava fish	Poor taste & too stiff	6	30.0
	Black fish	Bad smell and poor taste	4	20
	Sead Mackerel	Poor food value & taste & smooth skin	4	20
	Frigate Mackerel	Bloody and poor quality & taste	6	30
Tema	Herrings	Too bony & tasteless	4	30.8
	Trigger fish	Strange appearance & tasteless	3	23.1
	Sead Mackerel	Salty	3	23.1
	Squid	Ugly appearance & tasteless	3	23.1
Winneba	Trigger fish	Unpleasant smell, no food value	11	47.8
	Anchovies	No food value/badly processed	5	21.7
	Ahemmandzi	Bony and tasteless	7	30.4
Elmina	Trigger fish	Bony, hard & unfamiliar	10	37.0
	Bonga	Bony, tasteless & for health reasons	8	29.6
	Shark	Nasty fish, unfamiliar	6	22.2
	Squid	Dirty & dislike in family	3	11.1
Axim	Shark	Taboo,not good to eat, resembles human flesh	12 4	52.2 17.4
	Saman	Pungent smell, tastes badly	3	13.0
	Trigger fish	Traditionally unknown, superstitious about consumption	4	17.4

on time. The results have been presented in Table 9. It shows the species per each center, the frequency of purchase, (given in ranges of days per week a particular category of purchase is done) per species and per fishery products of the same species. The distribution of the data is done according to the centers. As it is , there are some difficulties for any suggestive conclusions to be drawn from the data. A lot of the cells have not been filled because of inadequate information. But, we can only say at this juncture that there seems to be a discrepancy in the information that would be obtained if the structure of preferences of fishery products were compared with the frequency and structure of the purchasing pattern. In other words we used this information from Table 9 to cross-check the validity/reliability of other information.

4.2. Reasons for Buying Fish at Certain Markets

We also wanted to know why respondents buy their fishery products at certain markets. We noticed in general they patronize three kinds of markets, viz, beaches, indigenous public markets the cold stores. The reasons for patronage are also given in Table 10. In general, the respondnets buy their fish more at the beaches than at the markets. The cold stores are less patronized. The importance of the reasons for patronage vary from one center to the other. However it seems that patronage is strictly related to the type of fishery products they buy. For the beaches are associated with the sale of fresh, unprocessed fish, the markets-with cured products, while the cold stores, if available sell only frozen fish.

Chapter 5.
CONSUMPTION AND UTILIZATION OF FISH

5.0. Consumption Pattern

Fish is generally eaten cooked, cured or in the processed form. Table 11 expresses the consumption pattern of the respondents. We used the same method in compiling this as was used in Table 9.

TABLE 8 WEEKLY EXPENDITURE OF FOOD AND FISH

Towns	% Range of Expenditure on Food (¢)				% Range of Expenditure on Fish (¢)			
	7-21	22-42	43-69	70+	7-21	22-42	43-69	70+
	NUMBER OF PERSONS RESPONDING							
Keta	18	25	5	2	45	4	-	1
Ada	11	21	11	7	41	8	1	-
Tema	18	17	3	-	31	7	-	-
Winneba	9	19	11	-	33	6	-	-
Elmina	12	26	10	2	43	5	1	1
Axim	16	22	12	2	42	8	2	-
TOTAL	34	130	52	13	235	38	4	2
% of sample size	30.1	46.6	18.6	4.7	84.2	13.6	1.5	0.7

TABLE 9 PURCHASE PATTERN FOR PREFERRED SPECIES AND FISHERY PRODUCTS

Towns	Species	Frequency of purchase	FISHERY PRODUCTS						
			Fresh	Frozen	Grilled	Smoked	Fried	Salted	Fermented
Keta	Herrings	1 - 2	5	2	1	2	-	-	-
		3 - 4	3	-	-	-	-	-	-
		5+	3	-	-	1	-	-	-
	Carp	1 - 2	3	-	-	-	-	-	-
		3 - 4	6	-	-	-	-	-	-
		5+	2	-	-	-	-	-	-
	Anchovy	1 - 2	5	2	1	1	-	1	2
		3 - 4	2	-	-	1	1	1	-
		5+	-	-	-	-	-	-	-
	Tsiyiyi	1 - 2	3	-	1	-	-	-	-
		3 - 4	2	-	-	-	-	-	-
		5+	-	-	-	-	-	-	-
Ada	Herring	1 - 2	7	2	-	2	-	-	-
		3 - 4	5	-	-	-	-	-	-
		5+	5	-	-	-	-	-	-
	Barracuda	1 - 2	2	2	-	-	-	-	-
		3 - 4	4	-	-	-	-	-	-
		5+	1	-	-	-	-	-	-
	Kingfish	1 - 2	2	2	-	1	-	3	-
		3 - 4	1	-	-	-	-	-	-
		5+	2	-	-	-	-	-	-
	Gesu	1 - 2	3	-	-	1	-	-	-
		3 - 4	7	-	-	-	-	-	-
		5+	-	-	-	-	-	-	-
Tema	Herrings	1 - 2	2	2	-	1	-	3	-
		3 - 4	3	-	-	2	-	4	-
		5+	1	-	-	7	-	-	-
	Seabream	1 - 2	1	5	2	4	-	3	-
		3 - 4	3	-	4	3	-	-	-
		5+	-	-	7	10	-	-	-
	Sea Mackerell	1 - 2	1	3	4	6	-	2	-
		3 - 4	1	-	-	2	-	-	-
		5+	-	2	1	-	-	-	-
	Seabream	1 - 2	1	1	2	2	-	2	-
		3 - 4	-	-	1	4	-	1	-
		5+	-	-	-	-	-	-	-

TABLE 9 CONTINUED

Towns	Species	Frequency of Purchase	FISHERY PRODUCTS						
			Fresh	Frozen	Grilled	Smoked	Fried	Salted	Fermented
Elmina	Seabream	1 - 2	3	3	3	-	-	2	2
		3 - 4	8	2	1	1	-	-	-
		5+	5	-	-	3	4	-	0
	Herrings	1 - 2	3	4	2	3	-	-	1
		3 - 4	5	3	3	6	-	-	-
		5+	4	-	2	1	5	3	-
	Threadfin	1 - 2	1	-	-	-	-	-	-
		3 - 4	3	-	-	-	-	-	-
		5+	1	-	-	-	-	-	-
	Barracuda	1 - 2	2	1	1	-	-	-	1
		3 - 4	3	-	-	1	-	-	-
		5+	-	-	-	-	-	-	-
Axim	Herrings	1 - 2	4	1	-	2	-	-	-
		3 - 4	3	1	1	-	-	-	-
		5+	3	-	1	1	2	-	-
	Seabream	1 - 2	3	-	1	1	-	1	2
		3 - 4	6	4	3	2	-	1	1
		5+	2	-	-	2	2	-	-
	Barracuda	1 - 2	3	-	1	-	-	-	-
		3 - 4	4	-	-	2	-	-	-
		5+	2	-	-	-	1	-	-
	Threadfin	1 - 2	2	-	-	-	-	-	-
		3 - 4	1	-	-	-	-	-	-
		5+	2	-	-	-	-	-	-
Winneba	Herrings	1 - 2	5	3	-	1	1	1	-
		3 - 4	-	-	-	1	-	1	-
		5+	-	-	-	-	-	-	-
	Seabream	1 - 2	11	3	-	1	-	1	-
		3 - 4	1	-	-	4	-	-	-
		5+	1	-	-	-	-	-	-
	Threadfin	1 - 2	6	1	-	2	1	-	-
		3 - 4	2	2	-	3	-	-	-
		5+	-	-	-	-	-	-	-
	Kingfish	1 - 2	7	3	-	1	2	-	-
		3 - 4	3	1	-	2	-	1	-
		5+	-	1	-	1	-	-	-

Consumption pattern vary from one town to the other, among the species and their respective cured products. We did not explore the factors which might have caused such variations. However, the frequency of consumption is limited to between 1 and 4 days a week. When we compare Table 11 with Table 9 we notice that the patterns they describe are different from one another. For instance in Keta, 3 of the respondents bought fresh herrings 3/4 times a week, but in Table 11 3,6 and 9 people ate respectively grilled, smoked and fried herrings 3/4 times a week. There is no explanation for the fish consumed. The importance of Table 11 therefore is to cross-check information on patterns of purchase and supply. Of course they need not coincide but the descrepancy shouldn't be too wide either.

5.1. Utilization of Fish

There are several ways of using fish along the coast. Fish is generally used in preparing food. Occasionally it may be used in some religious ceremonies.

5.1.1. Fish for Food

The information on the use of fish for food is given in Table 12. In order to prepare this table we categorized the foods under soups, stews and instant foods. Both the preferred and other species of fish from the towns we surveyed were distributed under the food preparations. We also gathered information on the form of fishery products used and how important the fishery products are to the various food preparations. The amount of work involved in analysing Table 12 is so much that we thought it wiser to leave as it is. However the table shows that various kinds of species and fish products are used in the preparation of foods in this country. There seems to be some kind of relationship between the type of food preparations and the type of fishery products used.

TABLE 10 REASONS FOR BUYING FISH AT CERTAIN SELLING POINTS/PLACES

No.	Places of Purchase		Reasons	Keta	Ada	Tema	Winneba	Elmina	Axim	Total	% of sample size
1.	Beaches	i	Relative cheapness	19	15	8	9	5	19	75	26.8
		ii	Easily obtainable	19	20	3	12	7	8	69	24.7
		iii	Proximity to house	4	12	-	-	3	4	23	8.2
		iv	Quality freshness	12	9	-	6	10	20	57	20.4
		v	Alternative to markets	2	8	-	6	1	4	21	7.5
		vi	Other reasons:a) own fish	2	4	-	-	6	9	21	7.5
2.	Markets	i	To obtain fresh & cured fish	3	17	13	10	8	17	68	24.3
		ii	Proximity to house	3	5	8	9	4	2	31	11.1
		iii	Availability of variety and choice of fish	7	15	12	12	5	3	54	13.3
3.	Cold Store		Scarcity on other markets cheapness	no cold stores	6	6	6	1	3	22	7.8
						4	4		1	9	3.2
									TOTAL	450	

TABLE 11 NUMBER OF TIMES PER WEEK PREFERRED SPECIES AND CURED PRODUCTS ARE CONSUMED

Towns	Preferred Species	Frequency of Consumption	CURED FISH PRODUCTS				
			Grilled	Smoked	Fried	Salted	Stink
Keta	Herring	1 - 2	2	3	4	-	-
		3 - 4	3	6	9	-	-
		5+	-	1	1	-	-
	Anchovy	1 - 2	1	2	-	1	2
		3 - 4	1	6	-	1	3
		5+	1	2	-	-	-
	Tilapia	1 - 2	-	-	-	2	-
		3 - 4	3	4	3	-	-
		5+	-	1	2	1	-
	Tsiyiyi	1 - 2	-	1	-	-	-
		3 - 4	2	1	-	-	-
		5+	-	-	-	-	-
Ada	Herrings	1 - 2	4	7	3	-	-
		3 - 4	5	14	11	-	-
		5+	-	5	3	-	-
	Barracuda	1 - 2	-	4	4	-	2
		3 - 4	1	4	1	-	-
		5+	-	1	-	-	-
	Kingfish	1 - 2	3	6	1	1	-
		3 - 4	1	-	1	-	-
		5+	-	-	-	-	1
	Gesu	1 - 2	-	-	-	-	-
		3 - 4	-	6	-	-	-
		5+	-	-	-	-	-
Tema	Herrings	1 - 2	1	4	2	-	-
		3 - 4	1	2	2	-	-
		5+	-	6	1	-	-
	Seabream	1 - 2	2	6	1	-	-
		3 - 4	-	2	3	1	-
		5+	-	3	-	-	-
	Sead Mackerell	- 2	-	3	2	-	-
		3 - 4	-	-	-	-	-
		5+	-	-	-	-	-

TABLE 11 CONTINUED

Towns	Preferred Species	Frequency of Consumption	CURED FISH PRODUCTS				
			Grilled	Smoked	Fried	Salted	Stink
Winneba	Herrings	1 - 2	3	5	2	-	-
		3 - 4	2	4	6	-	-
		5+	-	5	4	-	-
	Seabream	1 - 2	4	2	6	-	-
		3 - 4	1	4	2	-	-
		5+	-	-	-	-	-
	Threadfin	1 - 2	3	2	4	-	-
		3 - 4	3	1	2	-	-
		5+	-	-	-	-	-
	Kingfish	1 - 2	2	7	3	-	-
		3 - 4	3	1	4	-	-
		5+	-	-	-	-	-
Elmina	Herrings	1 - 2	1	2	2	-	1
		3 - 4	1	5	4	-	-
		5+	-	1	1	-	-
	Seabream	1 - 2	1	3	5	-	-
		3 - 4	4	6	5	-	-
		5+	1	3	2	-	-
	Threadfin	1 - 2	2	2	-	-	-
		3 - 4	1	3	5	-	-
		5+	-	-	-	-	-
	Barracuda	1 - 2	1	3	5	-	-
		3 - 4	4	6	4	-	-
		5+	1	3	2	-	-

5.1.2. Ceremonial Uses of Fish

Occasionally fish is used for some kind of religious ceremonies. Information on this is given in Table 13. There is no information on this from Winneba. We assume that ceremonial uses of fish do not prevail in this town.

The table shows the type of ceremonies and the species together with the fishery products used. It may be noticed that some of the species belong to the most preferred ones while others are rare and do not even belong to the commercial species.

5.1.3. Underutilization of Some Species

Naturally given the patterns of supply, consumption and other forms of utilization we can genuinely conclude that some species are underutilized in some places. The information on disliked species also give credence to this remark. Some of these species form what is known as trash fish which vary from one location to the other

5.1.4. Recommended Species for Laboratory Studies

Anchovies, Scad mackerel, crabs of certain kind, Herrings. Unfortunately there was no information on the type of fish thrown away by the fishermen.

TABLE 12 SPECIES AND FISHERY PRODUCTS USED IN TRADITIONAL FOOD PREPARATIONS

Towns and food Preparations	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
A. SOUPS								
1. Keta	Preferred							
	Anchovy	10[a]	-	1[b] 1[c]	7[b] 2[c]	1[c]	1[a] 1[b] 2[c]	1[a]
	Herrings	1[a] 4[b] 2[c]	-	-	1[a] 7[b] 2[c]	-	3[a] 1[c]	-
	Tilapia	12[c]	-	1[c]	5[b] 1[c]	-	-	-
	Seabream (bigger fish)	-	-	-	-	-	-	-
	Others							
	Red Fish	2[b] 2[c]	1[b]	-	1[a] 3[b] 2[c]	-	1[a] 2[b]	-
	Tsiyiyi	1[b] 3[c]	-	1[b]	1[b] 2[c]		-	-
	Shark	3[c]	-	1[b]	2[b] 1[c]	-	-	-

TABLE 12 Continued

Town and food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
2. Ada	Preferred Herrings	10^b 11^c	1^a 2^b	2^a 3^b	15^b 11^c	-	2^a 4^b	2^c
	Tuna	2^b 4^c	-	-	5^b 3^c	-	-	-
	Kingfish	2^b 4^c	1^a 1^a	1^a 3^b	6^b 2^c	-	4^a 1^b	-
	Gesu	11^c	-	1^b	9^b 1^c	-	-	-
	Others Seabream	2^b	1^a	1^a	1^b 2^c	-	1^b	-
	Pata	-	-	-	-	-	-	-
	Seabream (bigger fish)	1^b	-	1^b	2^c	-	1^a 1^b	-
3. Tema	Preferred Herrings	1^a 6^b 2^c	2^b	2^a	4^a 5^b 7^c	-	-	-
	Red Fish	1^a 3^b 1^c	4^b	-	4^a 1^b 14^c	-	-	-
	Sead Mackerel	-	2^b	-	2^b 2^c	-	-	-
	Seabream (bigger fish)	1^c	-	-	1^c	-	-	-

TABLE 12 Continued

Towns and food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
4. Winneba	Preferred Herrings	5^b 7^c	-	-	1^a 9^b 4^c	-	3^b 1^c	-
	Redfish	3^b 2^c	-	-	5^b 3^c	-	4^b	-
	Threadfin	3^b 3^c	-	2^a 1^b	1^a 3^b 2^c	-	1^a 3^b 1^c	-
	Kingfish	1^a 4^b 4^c	1^a	1^a 2^c	1^a 7^b 2^c	-	1^a 5^b	-
	Others Tuna	1^b 4^c	1^a	-	2^b 3^c	-	3^b 3^c	-
	Sasakwesi	1^a 1^b 1^c	1^a	-	1^a 1^b 1^c	-	1^a 1^b	-
5. Elmina	Preferred Red fish	12^b 16^c	1^a	3^a 4^b 2^c	5^b 24^c	-	2^a 9^b 1^c	-
	Herrings	1^a 11^b 6^c	2^a	3^a 6^b 10^c	2^a 6^b 10^c	-	1^a 5^b	-
	Threadfin	3^b 5^c	-	1^b	4^c 7^b	-	2^b	-
	Longfin Herring	1^a 1^b 3^c	1^a	3^b	1^b 2^c	4^b	3^c	-
	Others Barracuda	2^b 3^c	-	-	1^a 5^b	3^c -	2^b	-
	Ribbon fish	6^b 3^c	-	-	3^a 4^b	-	-	-

TABLE 12 Continued

Towns and food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
6. Axim	Preferred Herrings	12^{b} 1^{c}	-	2^{a} 2^{b}	1^{a} 7^{b} 12^{c}	-	2^{a} 2^{b}	2^{a}
	Seabream	1^{a} 12^{b} 2^{c}	-	1^{a} 11^{b} 1^{c}	1^{a} 2^{b} 16^{c}	4^{a} 2^{b} 2^{c}	3^{b}	-
	Barracuda	6^{b} 2^{c}	-	1^{a} 2^{b}	7^{c}	-	1^{b}	5^{b}
	Kingfish	2^{a} 6^{b}	1^{a}	1^{a} 1^{b} 3^{c}	2^{b} 3^{c}	1^{b}	3^{a} 1^{b} 1^{c}	2^{a}
	Other Threadfin	2^{a} 6^{b}	-	2^{a} 1^{b} 1^{c}	7^{c}	1^{b}	3^{b}	-
	Opoku	3^{b} 1^{c}	-	1^{b}	1^{b} 3^{c}	-	-	-
B. STEWS								
1. Keta	Preferred Anchovy	1^{b} 2^{c}	-	-	1^{b} 1^{c}	-	1^{b}	-
	Herrings	5^{b} 1^{c}	-	1^{b} 1^{c}	6^{b} 6^{c}	1^{b}	6^{b} 6^{c}	-
	Tilapia	1^{b} 2^{c}	-	1^{b} 1^{c}	4^{b}	1^{b} 1^{c}	1^{b} 1^{c}	-
	Seabream (bigger fish)	2^{c}	-	2^{c}	2^{c}	-	1^{b}	-
	Other Red Fish	1^{c}	1^{b}	1^{b}	1^{b}	-	1^{b} 2^{c}	-
	Tsyiyi	2^{b} 2^{c}	1^{c}	2^{b}	2^{b}	1^{a}	2^{c}	-
	Shark	-	-	-	-	-	-	-

TABLE 12 Continued

Towns and food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
2. Ada	Preferred Herrings	1^a 4^b 1^c	1^a	1^a 3^b 1^c	1^a 6^b 3^c	-	2^b 8^c	1^c
	Tuna	2^a	1^a	-	1^a 3^c	-	1^b	1^b
	Kingfish	2^b 2^c	1^a	1^a 1^b	4^b 2^c	-	1^a 1^b 3^c	-
	Gesu	2^b 1^c	-	1^b	1^b 5^c	-	1^b 1^c	-
	Others Red Fish	2^b	1^a	1^a	1^b 1^c	-	1^b 1^c	-
	Tilapia	1^c	-	-	1^a	-	1^a 1^b	1^c
	Seabream (bigger fish)	1^b	-	1^b 2^c	-	1^a 1^b	-	-
3. Tema	Preferred Herrings	-	1^b	-	1^a	-	1^a 1^b 1^c	-
	Redfish	-	1^b	1^c	4^b	-	-	-
	Sead Mackerel	-	-	1^b 1^c	-	-	-	-
	Others Tilapia	-	-	1^b	-	-	-	-
	Seabream (bigger fish)	-	-	1^c	-	-	-	-

TABLE 12 Continued

Towns and food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
4. Winneba	Preferred Herrings	3^b 2^c	1^b	1^a	3^b 1^c	-	3^b 3^c	-
	Redfish	3^b 2^c	-	2^b	2^b 3^c	-	4^b 2^c	-
	Threadfin	5^b	-	2^a	3^b 1^c	-	1^b 5^c	-
	Others Kingfish	-	-	-	-	-	-	-
	Tuna	4^b	-	-	3^c	-	3^b 1^c	-
	Sasakwesi	1^a 1^b	1^c	-	1^b 1^c	-	1^b 1^c	-
5. Elmina	Preferred Redfish	8^b 8^c	2^a	4^a 7^b	6^b 7^c	1^c	2^a 5^b 10^c	-
	Herrings	1^a 5^b 5^c	2^a	2^a 6^b	9^b 4^c	1^a	3^a 3^b 4^c	-
	Threadfin	1^b 3^c	-	1^a 2^b	5^b 1^c	-	7^b	-
	Others Barracuda	2^b 1^c	-	1^a 1^b	2^b	-	3^b 3^c	-
	Ribbonfish	2^b 3^c	-	-	1^b	-	2^b 2^c	-
	Longfin Herrings	1^c	-	-	1^c	-	1^b	-

TABLE 12 Continued

Towns and Food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
6. Axim	Preferred Herrings	9^b 1^c	-	2^a 4^b	6^b 8^c	-	3^a 1^b 3^c 3^a	
	Seabream	1^a 4^b	-	1^a 3^b 2^c	2^b 2^c	2^b 2^c	3^b 1^c	-
	Barracuda	1^a 3^b	-	1^a	1^a 1^b 6^c	1^a	2^a 1^b	-
	Others Threadfin	1^a 4^b	-	1^a 3^b 2^c	2^b 6^c	2^b 2^c	3^b 1^c	-
	Opoku	4^b	-	1^a 4^b	4^c	-	1^b 1^c	-
	Kingfish	4^b 1^c	-	2^a 1^b	1^a 12^c	-	1^a 2^b	-
C. INSTANT FOODS								
1. Keta	Preferred Anchovy	-	-	1^a 4^b	4^b 1^c	-	11^b	-
	Herrings	-	-	1^a 6^b 1^c	6^b	-	3^b 10^c	-
	Tilapia	-	-	1^a 4^b	1^b 1^c	-	7^c	-
	Tsile	-	-	1^c	1^b	1^b	-	-
	Others Redfish	-	-	2^b	1^b	-	3^b 2^c	-
	Tsyiyi	-	-	1^b	1^b	-	-	-
	Shark	-	-	-	-	-	1^c	-

TABLE 12 Continued

Towns and Food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
2. Ada	Preferred Herring	-	-	8[b] 3[c]	1[a] 5[b] 4[c]	-	1[a] 4[b] 12[c]	-
	Tuna	-	-	-	-	-	-	-
	Kingfish	-	-	2[b]	2[b]	-	2[c]	-
	Gesu	-	-	3[b] 1[c]	1[a] 1[b] 1[c]	-	2[b] 3[c]	-
	Others Seabream	-	-	-	-	-	1[c]	-
	Tilapia	-	-	-	-	-	-	-
	Seabream (bigger type)	-	-	1[b]	1[c]	-	1[b]	-
3. Tema	Preferred Herrings	-	-	-	-	-	1[c]	-
	Redfish	-	-	-	-	-	1[c]	-
	Sead Mackerel	-	-	1[b]	-	-	1[b] 2[c]	-
	Others Tilapia	-	-	1[b] 2[c]	-	-	-	-
	Seabream (bigger type)	-	-	1[b]	-	-	-	-

TABLE 12 Continued

Towns and Food Preparations	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
4. Winneba	Preferred Herrings	-	-	1^b 1^c	3^b 5^c	-	4^b 5^c	-
	Redfish	-	-	3^b 1^c	3^b	-	2^b 3^c	-
	Threadfin	-	-	2^a	3^b 1^c	-	1^b 5^c	-
	Others Kingfish	-	-	-	-	-	-	-
	Barracuda	-	-	-	-	-	-	-
	Sasakwesi	-	-	1^b	1^b	-	1^c	-
5. Elmina	Preferred Redfish	-	-	2^b 2^c	-	-	1^b 3^c	-
	Herrings	-	-	-	1^b	-	2^b 1^c	-
	Threadfin	-	-	-	-	-	-	-
	Others Barracuda	-	-	-	-	-	-	-
	Ribbon fish	-	-	-	1^a 1^b	-	3^b	-
	Longfin Herrings	-	-	-	-	-	-	-

TABLE 12 Continued

Towns and Food Preparation	Species	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
		NUMBER OF PERSONS RESPONDING						
6. Axim	Preferred							
	Herrings	-	-	2^{b} 4^{c}	1^{b} 1^{c}	-	2^{b} 5^{c}	-
	Seabream	-	-	3^{b} 3^{c}	1^{b}	-	2^{b} 5^{c}	-
	Barracuda	-	-	2^{b}	-	-	2^{b}	-
	Others							
	Threadfin	-	-	3^{b}	1^{b}	-	1^{b} 6^{c}	-
	Opoku	-	-	-	-	-	-	-
	Kingfish	-	-	2^{b} 3^{c}	-	-	1^{b}	-

Superscripts:

a) - not important
b) - important
c) - very important

TABLE 13 CEREMONIAL USES OF FISH

Towns	Ceremonies	Species	FISHERY PRODUCTS					
			Fresh	Frozen	Grilled	Smoked	Salted	Fermented
Keta	Hanuhanu	Akpa	1	-	-	-	-	-
	Torgbe/ Anyibla	Blackfish	-	-	-	1	-	-
Ada	Oko	Carp	-	-	-	-	-	-
	Asafotu	All species	-	-	-	-	-	-
Tema	Homowo	Seabream (bigger fish)	-	-	2	4	-	-
		Tuna	2	-	1	2	-	-
		Tuna	-	-	-	1	-	-
	Ramadan	Seabream	-	-	1	1	-	-
		Tuna	-	-	-	1	-	-
	Tuna	Electric Fish	-	-	-	2	-	-
		Mudfish	1	-	-	3	-	-
		Longfin Herring	-	-	-	1	-	-
Elmina	Bakatue	Herrings	2	-	1	-	-	-
		Horse Mackerel	1	1	1	-	-	-
		Moambae	1	-	1	-	-	-
Axim	Kuntum	Chub Mackerel	4	1	10	-	-	-
		Shark	-	-	3	-	-	-
		All species	9	9	11	9	-	9
	Wanayebro	All species	11	-	-	1	-	-

Appendix B-1

FRI / URI : ICMRD Fishery Research Project

Coastal Fish Production, Utilization and Consumption Surveys

A. Personal Data

1. Interviewee No..... 2. Age..... 3. Sex.....
4. Marital Status: married, divorced, single, widow.....
5. Size of family.....
6. Occupation.....
.....

B. Food Expenditure

7. How much do you spend on food? i. per day.....
ii. per week.....
8. How much do you spend on fish? i. per day.....
ii. per week.....

C. Consumption

i) Motivation

Why do you eat or buy fish? Because (tick where applicable)

(1) of its food values.....
(2) of its taste.....
(3) it is easily obtainable.....
(4) traditionally we eat food with fish.....
(5) it is cheaper than meat.....
(6) other reasons.....
.....

ii) Fish Preferences

a) Name the kinds of fish in order of preference and state in what form or forms do you usually buy or eat the fish (use the table)

KINDS OF FISH	Form in which fish may be bought or eaten						
	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
e.g. Tsile			X	X			

b) Do you have any reasons for buying one kind of fish as opposed to another? E.g. buying seabream instead of herrings. Give answers on 3 of the preferences stated in question ii) a) above.

1.....
.....
2.....
.....
3.....
.....

c) What other reasons would you give for buying one kind of fish product as opposed to another? E.g. buying fresh instead of smoked fish. Give answers on three of your preferences from question ii) a)

1.....
.....
2.....
.....
3.....
.....

d) What types of fish don't you like and why?

Type of fish	Reasons for dislike

iii) Habits

1. How often, i.e. number of times per week, do you buy or eat fish in the form(s) that you have indicated in question ii) a). For the answers affix "b" meaning bought or "e" meaning eat to the figures E.g. 3b or 4e means "buys 3 times" or eats 4 times". Use the table below.

KINDS OF FISH	Forms in which fish may be bought or eaten						
	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
E.g. Seabream	3b		4e				

iv) Food Preparations

Name the kinds of food preparations of which the kind and the form of fish is an important ingredient. Use 1.2.3.4.5. as the valuation of the degree of importance. Fill the table below.

Food Preparations and kinds of fish	Type of fishery product						
	Fresh	Frozen	Grilled	Smoked	Salted	Fried	Stink/ Momoni
E.g. Palm Soup							
1. Seabream			4	5			
2. Herrings				5			

v) Ceremonies

What type of fish do you know is used in traditional or religious festivities? Use the table below.

Religion/ Festival	Type of Fish	Fishery Products					
		Fresh	Grilled	Smoked	Salted	Fried	Stink

D. Place of Purchase

Where do you normally buy fish and why? Use the table below

Place of Purchase	R E A S O N S

E. Storage

1. If you keep some of the fish for sometime, state the type of fish and/or fish products, quantity, keeping time, package or container used and where the fish is kept.

Type of fish and fish products	Quantity weight or units	Type of package/ containers used	Storage or keeping place	Keeping time (days)	State of fish after keeping
E.g. Smoked herring	5 units	newspaper	basket in the kitchen	2	Good
.....	.....	.....	.....	.....	.....

2. How can you tell whether the fish is good or bad? Check below

a) by smelling.....

b) examine (describe).....

.....

.....

c) by touching..... What do you look for when you touch the fish?.....

.....

.....

3. What do you do when you find the fish in any of the states described in question E.1?.....

.....

.....

APPENDIX 3

A Method for the Determination of Fish Freshness

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ABSTRACT

A fish freshness index has been developed based on the extraction of water soluble oxidisable substances. These substances were reacted with alkaline potassium permanganate solution to give varying shades of color from red to yellow or light brown which were measured colorimetrically. The colorimetric measurements correlated very well with corresponding organoleptic assessments.

INTRODUCTION

After death a number of chemical and microbiological changes occur in fish flesh which reduce its quality and leads to a spoiled condition which is not fit for human consumption. The point along the spectrum of chemical changes at which fish is considered spoiled varies widely with individuals, geographical location, race, custom and eating habits.

In Ghana many situations exist that require fish quality control for consumer protection. For example fresh fish offered for sale by fishmongers or fish intended for frozen storage by fishermen may be uncovered, uniced and exposed to the sun for long hours before the consumer or the cold store receives them. In the interim the quality is reduced to a level dependent upon the chemical reactions that have occured in the fish flesh.

Gas chromatographic analysis show that much of the natural substances responsible for off flavor consist of saturated and unsaturated aldehydes (carbonyls), short chain esters and free fatty acids (Jacini et al, 1965). Diemair (1965) in a similar study has, on the other hand, stated that fresh fish taste and odor are associated with low molecular weight aldehydes together with traces of pyridine. These low molecular weight aldehydes increase in concentration immediately after death and during storage its composition becomes more varied.

One such low molecular weight aldehyde formed in storage is formaldehyde and it is derivable from TMAO according to the equation (Soudan, 1959) --

$$\text{TMAO} \longrightarrow \text{DMA} + \text{H}\cdot\text{CHO}\cdot$$

The concentration of formaldehyde in the cod tissue has been found to increase to a maximum and then decrease at a rate dependent on storage temperature. This decrease in formaldehyde coincides with the period of greater bacterial activity (Amano and Yamada, 1965) and the point where signs of spoilage are beginning to be detected. The disappearance of formaldehyde and other low molecular weight aldehydes could result from their oxidation to corresponding saturated and unsaturated free fatty acids which are also linked to the development of off flavors in fresh fish (Jacini et al, 1965; Diemair, 1965).

Indeed a large number of deterioration products related to odor and flavor, some of which are carbonyl compounds, are also known to form during unsaturated fatty acid oxidation (Stansby and Jillinek, 1965) to the extent that Pearson (1968) has indicated that estimates of free fatty acids may be more reliable as indices of fish freshness.

All the types of chemical reactions occuring in fish undergoing spoilage do not occur at the same time: some appear too late along the spoilage line, others occur too variably while still others may disappear rapidly, to be used separately as indices of fish freshness. Hence Baines et al (1965) have indicated that in so far as the chemical reactions occuring in the dead fish are complex a spoilage index is best which relies on an estimate embodying substances subject to the action of a number of causative agents.

Among chemical methods currently used to assess spoilage and which conform to this criterion is the determination of Volatile Reducing Substances (VRS) which is a method that uses the entire odor-complex present and does not rely on any one compound such as hypoxanthine or TMA (Farber, 1965) and indeed has a considerable range of applicability to both fresh and frozen fish of all types and processing conditions.

A search through the published literature show that a parallel group of substances whose utility as a fish spoilage index has not been explored is the Water Soluble Oxidisable (Reducing) Substances (WSOS). These are substances likely to accummulate in the fish after death due to a lack of oxygen supply to the tissues. These substances embrace many of the individual substances currently estimated as measures of quality in fish e.g. carbonyls, amines, unsaturated fatty acids, hypoxanthine, etc.

In the course of studeis carried out in Ghana it became necessary to find a simple inexpensive index to determine the degree of freshness of fish offered for sale on Ghanaian markets. We therefore decided to explore the utility of WSOS group of substances for this purpose.

Preliminary Consideration

In the extraction of a heterogenous group of water soluble substances the important factor to consider is the extraction temperature. Since no single extraction temperature would be satisfactory because of the different solubilities involved it was decided to adopt a hot water extraction

procedure by which the WSOS in a given sample were extracted in water heated from room temperature up to 100°C.

The oxidizing agent selected for use in this study was an alkaline $KMnO_4$ solution. This is a very active oxidising agent which reacts with a wide variety of odoriferous compounds (Farber, 1965). It is also the oxidising agent, most frequently used for the oxidation of unsaturated fatty acids (Pearson, 1968).

Materials and Methods

The fish species used was red seabream known in Ghana as wiriwiriw and favored by the Ghanaian consumer.

In a preliminary comparative study of fresh and spoiled samples of the red seabream equal extracts of the WSOS in the two samples gave two contrasting colors with a fixed volume of 0.05% alkaline $KMnO_4$ solution - a red hue with a transmittance of 34 at a wavelength of 590nm for the fresh and a yellow hue with a transmittance of 49 for the spoiled sample at the same wavelength. This preliminary result gave the indication that given other samples between these two extremes the observed color could grade from red to yellow to indicate visually the state of freshness of a given sample of fish.

Mechanism of Reaction

In alkaline solution $KMnO_4$ reacts with oxidisable substances and is reduced according to the equation --

$$\underset{\text{(purple)}}{2MnO_4} + H_2O \longrightarrow 2MnO_2\downarrow + 2OH^- + 3O$$

Under basic conditions manganous ions react with -OH ions to form managanous hydroxide which quickly oxidises in air and turns brown owing to the formation of hydrated manganese dioxide.

$$\underset{\text{(pink)}}{Mn^{++}} + 2OH^- \longrightarrow \underset{\text{(white)}}{4Mn(OH)_2} \xrightarrow{O_2} \underset{\text{(light brown)}}{4MnO_2 \cdot 2H_2O}$$

The color of the reaction solution therefore changes from a purple color through various shades of mixtures of purple, pink and brown to a light brown or yellow color dependent upon how much WSOS is available for reaction. These colors may then be measured colorimetrically.

Detailed Procedure

Preparation of sample

Fresh seabream was bought from fishermen soon after landing and transported, over ice, to the laboratory and kept in a deep freezer over night. The next morning, starting at 8:00 am and to simulate market conditions samples of the fish were exposed at room temperature (85^{o}F) in duplicate at regular intervals for periods up to a total of 28 hours. After 28 hours there were samples that had been exposed for 28, 24, 18, 14, 8, 4 and 0 hours. The zero hour sample served as a secondary control along with samples examined immediately on reaching the laboratory without freezing. It may be warned here that the fish as landed by fishermen may not be at their freshest since considerable time lapse may exist between the time the fish was caught and the time of landing. This should, however, not detract from the results of these studies since it only results in the shortening of the freshness spectrum along the time axis.

Examination of sample

From each sample 10 gms. of fish steak without the skin was removed from the dorsal side and cut up into tiny bits with a pair of scissors into a conical flask having a rubber bung that is fitted with a bent glass trap (Fig.1). Forty milliliters (40 ml.) of distilled water were measured and part poured onto the cut pieces of steak in the flask and saving just a little to fill the bend in the glass trap fitted to the rubber bung. The conical flask was shaken in the hand to disperse the cut pieces in the distilled water and then stoppered tight with the rubber bung. The stoppered flask was positioned on an electrically heated plate and the bent neck of the glass trap containing distilled water was placed in a beaker of tap water to cool the glass trap to condense any escaping water vapour from the flask as well as any WSOS vapor during heating. The contents of the flask were heated slowly at low heat for 10 to 12 minutes to simmering point when the flask was removed from the hot plate and left to cool at room temperature. The water in the neck of the trap was tipped back into the flask and the flask contents filtered through a Whatman #1 filter paper.

To 4 ml. of the cooled filtrate was added 1 ml. of N/10 NaOH solution followed by 4 ml. of 0.05% $KMnO_4$ solution. Reaction was allowed to proceed at room temperature for 6 minutes and the percent transmittance read at 590nm using distilled water as blank on a Bausch and Lomb Spectronic 20.

Sensory evaluations

For a chemical or instrumental method to be useful it must correlate with sensory evaluations. For this purpose an organoleptic assessment of the various samples in their raw and steamed forms was organized. The steam cooked samples were assessed by a panel of ten members and the raw by a panel of eleven members.

Each sample was gutted together with the gills and then washed. Half of each sample was cut up into a sufficient number of pieces to go round the panel members and steamed in a glass container for ten minutes; the remaining half was cut up into an equal number of pieces as the steamed samples and presented raw to the panel members.

Each panel member assessed one freshness factor of the raw fish (Raw odor or smell-RO) and 2 of the cooked (taste/flavor-CF and texture i.e. chewiness, bite or softness-CT). In addition each panel member was asked to express his preference (likeness or dislikeness-CD) for the taste of the cooked sample.

Each panel member finished with his assessments of all the labelled raw samples presented before being offered with the cooked samples in an order different from that in which the raw samples were presented.

The maximum scores for each factor on each sample was 4; high scores indicated poor quality. Panel means were used in all subsequent calculations.

Bacteriological examinations were conducted on the skin of some of the experimental samples and on some market samples. The medium used was trypticase soy agar widely used for the enumeration of fish spoilage micro-organisms. The incubation temperature and time were $30^{o}C$ and 48 hours respectively. Results were expressed as count per square cm. of skin surface.

Results and discussion

Transmittance and therefore WSOS concentration increased linearly with time and with RO (Fig.1) and exponentially with CF and CD (Fig.2) indicating in either case that increasing WSOS production induced increasing off freshness in the fresh fish.

CT was not correlated with either time or transmittance and hence not with WSOS production. Indeed Burt et al (1975) have noted that texture scores are not reliable measures of freshness as they are so variable in the freshly caught fish. CT scores here similarly show that texture scores of cooked fish are also not reliable measures of fish freshness.

Figs. 1 and 3 show that the development of off freshness was detected quicker by smell (RO) than by taste (CF). The samples were acceptable by taste up to 12 hours exposure (Fig.2) while they were acceptable by smell only up to four hours exposure (Fig.1). The acceptability by smell agreed very closely with color reaction of the WSOS extracts with alkaline $KMnO_4$ solution. Up to 4 hours exposure which was acceptable by smell the color reaction was reddish while beyond this level of exposure, which was not acceptable by smell, the color reaction was yellowish. It may also be observed from Fig.1 that the rate of bacterial growth on the skin paralleled that of RO development.

These findings bring into sharp focus the justification for discarding fish on the basis of smell especially that of TMA. It is noted that this amine plays no part in the nutritive value of the fish (Holston and Slavin, 1965) and is also not poisonous. Such malodorous substances may reside only on the skin as a result of bacterial degradation of the skin tissue and might not have penetrated into the flesh. At the point of rejection therefore such discarded fish might not have suffered any proteolysis and no loss of nutritional values and therefore nutritionally satisfactory.

By using technology to limit the activities of the strains of bacteria inducing malodorous substances on the surface of the skin or by masking these substances with some safe chemical the supply base of fish may be safely extended in developing countries. Indeed the fishmongers' practice of washing freshly landed fish may be aimed at just

this result. Indeed the difference between the red and yellow color reaction of WSOS extratives with alkaline $KMnO_4$ solution serves to visually indicate the limit of aesthetic unacceptability and not that of edibility which is not reached until later in the seabream.

Table 2 gives the evaluations of samples of seabream sold at the beach, at an Accra market and at an Nsawam market which is about 25 miles inland away from Accra. While all the Accra samples were fresh, indicated by the red color reaction of WSOS extracts with alkaline $KMnO_4$ solution, the inland samples from Nsawam were definitely off fresh. The difference between the two markets arise perhaps from their methods of storage of stock samples. The Accra fishmongers stored their bulk stocks in some amount of ice at the markets while the Nsawam fishmongers had no ice storage whatever.

The bacterial counts recorded (Table 2) were high and varied widely from sample to sample. The high levels of the bacterial counts, however, may account for a high incidence of spoilage at the market when stored without ice.

Table 1. Chemical, sensory and bacteriological scores on samples of seabream exposed for different times at 85°F.

Sample	Hrs. of exposure	%Trans. (590nm)	Color with alk. $KMnO_4$ solution	RO	CF	CT	CD	log bacterial count/sq.cm.skin
				(arbitrary average scores)				
A	0 (unfrozen)	41	Reddish	1.2	1.5	2.3	2.1	--
B	0 (unfrozen)	42	"	1.4	1.6	2.2	2.1	10.5
C	4	42	"	1.7	1.6	2.3	2.0	11.8
D	8	46	Yellowish	2.1	1.6	1.7	1.9	13.2
E.	14	50	"	3.1	1.8	2.2	2.4	15.0
F	18	55	"	3.1	2.4	1.7	2.9	--
G	24	51	"	3.1	2.1	2.2	2.3	--
H	28	55	"	3.8	3.7	2.1	3.7	--

Table 2. Quality of seabream sold as fresh at Salga market at Accra and at Nsawam.

Sample #	Location	% Transmission 590 nm	Color reaction	Bacterial count/sq.cm.of skin
I	Teshie Beach	35	red	--
II	Accra	40	red	28×10^8
III	"	42	red	34.5×10^8
IV	"	44	red	15.4×10^8
V	"	41	red	4.7×10^{10}
VI	Nsawam *	51	yellow	--
VII	"	49	yellow	--

* 25 miles inland from Accra.

Acknowledgement

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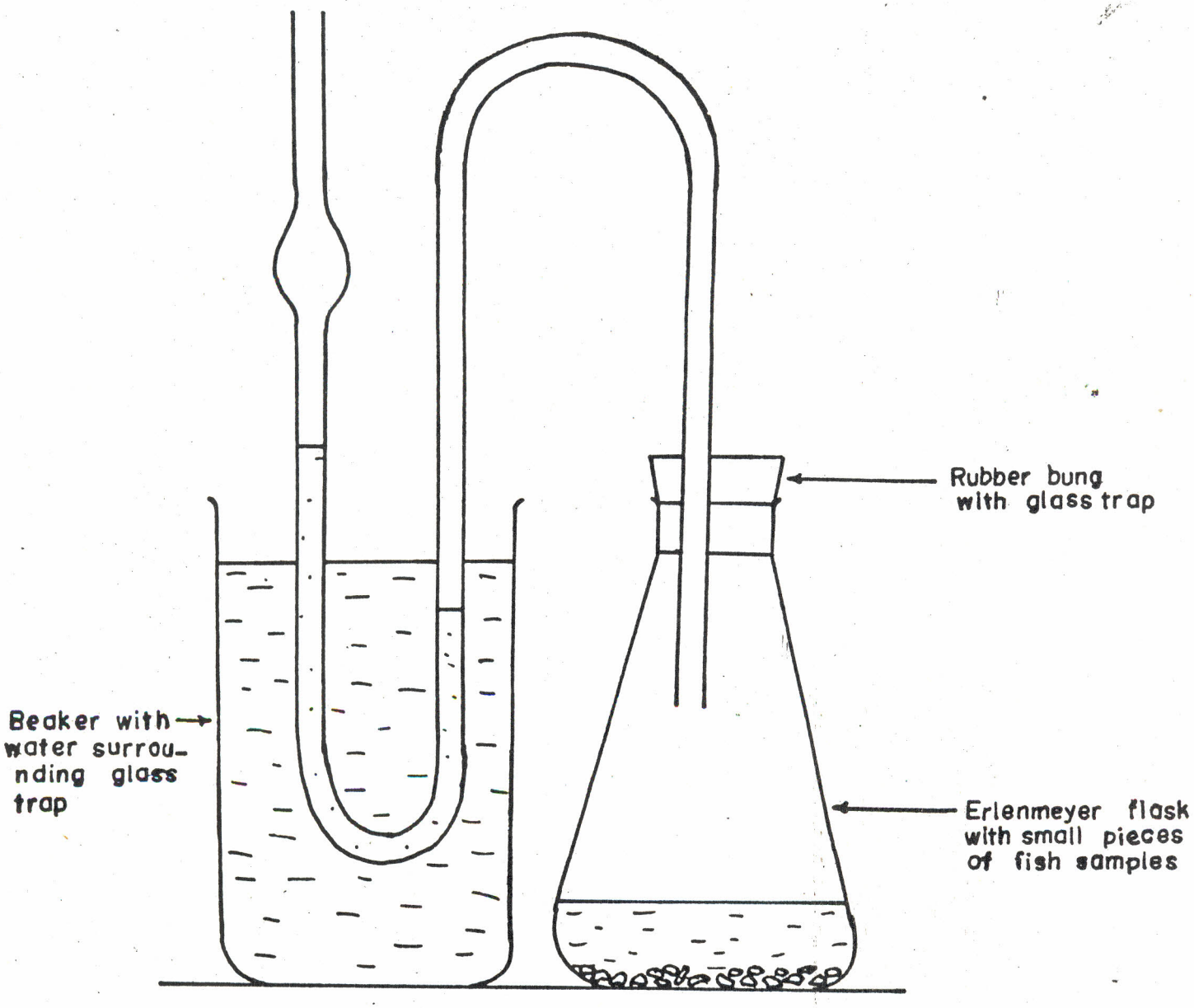


FIG. 1 Apparatus for extracting WSOS from fish samples.

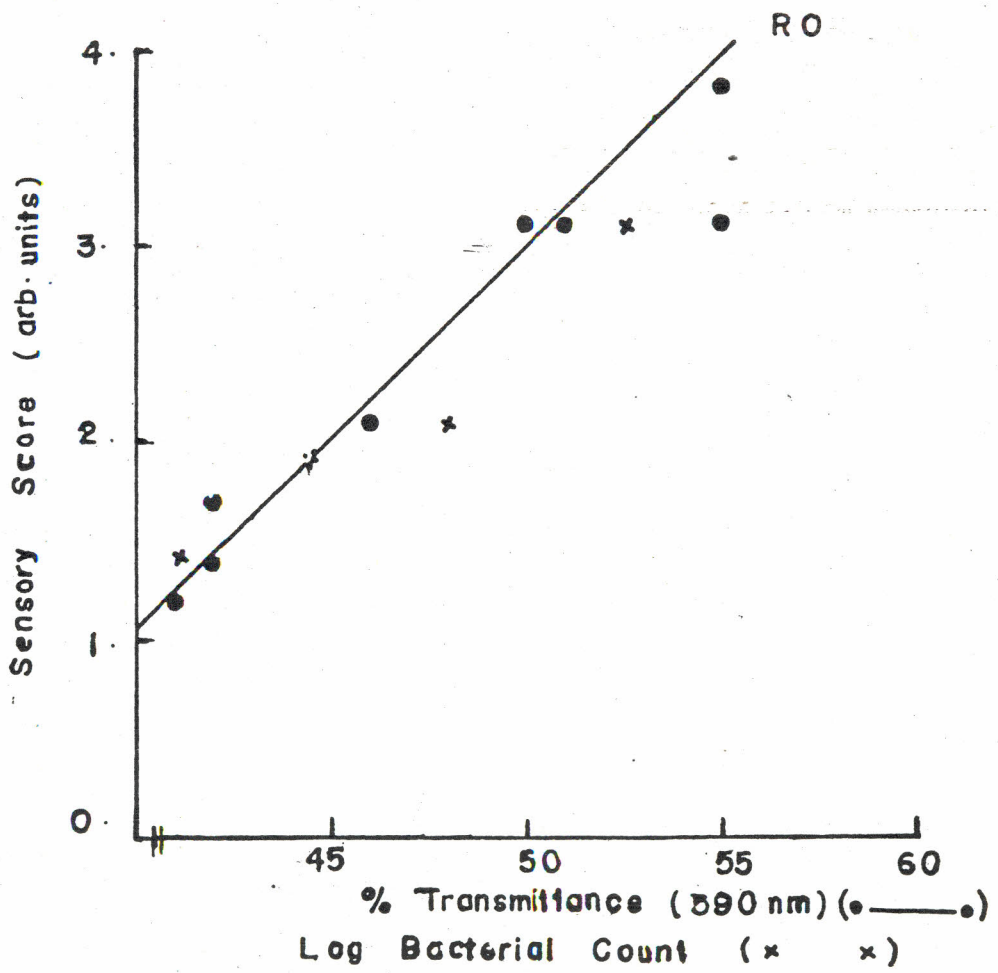


FIG 2. Correlation of raw odor scores (RO) of fish samples with per cent transmittance and bacterial count

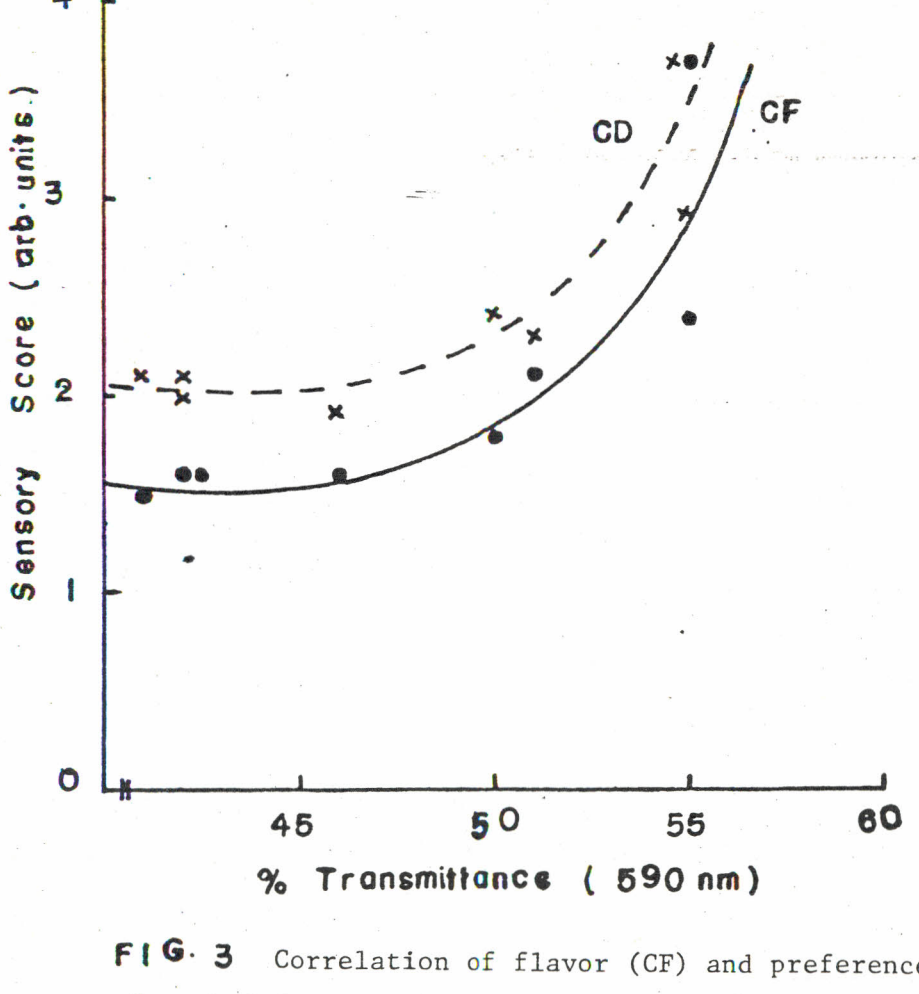
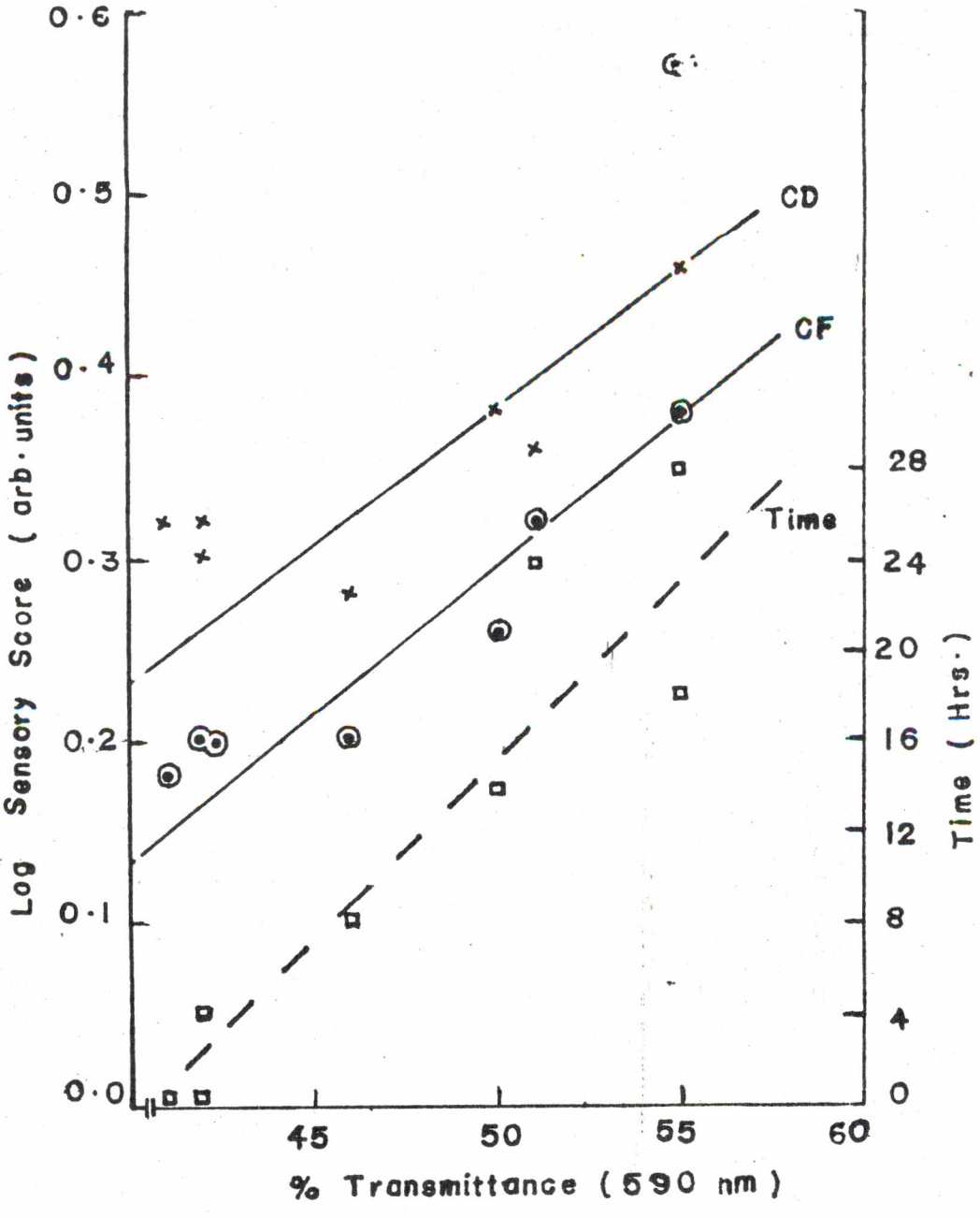


FIG. 3 Correlation of flavor (CF) and preference (CD) scores of cooked fish samples with per cent transmittance.



FIG· 4 Linear correlation of flavor (CF) and preference (CD) scores of samples in Fig. 3 and the correlation of time with per cent transmittance.

APPENDIX 4

Specimen Form for Organoleptic Testing of Fish

Name:

Date:

We want to assess the freshness or quality of these samples of fish. Indicate the description which fits your impression of the samples.

Sample	C O O K E D			R A W
	Texture-chewiness or bite (CT)	Taste/flavor (CF)	Dislikeness (CD)	Raw odor/smell (RO)
A B C D E F G H				
Descriptive terms (and their numerical scores	Fibrous(1) Less Fibrous(2) Soft (3) Very soft(4)	Fresh flavor(1) Slightly off fresh flavor(2) Definitely off fresh flavor(3) Strongly off fresh flavor(4)	Like very much (1) Like (2) Dislike (3) Strongly dislike(4)	Fresh odor (1) Slightly off fresh odor(2) Definitely off fresh odor(3) Strongly off fresh odor (4)

Appendix 5. Map of Ghana Coastline
showing towns where surveys were conducted