* FISH PRESERVATION

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* FISH PRESERVATION: REASONS FOR SPOILAGE OF FISHES

FISH PRESERVATION

Preservation of fishes is a very important part of commercial fisheries. It is done in such a manner that fishes remain fresh for a long time, with a min^m loss of taste, colour, flavour, nutritive value and the digestibility of their flesh. Since are quickly perishable commodities and are spoiled if not properly preserved during peak period, large quantities of fishes are caught and require proper preservation so as to be available during lean period.

After preservation, fishes can be transported to long distances for consumption. In India, with its tropical and sub tropical climate, the problem is more acute, as heat and moisture promote fish deterioration. Landed fishes may ordinarily remain fresh for not more than 8 hrs and begin to decompose rapidly after that.

[A] REASONS FOR SPOILAGE OF FISHES

Fishes spoilage occur chiefly due to three acting agents.

i) MICROBIAL ACTION
ii) ENZYMATIC "
iii) CHEMICAL "

1) FISH SPOILAGE DUE TO MICROBIAL ACTION

Microbial action evolves mainly bacterial spoilage of the fish flesh. A large no. of bacteria present on the body, gills and guts, fish is a good medium for development due to high moisture (75-80%) contents in the fish flesh. Also during catching operation, fishes get cuts, abrasions, etc leading to haemorrhage. These provide an ideal environment for bacterial activity which are most destructive to the fish.

The degradation of specific food components occur through its specific microbes in three way.

MICROBES INVOLVE	COMPONENT	PRODUCT
i. Proteolytic Enzymes like Pseudomonas, Proteus, chromobacterium, Halobacterium, Micrococcus, etc.	Protein	Amino acids + amines, Ammonia + H_2S + CO_2 ↑
ii. Fermentive microbes eg. staphylococci, leucocytoc	Carbohydrate	Acid + alcohol + gases.
iii. Lipolytic Microbes gram -ve bacteria	Fats	Fatty acid + Glycerol

II FISH SPOILAGE DUE TO ENZYMATIC ACTION

Quite a large amount of fish flesh is spoiled by the action of digestive enzymes which remain active even after death of the fishes and soften the flesh by autolysis and to make the fish susceptible to bacterial infection.

ENZYME	COMPONENT	PRODUCT
Proteinase	Muscle protein	Amino acids, NH_3, CO_2, amines, indole and skatole, etc
i. Catalase		Gill spoilage
ii. ATPase		Complete removal of ATP from muscle tissue

III FISH SPOILAGE DUE TO CHEMICAL ACTION

Spoilage of fish flesh due to chemical action is more pronounced in fatty fishes like sardines, mackerels, trout, catla, grass carp etc., as a result following changes occur in fish.

a) Fish become decolourised
b) Rancidity of fish oil starts by oxidation as fish flesh oil comes in contact with the atm. air.
c) Viscosity of flesh oil changes.

Rancidity may be prevented by the use of antioxidants like polyphenol or other vitamin and minimising exposure of fish to moist atm. air.

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B] POST MORTEM CHANGES IN THE FISH MUSCLE

The post-mortem changes take place consequently by stoppage of oxygen supply to the tissue due to ceasing of blood circulation, degradation of the muscle tissue component by autolysis and several other changes such as —

a) Glycolysis
b) Rigor-Mortis
c) Hydrolytic changes

A] GLYCOLYSIS :—

In live fishes glycolysis takes place with the help of oxygen supplied through the blood but soon after death, as the blood circulation stops, the muscle cells do not receive oxygen any more i.e. aerobic ord^{n} ceases. But Anaerobic ord^{n} of glucose with the help of enzymes present in the muscle takes place producing lactic acid.

Due to accumulation of lactic acid the PH of the muscle falls. Glycolysis will continue until the glycogen content is completely used up. Because of the red^{n} of the PH of the muscle to the acidic side the fish flesh gets protection against bacterial invasion.

B] RIGOR-MORTIS :—

It is the phenomenon of stiffening of the muscle taking place shortly after death. During rigor-mortis the muscle become hard and inelastic and unable to stretched out. The texture of the fish muscle is by no means the same in pre and post-rigor mortis.

Because of the lowering of the PH, the protein lose the water holding capacity i.e. protein get progressively denatured. Further, the myofibrillar proteins actin and myosin combine to form actomyosin resulting in the muscle shrinkage causing stiffness of the muscle. The development of stiffening is also related to the degree of degradation of ATP in the muscle.

The combination of actin and myosin is accompanied by stepwise hydrolysis of ATP → ADP → Adenosinemono phosphate (AMP) → Inosine monophosphate (IMP) → Inosine → Hypoxanthine.

The hypoxanthine content will progressively increase with lapse of time and its conc^{n} is considered as an index of freshness of fish. The stiffness of the muscle begins when the content of ATP reaches a low level of abt. 5% of the original.

IMP has distinct taste and is a flavour component in fish whereas hypoxanthine is bitter and imparts an off flavour.

Rigor mortis is of great significance in fish processing, particularly freezing. If the fish are filleted pre-rigor, the fillet pass into rigor before attaining the freezing temp. resulting in severe contraction of the muscle and causing heavy loss in weight on thawing.

[Post rigor fish will retain pressure marks if pressed bet^{n} fingers whereas pre-rigor fish being inelastic will not retain the impression].

C] HYDROLYTIC CHANGES :—

PH ↓

Due to lowering of PH after death, the lysosomal membrane gets ruptured releasing the hydrolypases like proteinases, nucleotidase, lipases, etc resulting in the rapid degradation of tissue constituents as proteins, nucleic acids, lipid, carbohydrate, etc.

The degradation of proteins results in raising of water holding capacity and PH. The proteins are converted to proteases, peptones, polypeptides and amino acids which together with nucleotides, minerals and vitamins constitute an ideal medium for microbial proliferation. This favours the onset of rapid microbial spoilage.

The extracellular bacterial enzymes degrade the tissue further with the concomitant rise in spoilage indices like trimethylamine, total volatile bases etc.

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[C] CHANGES TAKING PLACE IN DIFFERENT TISSUE CONSTITUENTS DURING SPOILAGE :-

i. WATER AND PROTEIN :-

Water in the tissues exist in two different forms. FREE WATER and BOUND WATER. Water molecules attached to other molecules like protein, etc. through strong or weak chemical bonds constitute bound water. Removal of water by any process will results in alterations of the structure of the molecule.

The physical and biological properties of protein are due to the unique structure of these molecules. In a living system this structure is kept in tact. Changes in PH, temperature, etc will effect the structure of the protein molecules especially once the system is dead. Under such cond^{n} the denaturation of protein occur which will result in loss of texture, reduced to water holding capacity etc. and unbalance in

ii. LIPIDS :-

The important deterioration in the lipids are -

a) AUTOXIDATION
b) HYDROLYSIS

a) AUTOXIDATION :-

Fish tissues are supplied with antioxidants like α-tocopherol through the circulatory system and hence the fat in the living tissue does not become oxidized. However, with the stoppage of circulation on death, the fat in the tissues undergoes rapid oxd^{n} by atmospheric oxygen. Certain enzymes in the tissues act as pro-oxidants and play very important role in the oxd^{n} and rancidity. Exposure to oxygen initiates the reac^{n} and then it propagates by a free radical mechanism. Traces of iron, copper, etc present in the system act as catalysts.

The primary products of autoxidation viz. peroxides and hydroperoxides decomposes rapidly into various products like aldehydes, ketones, etc. Peroxide form^{n} is slow in the initial stage and called as Induction period. The length of induction period depends on various factors like initial freshness of the fish, temperature of freezing and storage, biochemical composition of the tissues etc. After the induction period, the peroxide conc^{n} increases and reaches a max^{m}. Fish stored for a longer time may have lower levels of peroxides than those stored for shorter periods.

Denaturation occurs in frozen fishes in extreme cases of oxidation.

b) HYDROLYSIS :-

Lipid hydrolysis is caused by the lypolytic enzymes present in the tissues. Accumulation of free fatty acids results in further deterioration in quality. Free fatty acids accelerates protein denaturation and in their free state are more susceptible to oxd^{n} than in esterified state. Therefore, hydrolysis of the lipids indirectly promotes lipid oxd^{n}.

[D] SPOILAGE INDICES :-

(A) Subjective Method

In the trade, freshness is usually judged based entirely on the appearance, odour, and texture of the raw fish. Since, this assessment depends on the sensory, these factors are called sensory or organoleptic parameters. This is a subjective method.

(B) Objective Method

Measurement of the conc^{n} of certain chemicals in the tissues serves as an objective method of assessing the quality. The changes in odour, flavour and texture of the fish flesh appear to run parallel to the certain chemical changes in the spoiling fish. Therefore, determining the conc^{n} of products of chemical and bacterial processes may be useful in determining the extent of spoilage.

Since the spoilage is the result of many complex changes and most chemical methods involve the measurement of only one, or at the most of a few indices, some of the important indices are as below.

Tabular form

1. TVN (Total Volatile Nitrogen) / Total volatile bases:

Spoilage of fish is accompanied by the release of volatile compounds like trimethylamine, ammonia etc.

* Fish Spoilage Indices and Methods of Fish Preservation

The conc^{n} of these compounds vary from 30 to 60mg/100g fish flesh.

ii. Trimethylamine (TMA) – Very fresh fish has only very low content of TMA and its conc^{n} increase as spoilage advances.

iii. K-Amino nitrogen and ammonia increase as increase in degradation of muscle protein. Ammonia will appear as the result of decomposition of urea in elasmobranchs.

iv. Volatile Reducing Substances (VRS) are compounds responsible for off odour and flavour and many of them are reducing agent.

v. Formation of hypoxanthine is somewhat proportional to spoilage during early stages.

vi. Peroxide Value (PV) – It is the measure of the degree of oxid^{n} of the fat. As the oxid^{n} of fat increase PV increases and rancidity also increases.

vii. Thiobarbituric Acid (TBA) Value – Oxidised fat reacts with TBA to produce red pigment. The reactive material is supposed to be malonaldehyde (MDA) mainly produced from methylene separated dienoic and polyenoic acid. TBA test is used to determine the malonaldehyde in the fish.

viii. K-Value (%) = $\frac{HX + HXR}{ATP + ADP + AMP + IMP + HX + HXR} \times 100$

[E] METHODS OF FISH PRESERVATION :–

The most important principle of preservation of fishes is cleanliness and sanitation. Preservation can be done both for short and long duration by employing methods given below.

SHORT DURATION PRESERVATION

When short duration preservation is required for short-duration (2-4 days), the captured fishes are kept in crushed ice the range of temperature is from 0-4°C, which retards the microbial action as well as autolytic enzymic activities are also checked.

LONG DURATION PRESERVATION

When the preservation is needed for a long period of time, the caught fishes are passed through the following steps.

i) cleaning (2) Degutting and (3) Conservation and Storage

cleaning is done by cold clean water to remove microbes like bacteria and slime, blood stains, mucus, faeces, sand and mud, etc. from the body surface of fish.

Then, cleaned larger fishes are degutted i.e. all the internal organs or viscera are removed and the body cavity is washed. It is required to prevent microbial decomposition and enzymic autolysis respectively.

Conservation is essential for keeping the dead fishes in fresh condition for quite a long duration. It is achieved by employing various methods. Some of them are as described below.

[1] REFRIGERATION :–

The recent method of preservation is refrigeration as it prevents putrefaction and decay. Frozen fishes retain their nutritive qualities for a long time, perhaps even for a year. Fishes are packed in ice layers for short-time preservation in markets or for transport. For long-time preservation, large electric refrigerators or deep freeze cabinets are employed.

In big commercial concerns like those in Sassoon Docks in Mumbai, rooms are cooled by electric refrigerating methods and large quantities of fishes are stored in them for months. Quick freezing is advised where fishes have to be kept for a longer period. The carrier air plant type of quick freezing is employed at Mumbai, Mangalore, Calicut, Cochin and Trivendrum.

Lowering of the temperature to about 0°C (i.e. called chilling) is the most effective method of preventing putrefaction and extending the life of the dead fishes. For chilling, large amount of ice is used to lower the temperature of the fish. Large fishing vessels are provided with such facilities. Alternate layers of ice and fish must be arranged

* Methods of Fish Preservation Continued..

to bring down the temperature of the flesh to about 0°C. In the large fishes, ice must be applied in the abdominal cavity after gutting.

Antibiotics like terramycin and aureomycin can be incorporated in the ice to inhibit the microbial growth.

Chilling does not alter the physical state of the fishes and keep them in palatable state for a few days.

However, this method is not suitable, when the intention to keep fishes for a period of more than two weeks.

[II] DEEP FREEZING:

For deep freezing, captured fishes are cleaned, gutted, sorted and trimmed to suitable sizes. They are frozen either immediately within 20 minutes of their catch (quick freezing) or within a period extending from 3 to 12 hrs (slow freezing). The freezing is achieved in ice, mixed with salt. Addition of salt brings the temperature gradually down from −1°C to −18°C.

By deep freezing, fishes may be preserved for a very long period. Preservation by deep freezing often causes loss of flavour and slight damage to tissues. Some times fish becomes tasteless. This may be prevented by wrapping wax paper or cellophane and by glazing fish.

Deep frozen fishes should be immediately used after thawing, because surviving microbes begin to multiply rapidly as soon as the frozen fish is warmed.

[III] FREEZE DRYING: —

It is complicated process and requires considerable establishment. As it is costly and laborious process, only the best fishes are treated.

The fishes are first frozen and then dried by sublimation i.e. the ice is converted into water vapour without melting into water. The flavour and colour and nutritive value of the fish remains fully preserved. The fish is first cooked, if it meant for immediate consumption, after opening the packet or tin.

The fish is frozen to −20°C by placing it in a freezing chamber. Fish trays are then transferred to a chamber containing horizontal heating plates for drying in vaccum. The dried fish is packed or canned in air conditioned room.

[IV] SALTING: —

Salting is a form of pickling and is a very old and common method of preserving fish in India and also throughout the world.

In salting, the fishes are treated with salt (NaCl) sol^{n}. Salt dehydrates the killed fishes by osmosis and enters their body tissues to increase conc^{n} to the saturation point. A conc^{n} of salt above 25% stops further multiplication of microbes and even kills them, specially the halophobic microbes. However, few strain of bacteria like halophilic, remain unaffected causing pink or dun spoilage of the fishes. Normally, 20 kg of pure salt is required for each 100 kg of fishes. It is found only oily fishes require more salts.

There are mainly three methods of salting —

i) Dry salting
ii) Wet or brine salting and
iii) Cold salting.

i) DRY SALTING

- Firstly fishes are cleaned and rubbed with salt powder and then packed in tubs or cemented tanks.
- Dry salt powder is sprinkled in between layers, as the fishes are arranged in the container.
- The ratio of salt to fish varies from 1:3 to 1:8 depending on local practice, weather conditions and type of fish.
- After 2-3 days the fishes are removed from the tubs or container and dried in sun for 2-3 days.

Dry salt practice in pits for fish preservation is done along the east coast of India and in Andhra Pradesh. Such preserved fishes are of inferior quality but find good market among poor classes.

* Methods of Fish Preservation Continued..

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ii) WET OR BRINE SALTING – It is mostly practised on the Konkan coast.

- cleaned fishes are packed in large containers having concentrated salt sol^{n} (20-30%) and stirred daily till properly pickled.
- Large sized fishes like Indian salmon, seerfishes and black pomfrets are ungutted first and inside is cleaned. Also longitudinal slits are made in the flesh to allow penetration of salt.
- On the first day, half of the salt is rubbed into the incisions and the fishes are stored on the cemented floor of the curing yard.
- On second day, the fishes are shuffled so as to bring the bottom layer on top and half of the remaining salt is rubbed and fishes are restocked.
- The stock is left undisturbed for 7-10 days. The salty water that oozes out from the fishes is allowed to drain off.

Wet salted fishes may be sold without drying. It does not keep good for long and therefore has to be used within 3-4 months.

iii) COLD SALTING: –

This is done by spreading powdered salt and crushed ice on the fish. About 22-26 lb of powdered salt per 10 kg of fish is usually recommended. After salting the conservation is done in cold rooms, having temperature range of 2-3°C.

These salt fishes are used after soaking them in freshwater overnight.

[V] SMOKING: – Smoked fishes is not as popular in India as it is in Western countries like Norway and Sweden. However, small quantities of surplus fishes are smoked in Chennai and Orissa. Sardines, mackerels, seerfish, pomfret, few fish and Hilsa are considered good varities for smoking.

- First of all, fishes are cleaned and ungutted then soaked into salt sol^{n} or brine.
- They are taken out from the salt sol^{n} and a suspended on rods in smoke house which is merely a shed or a box over a fire. It is such controlled that it produces

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smoke instead of flame.

- It takes about 6 hrs to smoke fishes so that they can be eaten or stored.

Smoking removes additional moisture and increases the flavour of the fish flesh but it does not last as long as salted fish because it must be refrigerated, frozen or canned, if it is to be stored.

[VI] DRYING: – The main objective of drying is to remove moisture from fish tissues to arrest bacterial and enzymic putrefaction. When moisture content reduce upto 10-20%, the fishes are saved from being spoiled, provided they are stored in dry condition. In India, over 35% of the total catch of sea is cured in the sun.

Small marine fishes, such as ribbon fish, silverbellies and Bombay duck are spread on the open sandy beach. Sometime mats made of coir or palm leaves are used for spreading the fishes.

Fish drying can be achieved either naturally or by artificial means.

A] NATURAL DRYING: – In natural drying, the caught fishes are cleaned and dried in sun shine so called Sun-drying. It has certain disadvantages because it results in much loss through putrefaction and spoilage and the dried fish develops a peculiar odour.

Only thin fishes can be preserved by this method bcoz the fat fishes have much flesh allowing microbial decomposition to continue in deeper parts of their body.

B] ARTIFICIAL DRYING: – In artificial drying, the killed fishes are cleaned, ungutted and decapitated. They are then cut lengthwise to remove large part of their spinal column, followed by washing and drying mechanically. This process yields a high quality product, which retains the natural flavour and nutritive values.

* Methods of Fish Preservation and Its Demerits Continued..

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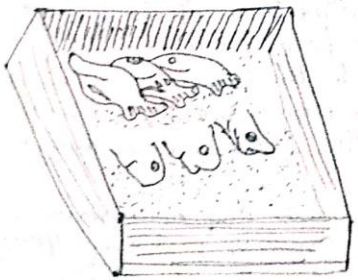
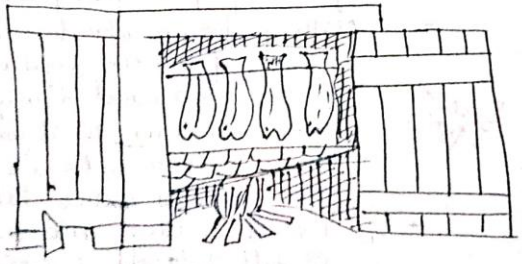
(iii) CANNING :- Canning is a complicated process and costly machinery and technical expertise required, so its products are costly. This process of fish preservation was initially evolved in Europe and now in other countries including India. The canning process is done by the following steps :-

- Firstly, the fishes used for canning are gutted out and cut into pieces of suitable size. Their head, tails, fins and viscera are removed and the pieces are dipped into brine to remove blood etc. from tissues
- Pieces are now immersed in hotwater or exposed to the steam to remove adhering materials which could not be removed by cleaning with cold water
- Pieces are salted and dried and then mixed with a spicy paste ground by mixing vinegar, red chillies, mustard, garlic, turmeric and tamarind in oil medium.
- For pickling, usually mackerel and sardines are used.
- Finally, the processed ~~process~~ pieces are sealed in containers, preferably tin boxes or jars. The sealed boxes are again subjected to heat treatment to kill completely the microbes left in the flesh of cut pieces of fishes.

PROCESSING :- All above mentioned process of fish preservation is called fish processing. It ~~mate~~ may also be processed into edible meals and oils obtained as bye-products.





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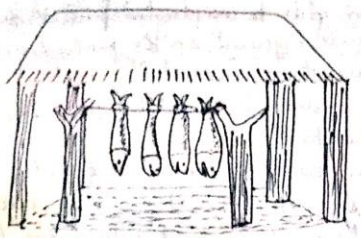

DEMERITS OF FISH PRESERVATION :-

Although the preservation and processing constitute a very important aspect of the fish industry, it has certain drawbacks as well, particularly with respect to retaining quality of fish flesh. Following points describe demerits :-

- If proper hygienic measures are not adopted during the processes like cleaning, gutting and evisceration etc. more harm would be resulting to the preserved material owing to increase in the microbial population.
- Poor or incomplete preservation leads to decarboxylation of flesh amino acid i.e. histidine to histamine.
- Drying reduces weight, nutritive value and the digestibility of the fish flesh.
- Chilling brings about denaturation of the fish flesh. It is because of the ice crystals formed during chilling and causing mechanical damage to the muscles. Cell membrane burst, structures get deformed and fish flesh loses much of its flavour and taste. The flesh becomes dehydrated and loses its texture too.
- Excess salting allows growth and multiplication of salt tolerant bacteria causing 'pink eye' spoilage of fish flesh.
- Salting combined with smoking results in loss of

Methods of Fish Preservation : Conclusion

protein (about 1.5% due to salting and 30% due to smoking). Smoking also promotes rancidity of fat-contents of flesh and hence diminishes digestibility of fat products. Canning leads to much loss of Vit B1, Pantothenic acid, and ascorbic acid.

CONCLUSION :—

The importance of fish as a food is primarily because of its unmatched nutritional qualities. Fish protein is one of the best from the nutritional point of view. It is easily digestible and it contains all the essential amino acids. Fish proteins also have hypocholesterolemic properties. Similarly, fish lipids, apart from serving as a source of energy, also have special nutritional importance. The polyunsaturated fatty acids in the fish oils are believed to be cholesterol removing factors. Long chain n-3 polyunsaturated fatty acids, especially the eicosapentaenoic and docosahexaenoic acids, play important roles in the functioning of the nervous system and in the process of blood clotting.

During spoilage many nutritional components are destroyed and some toxic substances accumulate. Changes in the structure of proteins and the lipid molecules during spoilage may render them nutritionally not available. Aggregation or polymerisation of proteins may make them indigestible. Partial hydrolysis of proteins releases certain amino acids preferentially and such losses results in decrease in the nutritional qualities.

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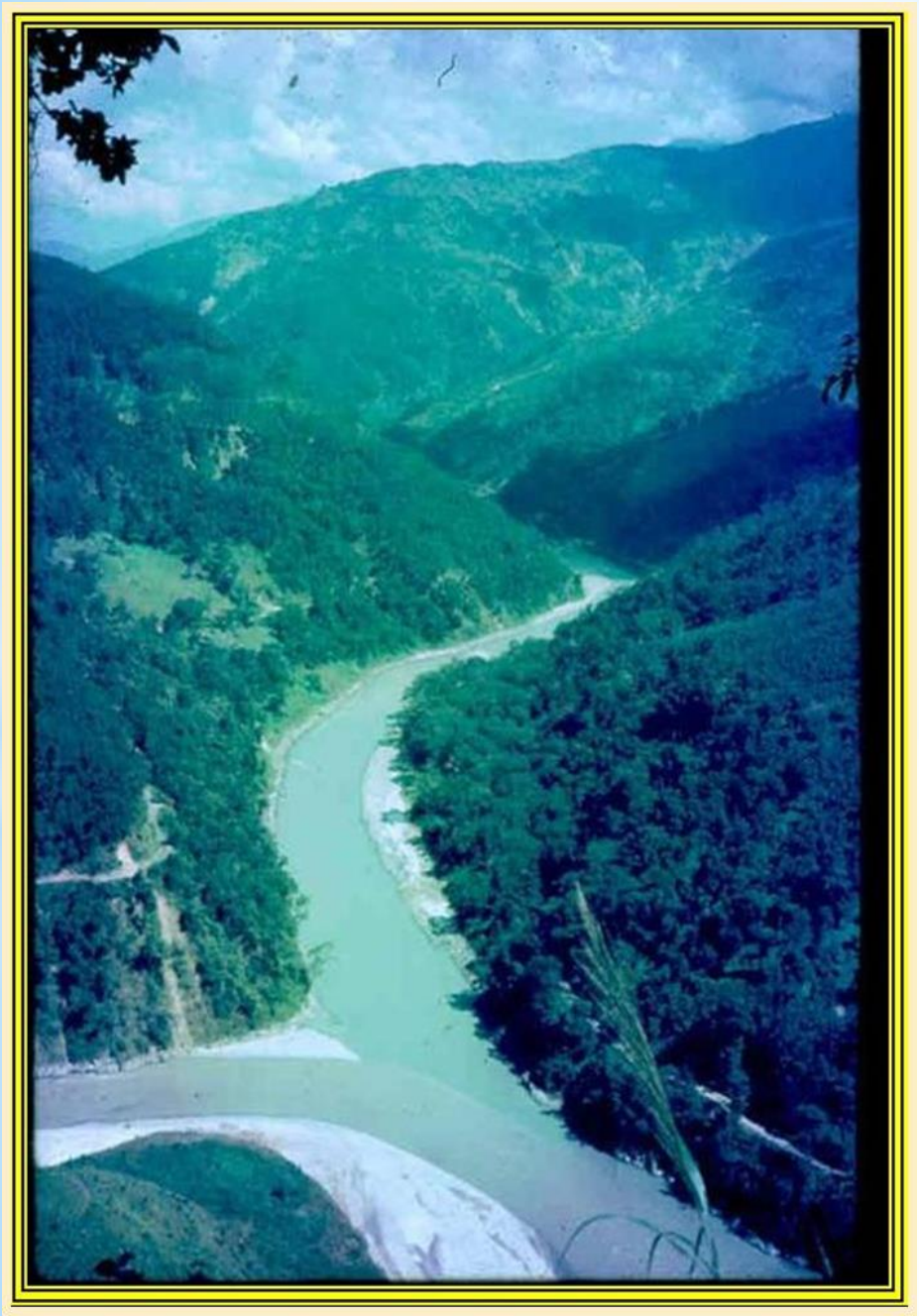

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