PROJECT REPORT ON THE RESEARCH PROJECT

DRYING OF FISH AND MEAT FOR SCIENTIFIC PRESERVATION WITH REFERENCE TO THE METHODS USED BY PLAIN TRIBALS OF THE BRAHMAPUTRA VALLEY

Sponsored by :

ASSAM INSTITUTE OF RESEARCH FOR TRIBALS AND SCHEDULED CASTES

GOVT. OF ASSAM

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INTRODUCTION

The nutritive and medicinal value of fish has been recognized from time immemorial. It provides an excellent source of protein for human diet. The protein is relatively of high digestibility, having biological and growth promoting value for human consumption. Nutritional studies have proved that fish protein rank in the same class as chicken protein and are superior to milk, beef protein and egg albumen. Fish protein comprises all the ten essential amino acids in desirable strength for human consumption (namely, lysine, arginine, histidine, leucine, isoleucine, valine, threonine, methionine, phenylalanine and tryptophane). This accounts for the high biological value of fish flesh. Fish, therefore, becomes a valuable supplement to human diet for people who are habitually taking cereals, starchy roots and sugar as their principal diet. Besides proteins, fish flesh also offers minerals, iodine, vitamins and fat. Over and above all, fish flesh cooks easily, offers a palatable taste and flavour, and is easily digestible.

Fish is consumed either as a preparation from freshly caught fish or from those that have been preserved in some form. However, fish in fresh condition makes a difference. The nutritional value, the look, the flavour and even the biochemical compositions do not remain constant and undergo changes during preservation processes and storage. Also, same speices of fish may show variation in biochemical composition of its flesh depending upon the fishing ground, fishing season, age and sex of the individual; fat and water content being most affected.

Fish is more easily perishable than cattle, sheep and chicken. To prevent spoilage of fish some form of preservation is necessary. Preservation means keeping the fish, after it has landed in a condition wholesome and fit for human consumption for a short period or a few days or for longer periods of over a few months. During the period of preservation the fish is kept as **fresh** as possible, with minimum losses in flavour, taste, odour, form, nutritive value, weight and digestibility of flesh. This preservation should cover the entire period from the time of capture of fish to the sale at the retailer's counter, including any storage time. The cost of preservation should, however, be low to ensure profitable return. The method of preservation should be simple, such as may be applicable on a commercial scale, and suitable for climate of the place concerned. The fish or its products, when preserved, should have good keeping quality, long keeping period or storage life, safe for human consumption, and can be **freshened** during preparation and cooking. It must be pointed out that imperfectly or poor preserved fish could be dangerous and may cause serious food-poisoning when eaten. There are several instances of heavy losses of human lives due to consumption of badly preserved fish or other meat products. There are regions in the world where fish or meat preservation is not necessary. In arctic zone, for instances, landed fish is rapidly frozen due to extremely cold climate. In temperate climate like European countries, the need for preservation

is not so pressing because fish can remain fresh for a few days without any preservation. The picture is quite different for tropical countries like Indian. Here the hot climate favours rapid spoilage of fish. In India, for example, landed fish can ordinarily remain fresh for not more than 6-8 hours after capture and after which decay is imminent. Fish must, therefore, be preserved soon after landing.It is unfortunate that most of the countries are economically backward or poor, faced with food scarcity and technologically underdeveloped. Wastage of animal protein by way of fish spoilage cannot be afforded. Preservation is greatly needed, but preservation is realtively more difficult in tropics than in temperate places. Large geographical size, poor transport facilities and lack of funds are some additional problems.

The objectives of fish preservation is, however, large. Besides ensuring availability of fish in a condition fresh and fit, it also helps -

[i] in maintaining a steady supply of fish in the market throughout the year, including the period of poor catches.

[ii] in keeping a control over the hike and fall in prices, thus stabilishing the price even in periods of low landing or bumper catches.

There are various methods of fish preservation, many of which are only of local importance. Those methods with a wider application are:-

* Chilling with ice or a mixture of ice and salt.
* Freezing and refrigeration.
* Storing in cold storage.
* Deep freezing and freeze drying.
* Sun drying.
* Mechanical drying.
* Dry salting.
* Brining.
* Smoking.
* Pickling etc.

Except the first five methods, rest methods are often described as curing. The methods variously adopt one or other principle of preservation or often also a combination of these. There are several drawback against each methods, but improvements, however, are being constantly made in the methods of preservation or to overcome these drawbacks.

Meat preservation by the plain tribes of Assam remains limited. This is owing to non-availability of sufficient amount of meat at a time. However, in some places pork and occasionally deer (hunting or

killing is prohibited by the law) meat are kept preserved for 2-3 months. Other types of meat like mutton/chickens or some other bird meat are not preserved because of their scarcity in these region. During the present investigation only a few records on pork preservation could be observed among the plain tribes of Assam.

Although originally we proposed to investigate the preservation of meat as well as fish, later on we had to confine our studies particularly on fish preservation only.

AIM OF THE PRESENT INVESTIGATIONS:

Assam is blessed with the water resources afforded by the river Brahmaputra with its large number of tributaries, streams, beels, swamps, which provide the occurrence of a large variety of freshwater fish resources. However, the occurrence of the freshwater fishes of commercial importance such as carps (Rohu, Labeo rohita; Mrigal, Cirrhinus mrigala; Catla, Catla catla; Baih, Labeo calbasu; Bhangan, Labeo boga, Cirrhinus reba), Chital, Kandhuli, (Notopterus Chitala, N. notopterus), Sal-Sol-Goroi (Channa; C. marulius, C. striatus, C. punctatus), Kawoi-Magur-Singhi (Anabus testudeues, Clarias batrachus, Heteropneustes fossilis), Puthi (Puntius sp.) and cat fish like Barali (Wallago attu), Ari (Mystus seenghala), Pabda (Ompok pabo) and other miscellaneous fish are not adequate to meet the daily demand of the large section of the fish-eating population. Moreover, fishing

in the Brahmaputra water-system including beels/swamps is restricted to the period after the recession of the flood water. Although throughout the year fishing is pursued on a small scales, yet this cannot meet the demands of the population in the interior places. Further the supply of fish through Government agencies or State Fishery Department in remote places of Assam is not uniform and constant. A large section of plain tribes inhabiting Assam follow different types of fish preservation. They not only use their preserved fish in the lean season, but also sell it as their livelihood. There are various methods such as sun-drying salting and smoking processes which are practised, whereby fish are preserved for few month (1-4 months) at a time. Besides these principal methods fish are preserved by pit-curing, preparing fish powder and adding of spices. It has been seen that the preserved samples cannot be kept for a long duration. Owing to deterioration of quality/appearance etc., they cannot sell or consume it. In view of such ideas the proposed investigation is aimed to explore -

A.[i] the <u>factors</u> deteriorating the quality of preserved fish and meat samples.

[ii] Analysis/survey of the different preserved sample from different places of the Brahmaputra valley prepared by the plain tribes of Assam.

B. Recommendations/suggestions to be followed during the preservation of fish and meat for preparation, storage and preservation for a longer duration among the different plain tribes without involving any sophisticated technology or high cost involvement for their use in commercial scale as well as for own consumption.

PLAN OF THE WORK AND PRESENTATION:

The entire work is planned to elucidate the facts in the following ways:-

1. Materials and Methods followed during the period of investigation
2. Types of fish used by the plain tribes for preservation.
3. Quality survey of the preserved samples from different tribal villages of Assam and analysis of the same to explore the quality in terms of
   - [i] Moisture content.
   - [ii] Protein content.
   - [iii] Ash (Minerals).
   - [iv] Sand particles.
   - [v] Fat/Lipid content.
   - [vi] Salt.

[vii] Microbial load with reference to total bacterial load, Salmonella, Vibrio cholerae and different fungal population

[viii] Organoleptic evaluation.

Note: The above survey or quality evaluation of the collected samples [(a) random colection, (b) seasonal collection on particular types throughout the year] is necessary to focus the problem associated with the particular type of preservation so that improvement of methods or precatuions could be followed, for which certain recommendations have to be made.

4. Recommendations/suggestions for quality improvement on techniques for preservation, storage based on the analytical data observed in above column [3]. The recommendations are based on low cost involvement and without using any high technology, so that they can expand the trade in commercial scales.

MATERIALS AND METHODS:

The materials used and methodology followed during the present investigation may be summarised as follows:

1. Collection of Samples:

Different preserved samples were collected either from the market, or from a community or an individual person. The collected samples were packed in air tight polythene packets and marked for future experiments.

2. Preparation of Samples:

Some fish were taken and different process of preservation such as sun-drying, smoking, salting were carried out followed by the addition of preservation such as sodium-benzoite and use of herbal sample and were prepared in the laboratory. Control of temperature and moisture regulation were carried out. Direct sun-light drying was conducted by keeping the sample on the roof of a 2-storied building with necessary precautions taken to keep off sand/dust and contamination of flies. The prepared samples were stocked/stored and their analysis was carried out as and when required.

3. Biochemical Analysis:

A. Protein: The protein content of the samples was analysed by dissolving the same with sulphuric acid through micro-kjeldal methods. Total nitrogen (multiplying the 'N' value with 6.25) of the sample was used for calculation of total protein (Homair, 1954; Hawk and Oser, 1965).

B. Fat/Lipid: Fat or lipid content was analysed after soxhlet extraction with diethyl ether for more than 12 hours. Etheral extract was evaporated (80°C) and fat/lipid content was estimated [Barua and Goswami, 1977; Duel, 1957].

C. Moisture: Sample were taken in a moisture-box and dried in an oven at 100°-105°C and cooled in a disicator. Process of heating and cooling were repeated till a constant weight was achieved (Karrick et al., 1956).

D. Ash:

[i] Samples were taken in a tared platinum (or procelain) crucible and heated over a low flame till all the material was completely charred. Later on it was heated in an electric furnace for about 3-5 hours at 600°C till the charred material was converted into white ash. Finally the weight of the sample was determined in an sensitive electric balance (CIFT, 1985).

[ii] Estimation of minerals: The presence of different minerals such as calcium, phosphorus, magnesium, zinc, copper, iron and maganese etc. were determined from their atomic absorption spectra from the ash samples of the fish. The final estimation was followed after comparing the absorption of known sample as those minerals.

E. Salts: Total salt content was analysed from the standard methods adopted by CFTRI- Cochin [CIFT, 1985].

F. Sand: Sand particles were estimated from the ash samples after treating it with 250 ml 1:1 hydrochloric acid. After cooling, the content was filtered and Chlorine-free residue was (after washing with

distilled water) and later on sand particles were weighted (Joshi et al., 1956; Love et al., 1959).

G. Microbial analysis: Microbiological analysis with reference to total bacterial load, Salmonella content, Vibrio-cholerae and identification of different fungal samples were followed from the standard microbial analysis procedure as described by Branstedt and Auerbach, 1961, Raghuramulu, et al., 1983; Tarr, 1961).

H. Organoleptic evaluation: Organoleptic evaluation of different samples were calculated from the standard organoleptic score forwarded by Miyanchi et al. (1964); Ohio Dept. Health U.S.A. (1953), Stansby (1944).

Sources of Chemicals and Solvents:

Standard chemicals from BDH-India, Emark and Loba chemicals were used. Necessary purification and standardization etc. were followed from Nair et al. 1971, 1974.

TYPES OF PRESERVATION AND VARIETY OF FISH SPECIES USED IN VARIOUS PROCESSES OF PRESERVATION:

Critical survey in the Brahmaputra valley extending upto Karbi and North Cachar Hill distrcts shows that various types of methods of preservation are practised by the plain tribes of Assam for their day to day use or for commercial production. Although several types

or qualities of preserved fish are available in different places with minor variations, yet the following are the principal methods of preservation that are used mainly in all communities of the various tribes encountered in the present investigation.

Types/Methods of Preservation:

1. Sun-dried.
2. Smoking.
3. Salting.

Besides the above principal methods there are lots of other methods such as:-

[i] Processed and sundried.

[ii] Processed and kept either in a pit/pot/bamboo cylinder/earthenware pot etc.

[iii] Processed-powdered and sundried.

[iv] Processed - Addition of spices, Aracha tuber powder, Siju leaves, banana ash, kathal pat etc. are some of the addition in processing the different preserved fish.

The varieties prepared by the plain tribes such as Naphum, Sidal, Ngo-San, Nakhum, dried powdered fish are more or less similar in nature. The use of different plant malter like aracha stem, tubers, kathal pat and banana ash or juice of ash (which is an alkaline juice prepared after burning the stem portion of banana etc. are some of the

different forms of preservation. But the above auxillary methods are not practised except one or two methods in large scale and very difficult to get throughout the year.

Type of Freshwater fish used in different preservation:

The plain tribes inhabiting both banks of the river Brahmaputra show a special interest and liking for the preservation of fish of freshwater origin. During the present investigation no such differentiation could be made regarding the particular type of the fish used. As a whole they like any type of preserved as well as fresh fish depending upon the availability of the same. In the following Table (Table I) the types of fish most commonly used in the various process of preservation are listed. Common names used by the local people of the Brahmaputra valley are stated along with the Latin names [Bilogical names]. The types of preservation followed with reference to specific varieties of fish have also been shown in this aforesaid table. The abbreviations used are Sd = Sun dried; Sm = Smoking; Sa = Salt application followed by Sun-drying; Ot = Other methods/miscellaneous types of preservation.

TABLE - 1

Local Names	Biological Names	Type of Preservation followed
Chanda	Ambassis nama	Sd, Sm, Sa
	A. ranga	
Mowa	Amblypharyngodon mola	Sd, Sm, Sa,Ot
Cuchia	Amphipnous cuchia	Sa, Ot
Baralia	Aspidoparia morar	Sd, Sm, Sa,Ot
	A. jaya	
	Baralius bendelisis	
Chelkana	Oxygaster bacaila	
Law-Puthi	Danio devario	Sd, Sm, Sa,Ot
	Chela laubuca	
	Esomus danricus	
Puthi	Puntius sophore	Sd, Sm, Sa,Ot
	P. ticto	
Cheni Puthi	Puntius sarana	Sd, Sm, Sa,Ot
Darikona	Rasbora daniconius	Sd, Sm, Sa,Ot
	Danio acquipinnatus	

Local Names	Biological Names	Type of Preservation followed
Elanga	Rasbora elanga	Sd, Sm, Sa
Rohu (Finglings upto 20 cm)	Labeo rohita	Sd, Sm, Sa
Catla (Fingerlings upto 20cm)	Catla catla	Sd, Sm, Sa
Bahu/Baih	Labeo calbasu	
Kurhi (Fingerling upto 12 cm)	Labeo gonius	Sd, Sm, Sa
Mrigal (Fingerling upto 20 cm)	Cirrhinus mrigala	Sd, Sm, Sa
Lachim Bhangan	C. reba	Sd, Sm, Sa
Boga Bhangan	Labeo boga	Sd, Sm
	Labeo bata	
	Labeo pangusia	
Nandhani Mas	Labeo nandina	Sd, Sm
Kandhuli	Notopterus notopterus	Sd, Sm
Chital (Upto 20 cm size)	N. Chitala	Sd, Sm
Botia	Botia dario	Sd, Sm
	Lepidocephalichthys guntea	
	Noemacheilus botia	

Local Names	Biological Names	Type of Preservation followed
Tengra	Mystus vittatus	Sd, Sm, Sa
	M. bleekari	
	M. cavasius	
	M. tengara	
Ari(upto 20 cm size)	Mystus seengala	Sd, Sm, Sa
Ritha(upto 12 cm size)	Rita rita	Sd, Sm, Sa
Pabha	Ompok bimaculatus	Sd, Sm
Barali(upto 20 cm size)	Wallago attu	Sd, Sm, Sa
Kajali Mas	Ailia coila	Sd, Sm
Karati	Gadusia chapra	Sd, Sm, Sa,Ot
Phasa	Setipinna phasa	Sd, Sm, Sa
Naria	Clupisoma garua	Sd, Sm, Sa
Magur	Clarias batrachus	Sd, Sm, Sa
Kawoi	Arabus testudineus	Sd, Sm
Singhi	Heteropneustes fossilis	Sd, Sm, Ot
Colisa	Colisa fasciata	Sd, Sm, Sa,Ot
	C. lilia	
	C. sota	
Turi	Mastacembelus pancalus	Sd, Sm, Sa
	Macrognathus aculeatus	

Local Names	Biological Names	Type of Preservation followed
Bami	Mastacembelus armatus	Sd, Sm, Sa
Sal (20 cm)	Channa marulius	
Sol (20 cm)	C. straitus	
Goroi Channa Sp.	C. punctatus	Sd, Sm, Sa
Chenal (20 cm)	C. amphibious	
Chengali	C. orientalis	
Pani-Mutura	Glossogobius giuris	Sd, Sm, Sa,Ot
Kokila	Xenentodon cancila	Sd, Sm
Bhehari/Gadgadi	Nandus nandus	Sd, Sm, Ot
Koya Mas	Gagata cenia	Sd, Sm, Sa,Ot
	G. gagata	
Ilish	Hilsa ilisha	Sd, Sm, Sa
Common Carp	Cyprinus carpiu	Sd, Sm, Sa
Paharua Mas	Chagunius chagunio	Sd
	Acrossocheilus hexagonolepis	
	Garra gotyla	
	Crossocheilus latius latius	

QUALITY SURVEY OF DIFFERENT TYPES OF PRESERVED SAMPLES COLLECTED FROM DIFFERENT STATIONS:

The collected samples were taken to the laboratory and the necessary labelling as well as analysis were done with reference to the parameters shown in Table 2 . The samples were marked numerically together with their collecting stations, the month of collection and other environmental parameters such as, weather condition etc. and the type of preservation and period covered on that day from the time of preparation etc. Samples were collected either directly from their homes or from the nearby market of that station. However, for some samples orders were placed for preparation and the analysis were made after collection from that station.

Sample collection and analysis:

Different types of presrved fish samples were studied from various villages/stations inhabited by the plain tribes. The preparation were collected as is shown in Table 2. The samples were marked against the varieties from each station and their quality evaluations were made as analysed later.

However, in some stations certain families were asked to prepare particular type of samples which were purchased and analysed. This is owing to the non-availability of those samples, or in some places

some tribes do not practise any methods of preservation from the last two years, hence they were requested to prepare a particular type. Further similar samples are knwon by different name in different localities, but here only the more common and established name have been cited [Bordoloi, 1988; Bordoloi et al. 1987].

TABLE - 2

Different samples were shown (No.) against each station and the type of preservation.

Station /village	No. of different preserved sample collected from May 1990 to August 1991 against the type of preserved fish.							
	Sun-dried	Smoking	Salting	Powder-ed fish	Nephum	Sidal	Ngo-San	Others
1	2	3	4	5	6	7	8	9
Subansiri	31	18	20	5	-	-	5	-
Kadam	18	10	10	5	5	5	-	1
Narayanpur	30	25	25	12	-	-	-	-
Bihpuria	30	26	22	10	10	-	-	-
Gogamukh	10	19	20	-	-	-	-	-
Ghilamara	25	20	20	10	10	5	-	-
Dhemajee	30	10	20	10	10	5	5	-
Bardalani	30	10	10	5	-	-	-	-
Jonai	18	10	15	5	-	-	-	-
Jengrai	10	5	5	-	-	5	-	-
Borhola	12	2	-	-	-	-	-	-
Thengalgaon	15	10	5	-	5	5	-	-
Parbatia	5	-	-	-	-	-	-	-
Kuruabahi	21	15	10	5	10	10	-	5
Pub-Konwarpur	5	2	-	-	-	-	-	-
Dalgaon	10	-	-	-	-	-	-	-
Rawta	15	15	5	3	2	-	-	-
Udalguri	10	10	10	-	-	-	-	2
Khairabari	5	-	-	-	-	-	-	-

Station /village	No. of different preserved sample collected from May 1990 to August 1991 against the type of preserved fish.							
	Sun-dried	Smoking	Salting	Powdered fish	Nephum	Sidal	Ngo-San	Others
1	2	3	4	5	6	7	8	9
Bhakatpara	10	5	2	2	4	2	-	-
Gohpur	8	5	5	5	2	2	3	-
Kalabari	2	3	2	-	-	-	-	-
Doom Dooma	5	-	-	-	-	-	-	-
Sirajuli	3	2	2	-	-	-	-	-
Bihaguri	10	3	7	2	2	-	-	-
Ghoramari	2	-	-	-	-	-	-	-
Haldhibari	3	2	2	-	-	-	-	-
Tengakhat	4	2	2	2	2	-	-	-
Tinkhong	7	2	5	2	-	3	-	-
Modurkhat	10	3	3	2	-	-	-	-
Talap	3	2	2	-	-	-	-	-
Uttar Sadiya	15	10	3	6	3	4	4	1
Kachugaon	10	10	5	10	6	4	-	-
Saraibil	10	10	2	5	3	4	-	-
Gossaigaon	5	15	2	6	2	4	-	-
Dotoma	10	5	-	3	2	1	-	-
Fakiragram	12	10	3	4	5	3	-	-
Patgaon	10	-	-	2	1	1	-	-
Sidli	15	5	2	-	4	2	-	-

Station /village	No. of different preserved sample collected from May 1990 to August 1991 against the type of preserved fish.							
	Sun-dried	Smoking	Salting	Powdered fish	Nephum	Sidal	Ngo-San-	Others
1	2	3	4	5	6	7	8	9
Bijni	10	8	6	3	2	5	-	-
Dudhnoi	20	10	5	15	20	10	-	-
Darrangiri	5	5	2	10	10	10	-	-
Ron juli	3	2	2	6	8	10	-	-
Rani	10	10	10	15	2	15	-	10
Bholagaon-Borduwar	7	10	-	1-	5	10	-	3
Kaklabari	2	2	-	-	-	-	-	-
Manikpur	10	-	-	-	-	-	1	-
Howli	10	10	2	6	3	3	-	-
Barama	10	8	-	10	10	6	-	-
Baska	5	5	-	5	-	-	-	-
Kumarikata	10	2	2	2	1	-	-	-
Goreswar	6	2	-	4	-	-	-	-
Boko	10	2	-	10	10	10	-	2
Chaygaon	5	5	-	5	5	2	-	-
Sonapur	4	10	-	-	-	-	-	-
Dimoria	6	10	-	5	2	5	2	2

A. Detailed food quality analysis of Sundried samples:

Out of 617 samples:-

A(i): 300 Samples showed their optimum condition, bearing good quality for human consumption. The quality of the 300 samples was analysed and the gross average value has been shown in Table 4[A]. The rest of the 317 samples were screened separately and out of which (Table 4, B):-

A(ii): 100 samples showed high presence of sand particles.

A(iii): 57 Samples showed maximum abundance of Salmonella infection.

A(iv): 5 Samples showed the presence of Vibrio cholerae.

A(v): 80 Samples showed high load of bacteria.

A(vi): Remaining 75 samples showed poor orgenoleptic characteristics.

A remark has been shown in Table 5 on the quality evaluation of the above samples.

Out of 1779 preserved samples collected from different station as shown in Table 2, analyses were carried out and their quality was determined as shown in Table 3.

TABLE - 3

Gross analysis of the different samples after its collection from different stations.

Total No. of different samples collected from various stations	Types of preservation of fish and their individual No. of collection	No. of Good samples having optimum food quality for consumption and commercial value (and their %)	No. of samples having poor quality and non commercial value (and their %)
1779	Sundried, 617	300 [48.6]	317 [51]
	Smoking, 402	319 [79.35]	83 [20.6]
	Salting, 275	157 [57]	118 [42.9]
	Powdered fish, 225	100 [44]	125 [55.5]
	Nephum, 66	35 [53.03]	31 [46.9]
	Sidal, 147	100 [68]	47 [31.9]
	Ngo-San, 20	9 [45]	11 [55]
	*Others, 27	15 [55.5]	12 [44.4]

* 'Others' includes the sun-dried or smoking followed by [i] burning and [ii] use of pickles etc.

TABLE - 4

Anlytical Reocrds of the Sun-dried Samples.

Name/Type of preserved fish samples and No. of collected samples	Physio-chemical and microbial characteristics of the collected preserved fish samples.										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio Cholorae	Fungi	Organanoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
A(A-i) Sundried (300)	18(±3)	51(±4)	9(±3)	0.06±.02	22±4	0.3±1	$5.5x10^2$±1.2	Nil	Nil	Rhizopus Sp.	Good
B(A-ii) Sundried(100)	18.5(±3)	50(±3.5)	8(±3)	0.3±0.5	22±4	0.3±1	$5.6x10^2$±1.5	Nil	Nil	Nil	Good
(A-iii) Sundried(57)	23(±2.5)	50(±4)	9(±2)	0.06±0.02	21±3	0.3	$5.8x10^2$±1	$6.9x10^2$±2	Nil	Penicillium Sp. Rhizopus Sp.	Good
(A-iv) Sundried (5)	25(±2)	51(±2)	8.5(±2)	0.07	22±3	0.3	$6.2x10^2$	$3.9x10^2$±2	$5.9x10^2$±2	Mucor, Penicillium Rhizopus	Medium
(A-v) Sundried (80)	24(±2)	51.2(±4)	9(±3)	0.07	21±4	0.3	$12.5x10^2$±3.5	-	-	Penicillium Aspergillus Chevalieri	Medium
(A-vi) Sundried (75)	24(±1.5)	50.5(±4)	8(±2)	0.06±0.02	22±4	0.3	$6.5x10^3$±2	-	-	Penicillium Aspergillus flavus Chevalieri . Amstelodumi Rhizopus	Poor

TABLE - 5

Remarks on the anslysis of the sundried samples.

Observation	No. of Samples	Quality evaluation
A(i)	300	: Followed the optimum condition required for sun-dried process of preservation with the maintenance of cleanliness and other hygienic condition.
A(ii)	10	: Precautions against sand/dust were not taken either in the process or during storage.
A(iii -vi)	217	: Proper cleanliness and other hygienic conditions either in preparation of storage were not maintained.

B. Analysis of Somked fish samples:

Out of 402 No. of collected smoked samples:-

B[i] : 319 samples showed optimum quality with regard to their food quality and commercial value.

B[ii] : 25 samples contained high bacterial load.

B[iii] : 20 samples showed the presence of high quantity of Salmonella species.

B[iv] : Remaining 38 samples showed the presence of large number of fungal species within them.

Remarks: The details have been presented in Table 6 and a gross remark may be concluded from the analysis of Smoked samples as shown in Table 7.

TABLE - 6

Analytical Records of the smoked samples.

Name/Type of preserved fish samples and No. of collected samples	Physio-chemical and microbial characteristics of the collected preserved fish samples.										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organanoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
B[i] Smoked (319)	17.5(±2)	51(±1.5)	9.2(±2)	0.05	21(±2)	0.4	$5x10^2$	-	-	Mucor [Trace]	Good
B[ii] Smoked (25)	20(±5)	50(±2)	9(±2)	0.05	22(±2)	0.4	$5.8x10^2$	-	-	Rhizopus	Moderate
B[iii] Smoked (20)	21(±5)	50(±3.5)	9(±2)	0.05	21(±2)	0.4	$5x10^2$	$7.8x10^2$	-	-	Moderate
B[iv] Smoked (38)	22(±5)	48(±3)	9(±2)	0.05	20(±2)	0.4	$5x10^2$	$5x10^2$	-	Rhizophus Penicilliun Mucor Chevalieri Amstelodam	Poor

TABLE - 7

Observation	No. of Samples		Quality evaluation
B[i]	319	:	Followed optimum condition of drying both initially with sun-drying followed by keeping over fire(smoking) with the maintenace of cleanliness and hygienic condition.
B[ii]	25	:	Precaution against cleanliness and maintenance of general hygienic condition were not maintained either during processing,handling further owing to the presence of high moisture value the bacterial proliferation is higher than the [B-i].

C. Analysis of Salted samples:

Out of 275 samples:-

C. [i] 157 were of good quality bearing optimum condition followed during the preservation.

C. [ii] 50 samples showed the presence of high sand content.

C. [iii] 68 samples showed the presence of high fungal content.

The detailed analysis has been shown in Table 8. The remarks on the quality assessment are tabulated in Table 9.

TABLE - 8

Analytical Records of the salted samples.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio Cholarae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
C [i] Salted (157)	19[±2]	51[±1.5]	8.5	0.05	23[±3]	0.4	$5.4x10^2$[1.2]	Nil	Nil	Rhizopus Mucor	Good
C [ii] Salted [50]	19[±1.5]	51[±2]	8 .8	1.2[±2]	22[±2]	0.4	$5.4x10^2$[±1]	Nil	Nil	Mucor	Medium
C [iii] Salted [68]	23[±3]	50[±0.5]	8.2	0.07[±0.1]	21[±2]	0.39	$5.8x10^2$[±2]	$5.5x10^2$[±2]	Nil	Mucor Rhizopus Penicillium Aspergilus Chevalieri	Medium

TABLE - 9

Remark on the quality of the salted samples.

Observation	No. of samples		Quality evaluation
C [i]	157	:	Followed optimum application of salts and sundried for initial drying followed by smoking for the removal of moisture upto optimum level.
C [ii]	50	:	Proper cleanliness and precaution against dust/sand were not taken.
C [iii]	68	:	Owing to presence of high moisture the salted samples develop a number of fungal specimens.

D. Analysis of Dry-powdered fish:

D [i] Out of 225 samples of dry-powdered fish, 100 samples are in relatively good condition and are found suitable to be kept upto 4 months of preservation. They are of good quality and have a commercial value.

[Remarks: Followed proper cleaning and the powdered were dried upto limiting amount of moisture content, showing good organoleptic condition].

D [ii] Rest of 120 samples showed high load of bacteria along with the presence of Salmonella and fungal species.

[Remarks:- The sample had high moisture content which yielded the growth of different mocrobes.]

D[iii] 5 samples showed the presence of maggots and eggs of flies.

[Remarks: High moisture content helped the flies to propagate their life cycle developing eggs and ultimate developmenting into maggots. The details of the analysis recrds have been shown in Table 10.

TABLE - 10

Analytical Records of the Dry-powdered samples.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio Cholarae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
D [i] Dry-powdered 66	19[±1]	50[±3]	8.5[±2]	0.3[±0.1]	22[±2]	0.35	$5.4x10^2$[±1]	Nil	Nil	Mucor Rhiphopus	Good
D [ii] Dry-powdered 120	24[±1.5]	49[±2]	8.8[±1]	0.4[±0.1]	22[±2.5]	0.35	$8.1x10^2$[±1]	$3.9x10^2$[±1]	Nil	Aspergillus Chevalieri Amstelodumi Penicillium Mucor Rhizopus	Medium
D [iii] Dry-powdered, 5	25[±2]	49[±1.5]	8.8[±1]	0.4[±0.1]	22[±1.5]	0.35	$8.7x10^2$[±1]	$5.2x10^2$[±1]	Nil	Aspergillus Chevalieri Amstelodumi Penicillium Mucor Rhizopus	Bad

E. Analysis of Nephum samples:

E [i] Out of 66 Nephum samples, 35 were good quality. It may be mentioned that there are various types of Nephum samples but the samples bearing good quality were of high commercial value with high standard analytical records as well as good organoleptic condition.

E [ii] 10 samples with whole fish [Puntius, Gadusia] preservation were found in several layers separated by Kathal Pat [Artocaupus heterophyllus]. These samples were infected with several fungal specimens along with high load of bacteria.

E [iii] 21 samples with whole fish [Puntius, Gadusia, Rasbora] packed in a bamboo cylinder were found to be infected with high fungal bacterial load along with salmonella infections.

The detailed quality assessment of the above samples [E i - iii] has been shown in Table 11.

TABLE - 11

Analytical Records of the Nephum samples.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
E [i] Nephum, 66	19.5[±1]	51[±2]	8.2[±1]	0.3[±0.1]	22[±2]	0.35	$3.5x10^2$[±1]	Nil	Nil	Rhizopus	Good
E [ii] Nephum, 10	21 [±2]	50[±1]	3.3[±1]	0.35[±0.1]	21[±1]	0.35	$6x10^2$[±2]	Nil	Nil	Aspergillus Chevalieri Amstelodumi Penicillium Mucor	Medium
E [iii] Nephum, 21	22[±2]	50[±1.5]	3.2[±1.5]	0.35[±1]	21[±1.5]	0.35	$7x10^{-2}$[±1.5]	$2x10^2$[±1]	Nil	Aspergillus Chevalieri Amstelodumi Penicillum Mucor Rhizopus	Bad

The overall remarks on the quality have been analysed in the Table 12.

TABLE - 12

Remarks on the quality of Nephum samples collected from different station as shown in Table 11.

Observation	No. of samples		Remarks
E [i]	35	:	The samples were cleaned, dried in direct sun light and moisture content was removed upto optimum concentration. They were later packed in bamboo cylinder [matured bamboo] and pickles, mustered oils along with salts [n=10] were added. Further in most samples alkaline juice prepared from banana ash has added [n = 10] and sealed. A large number of samples preserved after drying, salting without anything added and packed in bamboo cylinder were also found a relatively good condition. All these samples were handled and prepared in cleanliness in proper hygienic condition and packed in matured bamboo cylinder was used which maintained good level of preservation after closing

Observation	No. of Samples		Remarks
			the mouth with banana leaves followed by earthen sealing. These samples were found to be in good condition and no defects are found in preservation.
E [ii]	10	:	Here in 10 samples the use of Kathal Pat [Artocarpus heterophyllus, which might be not matured condition and bearing the load of several fungal specimen] might cause deteroriation after being kept for more than 25 days. These samples showed high density of fungal infection.
E [iii]	21		(a) Out of 21 samples 7 samples were packed in immature bamboo cylinders, which contained high water content and conducive for the development of high bacterial loads along with a large number of various fungal specimens.
			(b) Rest 14 samples were found loaded with Salmonella, bacteria and several specimens of Fungi.

Observation	No. of Samples	Remarks
		After careful examination it has been seen that the moisture content way high. The viscera of some fish were not removed, which added to the development of high bacterial load, infection of various species of fungi, Salmonella etc.

F. Analysis of Sidal Samples:

Altogether 147 sidal samples were collected from the different stations. Out of 147 samples:-

F [i] : 100 Samples were found in good condition having commercial value.

F [ii] : The remaining 35 samples were found infected with high bacterial load, different species of fungus.

F [iii] : 10 Samples were infected with Salmonella.

F [iv] : Vibrio cholorae were found in 2 samples.

The analytical records have been chalked out in Table 12 and the remarks on the quality assessments etc. are illustrated in Table 13.

TABLE - 12

Analytical Records of the Sidal samples.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
F [i] Sidal, 100	19[±1]	51[±1]	8.6[±1.5]	0.3[±0.1]	21[±2]	0.36	Nil	Nil	Nil	Mucor	Good
F [ii] Sidal, 35	22[±1]	50[±1]	8.6	0.3	20[±2]	0.36	$6x10^2$[±1.5]	Nil	Nil	Aspergillus Amstelodumi Penicillium Mucor	Medium
F [iii] Sidal, 10	22[±1]	51[±0.5]	8.5	0.3	21[±2]	0.36	$5x10^2$[±2]	$4x10^2$[±0.5]	Nil	Aspergillus Amstelodumi Penicillium Mucor Rhizopus	Medium
F [iv] Sidal, 2	22[±1]	51[±1]	8.5	0.3	22[±0.5]	0.36	$6x10^2$[±0.5]	$3x10^{-2}$[±1]	$3x10^2$[±0.1]	Aspergillus Amstelodium Chevalieri Mucor Penicillium Mucor Rhizopus	Bad

The remarks on the quality of the Sidal samples F [i -iv] are shown in Table 13.

TABLE - 13

Remarks on the collected Sidal samples.

No. of Observation	No. of samples	Remarks
F [i]	100	: The fish powder was prepared after proper cleaning and drying. The packings and storage along with addition of salts etc. are adequate, showing high quality.
F [ii]	35	: Samples were not cleaned, dried upto the content of optimum amount of moisture, which helped in the process of growth of high microbial load along with different species of fungus.
F [iii]	10	: Similar cause shown in F [ii], leads to the development of Salmonella.
F [iv]	2	: High moisture content, use of dirty water in cleaning the samples leads to the infection of Vibro cholorea. These samples emitted an obnoxius smell and showed poor organoleptic condition.

G. Analysis of Nogo-San Samples:

This is a special type of preservation used by the Mising Tribe. Altogether 20 samples were collected out of which G[i], 9 samples were found in perfect condition whereas the rest G[ii] were infected with Salmonella, high bacterial load along with several species of fungus [Table 14]. The remarks on the quality assessments have been shown in Table 15.

TABLE - 14

Analytical Records of the Nogo-San samples.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
G [i] Nogo-San, 9	20[±1]	50[±1.5]	8.6[±1]	0.3[±0.2]	22[±1]	0.35[±.1]	Nil	Nil	Nil	Rhizopus	Good
G [ii] Nogo-San, 11	23[±1]	49[±1.5]	8.6[±1]	0.3[±0.1]	22[±1]	0.35[±.1]	$6x10^2$[±1.5]	$3x10^2$[±0.5]	Nil	Aspergillus	Medium
										Penicillium	
										Mucor	
										Rhizopus	

TABLE - 15

Quality assessment of the Nogo-San Sample [G i-ii]

No. of Observation	No. of Samples	Remarks
G [i]	9	: Proper cleanliness, maintenance of hygienic conditions, drying of samples in sunlight followed by smoking with optimum proportion of moisture content helped the sample in keeping their quality.
G [ii]	11	: Thse sample showed a higher moisture proportion than the G[i] samples. Further cleanliness and lack of same hygienic condition during preparation [use of dirty water] etc. lead to the development of high bacterial load and other microbial specimens. Such as several species of fungi.

H. Analysis of Burnt samples:

27 Burnt samples of medium size more than 12 cm size fish such as Channa, Mastocembelous, Anabus, Glossogobius etc. were collected from different stations. The samples are first dried and followed by burning, [either direct burning or sun-dried followed by burns]. Out of 27 samples, - 15 samples were found in good condition H[i], whereas the remaining 12 H[ii] samples were not in optimum condition for consumption. The analysis is shown in Table 16 and the remarks tabulated in Table 17.

TABLE – 16

Analytical Records of the Burnt samples.

Name/Type of preserved fish samples and No. of Collected samples.		Physio-chemical and microbial characteristics of the collected preserved fish samples										
		Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organoleptic evaluation
		1	2	3	4	5	6	7	8	9	10	11
H [i]	Burnt, samples 15.	20[±0.5]	50[±1]	8.5[±1]	0.4[±0.1]	22[±1]	0.34	Nil	Nil	Nil	Rhizopus	Good
H[ii]	Burnt Sample, 12	23[±1]	49[±1]	3 .4[±1]	0.4[±0.1]	21[±1]	0.35	$8x10^2$[0.5]	Nil	Nil	Aspergillus Mucor Penicillium Rhizopus	Bad

TABLE - 17

Quality assessment of the Burnt sample.

No. of Observation	No. of Samples		Remarks
H [i]	15	:	Properly cleaned, sun-dried [3-4 days] followed by burning with less blackened postion in the body of the fish. Owing to low moisture content the samples are relatively good condition. Hwever, the continuous burnt with ash-covered condition sometimes do not encouraged the customers.
H [ii]	12	:	Burning is not uniform and unburnt portion showed the development of microbial and fungal infection. This ultimately led to poor quality and could not be recommend for human consumption.

RECOMMENDATIONS FOR IMPROVEMENT OF THE QUALITY OF PRESERVED FISH AND DEVELOPMENT OF LOW COST INVOLVEMENT FOR LARGE-SCALE PRESERVATION/ IMPLEMENTATION IN RURAL AREAS AND SPECIALLY IN THE TRIBAL-BELT OF ASSAM.

From the analysis of the different types of preserved samples practised by the plain tribes, it has been found that certain precautions as well as methods could be improved upon for better preservation and longer storage. The following recommendations have been put forwarded in order to improve the quality of the preserved products, so that they may adopt better methods of preservation.

1. Handling of Fish

The fish to be preserved should be procured from the fishing ground on from the market on trading place - should be kept in a clean place with the use of clear baskets or polythene sheet. Structural deformation during handling should be avoided by taking due care and caution.

2. Cleanliness

[a] The boat, nets or the other fishing implements should be properly cleaned with clean water and followed by sun-drying. It has been found that nets or bamboo-made fishing gears not properly cleaned contained Salmonella [n = 10], Vibrio cholerae [n = 2] along with large number of fungal samples [n = 15] which were found highly loaded with different bacteria. Proper cleaning after every fishing operation has to be strictly followed.

[b] The utensils where the fish will be cleaned, dissected and processed or further use should be washed followed by sun-dried. Every operations should be followed with the cleaning of the utensil with detergent and dried over some platform [bamboo-made platform, where there is direct sunlight, at least for 5-7 hours]. Further the utensils should be weekly rinsed with potassium permanganate [0.5 gm/1].

[c] The polythene-sheet or bamboo-made Shieve or "Chalani" etc. should be everytime [after completion of each operation] cleaned and rinsed in $KMNO_4$ [5%] solution and dried before placing them for drying or smoking or salting etc.

[d] The bamboo- "Chalani" or "Khaloi" or baskets [small size with cover] which are used for smoking purposes should be sun-dried and completely cleaned after everyday's smoking. It has been found that the some microbes develop on the fish juce and remained for long time in those surfaces of the chalani, khaloi or baskets.

[e] Use of water in cleaning the fish samples as well as utensils and others:

[i] In all operations clean water either from tube-well or from concrete well or chlorinated water should be used. The use of water from the ponds or from other swampy areas should be strictly avoided.

Such water carries the infections of various species of harmful microbes in the fish, which ultimately proliferate even after processing or preservation.

[ii] The use of potassium permanganate [0.5 gm/1 $KMNO_4$] in the water inhibits the contamination of microbes or increase of microbial load in the water. We have carried out some experiments and the average analytical value of 5 sets of such experiments with the use of 0.5 gm $KMNO_4$/Litre in sun-dried and smoked showed significantly less microbial infections rather than in the samples where potassium permanganate (0.5%) was not used. In the Table 18 and 19 the comparative microbial load of the samples treated with $KMNO_4$ and without $KMNO_4$ in water are shown. These experiments indicate that fish cleaned and washed with 0.5 g/litre $KMNO_4$ followed by processing for different types of preservation showed an encouraging quality.

TABLE - 18

$KMNO_4$ treated fish sample and their microbial analysis after 6 months.

Type of fish	Total bacterial load	Salmonella	Fungi
Sundried (n=5)	5×10^2 [±0.5]	Nil	Nil
Smoked (n=5)	5×10^2 [±1]	Nil	Nil

Other values of Protein, Lipid, ash, minerals showed normal condition.

TABLE - 19

Without $KMNO_4$ treated fish sample and their bicrobial analysis after 6 months.

Type of fish	Total bacterial load	Salmonella	Fungi
Sundried (n=5)	7×10^2 [±0.5]	Nil	Mucor [Trace]
Smoked (n=5)	6.5×10^2 [±1]	Trace	Mucor [Trace]

There is not much significant change of Protein, lipid, minerals etc.

3. Removal of Viscera/gills

The Vistera and gills etc. should be removed and cleaned with clean-water or water mixed with $KMNO_4$ in the fish to be preserved. The studies related with the fish having viscera, gills etc. showed microbial development even after treatment with $KMNO_4$ or removal of moisture upto the optimum level. Hence these organs should be removed and cleaned again. Viscera/gills etc. are the most susceptible sites of microbial infection during or after the process of preservation. Samples of fish without gills, viscera could be preserved for a longer period.

4. Initial washing with sodium choride (Common salt, 2 g/litre solution)

The fish which is to be preserved or processed for preservation should be washed initially with sodium chloride (2 g/litre) or common salt. The term initial washing necessitates that there must be a thorough washing with clean water (as described earlier), which is to be followed by washing with sodium chloride treated water. Sodium chloride helps in the removal of bacterial load.

In our earlier experiments the use of potassium permanganate has been recommended but there also the initial washing with sodium chloride showed better results than that of the earlier experiments.

Hence washing with regard to cleaning and reducing microbial load could be utilized in the following way for better preservation.

Fish

↓

Washing with clean water.

↓

Treatment :- [i] With sodium chloride mixed water [2 g/litre].

↓

Treatment :- [ii] With potassium permanganate [0.5 g/litre] mixed water.

The fish sample to be used for preservation treated with sodium chloride showed good results for long-time storage. They maintained a good quality as well as organoleptic condition with NaCl (2 g/litre). Several sets of experiments treated (10 minutes) with sodium chloride showed the following results (Table 20) with different types of preservation. The experiments were conducted by taking a control set without being treated with sodium chloride.

Further the experiments treated with both NaCl and $KMNO_4$ showed slightly better results and both compound after its treatment showed long-term storage as well as quality products. This simple and less expensive methods could be easily followed in any rural areas for production of quality products.

TABLE - 20

Analytical Records of the samples treated with sodium chloride [2 g/litre] and their analysis after 8 months.

Name/Type of preserved fish samples and No. of Collected samples.	Physio-chemical and microbial characteristics of the collected preserved fish samples										
	Moisture	Protein	Ash	Sand	Fat	Salt	Bacterial Load	Salmonell	Vibrio cholorae	Fungi	Organoleptic evaluation
	1	2	3	4	5	6	7	8	9	10	11
Sundried [n=6]	20[±0.5]	50[±2]	9[±1]	0.05	22	0.45	$5x10^2$[±0.5]	Nil	Nil	Nil	Good
Smoked [n=4]	19[±1]	50[±1]	9.1[±1]	0.05	20	0.4	$5x10^2$[±1]	Nil	Nil	Nil	Good
Salted [n=5]	19[±0.5]	50[±1]	9.3[±1.5]	0.06	21	0.42	$5x10^2$[±0.5]	Nil	Nil	Nil	Good
Nephum [n=3]	19[±1]	50[±2]	9.2[±1]	0.05	22	0.42	$5x10^2$[±0.6]	Nil	Nil	Nil	Good
Sidal [n=6]	20[±0.5]	50[±0.5]	9[±2]	0.05	22	0.41	$5x10^2$[±1]	Nil	Nil	Nil	Good

NOTE: The samples treated both NaCl + $KMNO_4$ showed better results and such samples could be preserved more than one year [n = 3, 13 months].

5. Precaution from dust/sand:

Dust/sand not only deteriorate the quality of preserved samples, but also act as a carrier agent for different types of microbes. In our present studies several sun-dried/salted samples from different places were found to be highly contaminated with sand, dust. It has been found that those samples were sun-dried along the bank of the Brahmaputra and during windy days resulting the contamination with sand or dust.

Type of cloth (light) of polythene side cover (30-38cm height as shown in Fig. I) could be used as a protection shield in the all four sides on the drying platform/table. Sample processed near the bank of river or along the road side should be kept protected from dust/sand as far as practicable.

6. Use of Tulsi leaves (Ocimum sanctum)

Several experiments showed that use of Tulsi (Ocimum sanctum) leaves showed good results during preservation. But the application of these leaves has to be carried out with utmost care. Two different kinds of application have been tested:-

[a] Tulsi leave extract: Tulsi leaves extract was placed in the storage packet or within the body of the bamboo cylinder and allowed to dry for 10-12 hours (within that period the juice gets dried within

the body of the packet or bamboo cylinder). After that the preserved fish samples were packed. It has been found that it increases the storage period of the sample upto 10-12 months which is difficult to get in untreated samples. In Table 21 the result of 12 months storage samples of sun-dried, smoked, sidal, Nephum along with non-treated tulsi-extract are shown.

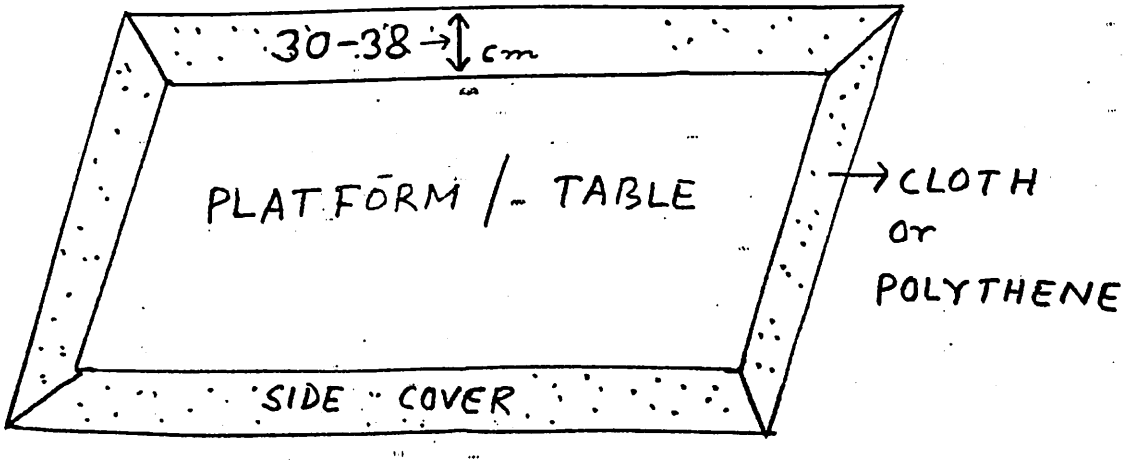

Fig. 1

TABLE - 21

Analytical records of different preserved fish sample treated with Tulsi [O. sanctum] leaves extract after 12 months [Abbreviations; TL-Tulsi leave extract; TLX - No Tulsi leave extract].

Type of preserved fish and No. of observation	Microbial Load	Salmonella	Fungi
Sundried [TL]	$5x10^2$[±0.5]	Nil	Nil
Sundried [TLX], 5	$8x10^2$[±1]	Trace	Mucor Rhizopus
Smoked [TL],5	$5.5x10^2$[±0.5]	Nil	Nil
Smoked [TLX],5	$7x10^2$[±1]	Nil	Aspergillus Mucor Rhizopus Penicillium
Sidal [TL], 3	$6x10^2$[±0.5]	Nil	Nil
Sidal [TLX], 2	$7x10^2$[±1]	Trace	High load of different Fungi specimen.
Nephum [TL], 3	$6x10^2$[±0.5]	Nil	
Nephum [TLX], 2	$7.5x10^2$[±1]	Trace	High load of of different species of fungi

Note: TL treated samples showed optimum concentration of protein, lipid, ash, along with good organoleptic condition.

7. Use of Kathal Pat (Artocarpus heterophyllus)

The use of Kathal Pat in Nephum samples should be done only by taking matured sample (before yellowshing/senescent leaves). Immature leaves create the ground for microbial proliferation. Experiments using matured leaves showed minimum microbial or fungal load even after long time storage (6-7 month, n = 5) in comparison with the use of immature leaves (n =5).

8. Use of Matured Bamboo in Nephum and Sidal and treatment of soil, which are used for sealing the bamboo cylinder:

Use of immature bamboo cylinder creates or shows ground for microbial proliferation. However, good results have been found by using matured bamboo cylinder (n=6) in storing nephum/sidal samples. Use of matured bamboo with long internodes is highly recommended.

Soil collected from around the house is used in sealing the mouth of the bamboo cylinder. It has been found that the soil sometimes contains microbial infection. It has been found that soil should be sun-dried and if possible heated. Later, by mixing with clean water, the mixture can be used for sealing the nephum or sidal samples. In the present investigation few samples (n = 7) were sealed with such treated soil (Table 22) and it has been found that there is a definite quality improvement and long storage which inhibit microbial proliferation.

TABLE - 22

Analysis of Nephum sealed with treated soil and their respective microbial load along with samples sealed with untreated soil.

Samples with the use of Treated/Untreated soil	Microbial load	Salmonella	Fungi
Treated [n=7]	$5x10^{2}$[±0.5]	Nil	Nil
Untreated [n=5]	$7x10^{-2}$[±0.5]	Trace[n=2]	Mucor[n=2] Rhizopus[n=3]

NOTE: Other qualities regarding protein, fat, ash and organoleptic conditions showed optimum condition.

[b] Use of dry-Tulsi leaves (Oscimum sanctum):

Completely dry Tulsi leaves also showed some effects on the control of the growth of fungal samples (n=6). Care has to be taken to use dry leaves, otherwise raw leaves will encourage the increase of moisture as well as proliferation of microbes.

A comparative analysis of the elementary composition of various elements of absorption spectroscopy from the different preserved fish samples, treated with tulsi leaves (Oscimum sanctum) and sodium benzonate (0.1 g/kg) and their proximate composition after 8 months of storage (within polythene packet) were analysed as shown below:

Sun-dried samples

Elements	Initial Sun-dried Fish (500 g)	Tulsi-treated Sun-dried sample after 8 month	Sodium-benzonate (0.1 g/kg) treated sundried sample after 8 months
Cu	70.2 ± 22.3	70.2 ± 23.9	75 ± 20.3
P	0.93 ± 0.04	1.02 ± 0.03	1.11 ± 0.03
Ca	0.39 ± 0.04	0.39 ± 0.02	0.41 ± 0.03
Mn	31.0 ± 8.2	31.0 ± 7.0	32.0 ± 4.0
Fe	10.2 ± 2.3	10.2 ± 2.0	11 ± 0.9
	Smoked samples		
Cu	70.0 ± 20.0	70.0 ± 21.2	72.0 ± 20.0
P	0.92 ± 0.02	1.0 ± 0.02	1.5 ± 0.03
Ca	0.38 ± 0.05	0.39 ± 0.02	0.45 ± 0.03
Fe	10.2 ± 2.0	11.2 ± 2.5	11.5 ± 0.5

* Values are expressed in microgram per 1 g. of samples.

9. Treatment of Banana (Musa paradiscia) Ash:

Banana ash is frequently used either the Nephum or in Sidal samples. Few equipments (n=6) with the use of treated ash (ash in sun-dried cleanly and after keeping 8 hours in direct sun light and later packed in glass bottles or polythene packet) showed lesser microbial proliferation. Most of the time ash is kept in the open and there is always possibility of contamination of areal microbes etc.

10. Use of Turmeric Powder:

Turmeric powder (dry) also gives long life in the process of storage and microbial control. Several experiments with sundried (n=7), smoked (n=6), nephum (n=2), showed such improved quality and longer storage life. However, it has been seen that some traders/consumers do not prefer the turmeric powder used samples.

11. Use of polythene-linined gunny bags/hard polythene bags:

Packaging and storage poses a serious problem. It has been found that most of the tribal people use bamboo basket or khaloi for keeping the preserved fish. But owing to the contimation with moisture and others, the samples deteriorate the quality. Polythene-lined (inner side of gunny bags or use of hard/thick polythene bags with complete air tight sealing help in transporation and storage for long time. As a whole polythene-lined gunny bags should be used for bulk preservation and storage.

12. Use of Sodium Benzonate:

Sodium benzoate is used in the preservation of fruits or other canned products. Experiments with the used of sodium benzonate (0.1g/kg) in sun-dried (n=6), smoked (n=5), sidal (n=6), showed better results and there was no microbial proliferation. In the following Table (Table 23) the analytical records of use of sodium-benzoate have been shown. From the experiments it has been found that sodium benzoate may be recommended for the control of microbial load as well as in the maintenance of quality of the products.

TABLE - 23

Application of Sodium benzonate and analysis of microbial condition after 10 months.

Type of preservation and No. of experiments	Microbial load	Salmonella	Fungi
Sundried [n=6]	$5x10^2[\pm0.5]$	Nil	Nil
Smoked [n=5]	$5.5x10^2[\pm0.5]$	Nil	Nil
Sidal [n=6]	$5x10^2[\pm1]$	Nil	Nil
Without sodium benzonate			
Sundried [n=6]	$6x10^2[\pm2]$	Trace	All samples
Smoked [n=5]	$6.5x10^2[\pm1]$	Trace	are loaded
Sidal [n =6]	$7x10^2[\pm1.5]$	Trace	heavily with different specimens of fungi.

Note: The protein, fat, ash and organoleptic conditions are optimum with Na-Benzonate treated samples; whereas (-) Na-benzonate showed poor condition in all respects.

13. Treatment of Colocasia (Colocasia esculeuta):

Colocasia (Colocasia esculenta) stem (long, slender) and root parts are used in preserving the nephum/sidol and even in dry fish powder. It has been found that in some places the raw stem or the root (slices or pieces which are grounded later) is used along with the sun-dried, smoked on powdered samples. The water content of colocasia will determine the storage life of the sample. However, dried colocasia stem or dried root powder has proved to be effective in the long storage life of different samples. Our experiments (n=4) with the dried powder of the root of colocasia showed a better storage life than the usual procedure.

14. Uniform sun-drying and smoking:

It has been found that fish samples are not uniformly sundried or smoked. Some parts of the samples contain more moisture, hence uniform sun-drying and smoking in all parts of the fish should be followed. During the process the sample should be kept by turning both sides with clean hands or with some bamboo/wooden spoons.

15. Moisture control and maintenance of optimum level of moisture:

It has been found that moisture is the main factor in deteriorating the quality of the preserved samples, where there is always microbial proliferation leading to poor organoleptic condition. An optimum 18-20% moisture content showed better preserved products and long storage.

1. Burning of fish : Uniform burning size of the fish and removal of viscera :

(i) It has been found that owing to lack of uniform burning of the entire surface or sides/ portions of the fish, some areas remain unburnt shawing the development of microbial proliferation from that area.

(ii) Further, in some cases, the use of large-sized specimens also creates problems. The penetration of the heat decreases when reaching the deeper parts of the muscles during burning (owing to large-sized samples), Hence a medium size sample should be taken(not above 18 c.m. size in case of Channa, Glossogobius, Mastocembelous, Minor carps etc.) The entire Problem lies with the girth of the samples, when the girth will not Permit the penetration of heat into the deeper parts of the muscle. Some of our experiment(n=6) with large girth showed such problems.

(iii) In all cases of the procedure of burning the fish should he cleaned properly. The removal of gills and viscera ensures less microbial proliferation(n=7).Before burning the gills and viscera should he removed.

Note : In the present studies no attempt has been made to recommed the use of solar energy for drying fish samples. A concereate and long terms study would be necessary to draw any canclusion for the use of solar energy for the drying process of fish. Farther the preparation of solar reflectors etc. will pose problrms for the rural population.

Besides the above recommendations forwarded, several chemicals,such as BHT,EDTA disodium salts, citric acid have shown long-tern preservation. However in the present studies the use of such chamicals have not been recommended as there are some problems of the storage of chemicals as well as non-availability in remote areas. Further the use and calculations of does concentration of the chemicals also requires a trained person.

As a whole, it may be concluded that if the above recommendations are followed, better products and longer storage can be expected without the use of sophisticated technology and high cost involvement.

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Appendix 1

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Appendix II

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