Fermentation technology

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Fermentation is a unique preservation method which is also used for preservation of fish and other aquatic animals. Its practise is continuing due to simplicity and economic viability of the process. Fish fermentation is practiced in various regions of the world and are more popular in Southeast Asian countries and several African countries. Some popular products are *nam-pla* and *pla-ra* in Thailand, *phu quoc*, *shiokara* and *narezushi* in Japan, *budu* and *belacan* in Malaysia, *patis* and *buro* in Philippines, *nuoc-mam* and *mams-ca* in Vietnam, *makassar* and *trassi* in Indonesia, *ngapi* in Myanmar, Lanhouin in Benin, Ghana, etc. These products are either in original shape, sauce or reduced to paste form. These products have high salt content and serves as condiments or as appetizer. Fermented fish products in northeast India unlike southeast Asian countries are seldom salted except *lona ilish* of Tripura. Unsalted products include *ngari* and *hentak* in Manipur, *tungtap* in Meghalaya, *shidal* in Tripura, *nghaum*, *nghathu* and *dan pui thu* in Mizoram, *ngyii papi* in Arunachal Pradesh, *seedal* in Assam etc.

Fermented fish products are consumed regularly as health food by the people of North-East India. These products are treated as important ethnic foods and are used as a regular source of nutrients for different group of people in North-East India. Among all the fermented fish products, *shidal* is one of the most consumed and popular products in all the north-eastern states of India. Due to diverse nature of raw material, fermentation technique, storage environment and retailing behaviour, there exists large difference in quality and microbial safety among these products. There is numerous beneficial effect of good quality fermented fish products which includes therapeutic, anti-stress, anti-hypertension, etc. as reported by many authors. Traditionally the fermentation of fish is done by fish farmers or local people of the respective region, so it differs in method of preparation, quality of raw materials and duration of fermentation.

The traditional fermentation process is carried out in a specially designed earthen pot usually for 4 to 6 months. Fermented fish products are known for its medicinal value and rich in bio-nutrients, minerals and act as appetizer (Muzaddadi and Basu 2003a). Generally fermented fish are nutritive and safe to consume but use of spoiled raw material, unhygienic preparation, cross contamination and unfavourable environmental condition may favour growth of public health significant microorganisms, deterioration of nutrient quality; and presence of hazards in the fermented fish products. Effort to ensure safety of the product is very essential as it is a good source of protein and essential amino acids.

Why to ferment fish?

- Preservation of fish/ to handle surplus catch/ prevent spoilage
- To overcome fishing off-season
- Flavour development
- Nutrients enhancement
- Value addition
- To develop product variety
- To develop unique taste (savory/umami)
- Fish is still fermented because the consumers enjoy the taste

How does fermentation preserve fish?

- It works as preservative technique by lowering the pH, Eh, a_w of matrix.
- In modern technique, bio-preservation by addition of lactic acid bacteria to the fish to be fermented.
- LAB produces antimicrobials such as lactic and acetic acid, antimicrobial nisin, hydrogen peroxide, and peptide bacteriocins.
- From preservation of foods to medicinal and nourishing properties in modern era.
- Some of the fermented fish products are marketed in the form of functional foods by various companies. Eg. Intestive, Seacure, Seavive, etc.

Types of fermented fish products

<u>Products retain original shape:</u>

- Examples: Pedah siam (Thailand), makassar (Indonesia), Burong Isda (Philippines), shidal (India), Perkasam (Malaysia), Surstromming (Sweden)

<u>Products in the form of a paste:</u>

- Examples: Ngapi (Myanmar), mams (Vietnam), prahoc (Kampuchea), belachan (Malaysia), trassi (Indonesia), bagoong (Philippines).

<u>Product a liquid form:</u>

- Examples: Budu (Malaysia), patis (Philippines), nuoc-mam (Vietnam), nam-pla, pla-ra (Thailand).

Table 1. Countries producing fermented fish product

COUNTRIES	SAUCE	PASTE	RETAIN ORIGINAL FORM
Japan	*Phu Quoc*	*Nukazuke, Shiokara,*	*Narezushi, Funazushi*
Thailand	*Nam-pla, pla-ra,*		*Plasom, som-fug*
Indonesia	*Makassar,*	*trassi*	
Malaysia	*Budu, pekasam, belacan*		
Philippines	*Patis, buro,*	*bagoong (shrimp)*	
Vietnam	*Nuoc-mam,*	*Mams-ca*	
Norway			*Fermented salmon, saithe*
Taiwan	*Fish sauce*		
Korea			*Jeotgal (shrimp, oyster, fish)*
Myanmar	*Ngapi*	*Ngapi*	
Bangladesh			*Shutki, Lona ilish*
India			*Seedhal, ngari, Hentak, Lona ilish, etc.*
Greece	*Garam*		
Egypt			*Feseekh (gray mullet)*
Iceland			*Hakarl (shark)*
Sweden			*Surstromming (herring)*
China			*Fermented silver carp*
Brazil			*Fermented sardine*

Important fish group used in fermentation around the World

a) **Herring (*Clupea harengus*)**
- Salted and pickled
- Salt varying from 15-36% in different cures e.g. Dutch, Scotch and Icelandic cures
- Typically contain 10-12% salt, halophilic bacteria

b) Anchovies (*Engrautis encrasicolus*)
- Popular in the Mediterranean area Salted and pickled
- Salted in layers in the ratio of 1:0.5-0.6 fish to salt.
- 6 - 7 months' process
- Traditionally, wooden barrels holding 50-200 kg capacity
- Can be carried out in sterile containers using sterile salt (tin plate cans, holding 20 kg)
- Thus appear that no micro-organisms are involved in the process.

c) Mackerel
- *Scomberomorus* species, *Rastrelliger* species, etc.
- Colombo cure is used in North Kerala
- About 8 kg of the fruit of *Garcinia cambogia* /tonne of fish
- Salt: fish (ratio 1:3)
- Fish remain in the brine for 2-4 months
- Use cement tanks or wooden barrels
- In other product no acid fruit pulp is used.
- These fish are exported in a very soft condition, sewn up in palm leaf bags, to the East Coast of Africa

d) Shrimp and fish pastes
- *Ngapi* of Myanmar, the *pra hoc*, *belachan* of Malaysia, *trassi* of Indonesia, etc.
- *Trassi* may be made from shrimp or fish.

Table 2. Major fermented fish products of North-East India

Sl. No.	State	Products
1	Tripura	*Puthi shidal, Phasa shidal, Lona ilish, Nappi*
2	Assam	*Seedal/ hidal*
3	Arunachal Pradesh	*Ngyii papi*
4	Mizoram	*Nghaum, Nghathu, Dan pui thu, Ai-um*
5	Manipur	*Ngari*, *Hentaak*
6	Meghalaya	*Tungtap*

7	Nagaland	*Japangangnagtsu* (fermented crabs)
8	Sikkim	Not available

States of North-East India
(Source: mapsofindia.com)

Preference of fish for fermentation in North-East India

Small sized freshwater fish species viz.

- *Puntius sophore*,
- *P. sarana,*
- *P. ticto*,
- *P. chola,*
- *Amblypharyngodon mola*,
- *Esomus danricus,*
- Small prawns and crabs, etc. are commonly used
- Another species used for shidal preparation is *Setipinna phasa* (called *phasa shidal*)

Steps for preparation of most popular traditional fermented fish product (*shidal*) in NE-India:

1. Raw materials (dry puti fish)
2. Sorting by hands
3. Sun drying in open space
4. Water washing and overnight partial drying at room temperature
5. Packing of oil smeared matkas with partially dried fish and filled up to neck portion

6. Sealing of mouth portion with cover paste
7. Covering of the paste with paper or banana leaves and keep it undisturbed for 3-4 days
8. Removal of the cover leaf and application of thick layer of mud on the mouth
9. Keeping the matkas undisturbed for 3-4 months for fermentation at ambient temperature
10. Final product shidal after 3-4 months by removing the mud and putrefied paste

Table 3. Score card designed for evaluating quality of *shidal* parameter, Prasad (2014)

Parameters	Description	Score	Grade
Appearance	All fish even size and whole fish intact, with typical colour	8-10	Excellent
	Un-even size and not all fish even colour	6-8	Very good
	Un-even size, more of broken fish, dark patches of colour	4-6	Good
	Uneven size fish with muddy colour	2-4	Average
	Insect infested	Score <2	Rejected
Odour	Typical fermented aroma of *shidal* fish	8-10	Excellent
	Slightly less fermented aroma	6-8	Very good
	Weak fermented aromas	4-6	Good
	Very weak fermented aromas	2-4	Average
	Offensive odours	Score <2	Rejected
Texture	Soft and whole fish intact	8-10	Excellent
	Less soft but whole fish intact	6-8	Very good
	Rough and greasy	4-6	Good
	Greasier and absence of softness	2-4	Average
	completely greasy, slimy with maggots	Score <2	Rejected

Benefits of fermented fish and fermentative microbes

- Competes and eliminates all unwanted bacteria and help to maintain good gut micro-flora.
- Helps in digestion, nutrient absorption and general well-being.
- Fermented fish has strong antioxidant scavenging capability against free radicals and reactive oxygen species
- Rich in protein hydrolysates, improving our body's ability to utilize amino acids in the production of muscle and in tissue repair
- Inhibits Angiotensin-I-converting enzyme (ACE), lower blood pressure.
- Peptide chain of Leu-Gly-Leu-Asn-Gly-Asp-Asp-Val-Asn, exhibited high levels of antioxidant activity (Ranathunga S., 2006).
- Boost immune system-by protecting cell damage (WBC) from free radicals. Vit.D helps this.
- Anti-cancer- a peptide from anchovy sauce -have apoptosis-inducing activities in human carcinoma cells - could be potentially useful in preventing the spread of cancer (Lee et al. 2004, Ngo et al. 2012).
- Prevent arthritis
- Prevent psoriasis- caused by compromised immune.

Table 4. Health benefits of microflora associated with fermented fish products

Microbe and Associated Fermented Fish Product	**Health Benefits of the Prominent Flora**
Monascus purpureus in colored Bagoong (Pattanagul et al. 2007)	cholesterol-lowering agent, and anti-inflammation agent (Lee et al. 2006)
Lactobacillus paracasei in Funazushi (Komatsuzaki et al. 2005) and in som-fak (Paludan-Müller 1999)	Bacteriocin production (Miao et al. 2014) and γ-aminobutyric acid (GABA) production (Komatsuzaki et al. 2005) (GABA-enriched food is good for relief from depression, sleeplessness)
Lactobacillus reuteri in Pla- som (Saithong et al. 2010)	Inhibition of binding of Helicobacter pylori to the glycolipid receptors (Mukai et al. 2002)
Lb. plantarum from Budu (Liasi et al.	Antimicrobial activities against Listeria

2009; Saithong et al. 2010), in Funazushi (Nakamura et al. 2012) and in gajami sik-hae (Park et al. 2013)	monocytogenes (Nakamura et al. 2012) Inhibits adipogenesis (antiobesity properties) (Park et al. 2013)
Staph. xylosus in Myeolchi-jeot (Mah and Hwang 2009)	Inhibition of biogenic amine formation in a salted and fermented anchovy (Mah and Hwang 2009)

Source: Kumar and Nayak (2014)

Factors affecting quality of fermented fish products

Several factors were identified:

- The microflora in the fish and salt used (if salt fermented)
- Proteolytic enzymes present in the fish
- Initial microbial load of the raw material
- Presence or absence of oxygen during fermentation
- Nutritional state of the fish
- Fermenting temperature
- pH of the fermentation mixture
- Length of fermentation and method of fermentation

Factors governing safety of fermented fish products

Generally, fermented fish products are safe to consume but there are several factors which are responsible for making the product risky. They are:

- Use of contaminated, low grade and poor quality raw materials
- Inadequate storage facilities of raw material
- Practice of unhygienic preparation methods
- Adulteration of products with chemicals
- Unhygienic marketing facilities
- Lack of standard packaging practices
- Cross-contamination during marketing which invites risk by favouring growth of pathogenic microorganisms, accumulation of harmful bacterial toxin, mycotoxin and carcinogenic agents in the fermented fish which may lead to unsafe product.

Potential hazards and risks in fermented fish

- The risk associated may be botulism, pathogens, biogenic amines, contaminants and chemicals.

- Alaska has more cases of botulism than any other state in the United States of America.

Why some people avoid fermented fish products?

- Intense strong flavour
- Unfamiliar taste
- Physical appearance
- Lack of knowledge about its benefits
- Cultural barrier

Conclusion

Fermented fish products are good source of nutrients. Balanced fatty acids and amino acids profile are reported. They possess antioxidant properties and other therapeutic value. Potential commodity for economic development for the individual and community as well. It is considered as health food by the consumers and has become indispensable in the diet of millions of people.

Suggested Readings

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