Chapter 7

Summary

Fermentation is an ancient form of preservation of fish. Fermentation of fish is common in several cultures because of their high nutritional value and range of sensory qualities. The fermentation process is unregulated and random in traditional fermented fish products, and since the products are frequently processed under local climatic conditions, sensory characteristics and consistency can vary. North East India is rich in natural resources and is a cauldron of variant cultures with unique food habits. Many traditional fermented fish products are recorded in India. *Napham* is a traditional fermented fish paste widely consumed in Kokrajhar district of Assam, being particularly popular amongst the Bodo people. The present study is hitherto the first attempt to do a biochemical and microbial analysis of *napham*.

The documentation of traditional method of preparing napham, the raw materials used and other informations associated with napham were executed in eleven locations in Kokrajhar town and its nearby locality. The plants and fishes used as raw materials were identified by authorized institutions (Botanical Survey of India and Zoological Survey of India, Shillong). A total of eighteen fish and four plant materials were recorded during the survey. *Napham* is prepared from a mixture of small fishes found in the locality and is an ancient method of fish preservation. Preparation involves combined methods of sun drying, smoking, and fermentation. The dried fish and the stem of *Colocasia esculanta* are mixed and pounded together. Sometimes other plant materials like papaya, ash gourd and hibiscus sabdariffa are also used. The raw mixture paste is inserted inside the hollow bamboo stem or glass container and covered by a layer of *kharwi* (local alkali) which is again covered by a piece of dried banana leaf. This content is then sealed with a layer of ash paste. The fermentation ends within three months, but *napham* can be preserved for almost one and a half years. *Napham* making and selling is a good source of income in markets, but apprehensions are there amongst the consumers regarding the quality of the product. *Napham* is consumed mainly as a condiment and flavoring ingredient.

In the present study Biochemical analysis was done to know the nutritional qualities of *napham*. AOAC methods were used for the proximate analysis. For mineral analysis, Graphite Furnace Atomic Absorption Spectrum (GFASS) Model

Analytic Jana Vario 6 was accessed from the Analytical Instrument Facility (SAIF), NEHU, Shillong. For amino acid analysis, the HPLC instrumentation facility (WATERS Alliance Separations module 2695) and for fatty acid analysis, Gas Chromatograph GC-2010 Plus was availed from M R Labs, Hyderabad.

The moisture content of raw sample without the plant additives was 25.5 %. The moisture content of fermented samples ranged from 36.4 to 41.2%. The ash content of raw non-fermented material without additives was found to be 16.7%. In fermented samples it ranged in 11% to 16 %. The crude protein of raw sample was51.9 % and in fermented samples it ranged in 29% to 32%. The pH ranged from 6.5 to 7.7 in fermented products. In raw sample Ph was 6.5. The crude fat content of fermented product was 24%.

Macro mineral elements detected in *napham* were Calcium, Sodium, and Magnesium. The micro-mineral elements were Iron, Zinc, Copper, Potassium, Manganese, Molybdenum, and Chromium. Ultra-trace mineral elements present were Nickel and Cobalt.

Both essential and non-essential amino acids were detected in *napham*. Aspartic acid, glutamic acid, glutamine, alanine, and lysine were the dominant amino acids, and amongst the essential amino acids, lysine, serine, and threonine were dominant.

The fatty acids detected at a higher percentage in *napham* were: Palmitic acid (16.01%), Linoleic-acid (10.41%), Alpha-Linoleic acid (9.53%), and DHA (8.03%). Monounsaturated (MUFA), polyunsaturated fatty acids (PUFA), DHA, Omega 6 fatty acids, and Omega 3 fatty acids were the essential fatty acids detected in ***napham*.**

. The microorganisms in *napham* were enumerated using seven different media. The microbiome biodiversity of four *napham* samples (S1, S2, S3 & S4) was studied using two techniques: WGS metagenomics and 16S metagenomics. WGS metagenomics aims to sequence all the genomes existing in a sample to analyze the biodiversity and the functional capabilities of the community studied. The 16S rRNA metagenome target prokaryotes containing 16S ribosomal RNA (rRNA) sequence.

The workflow for WGS metagenomics consisted of metagenomic DNA extraction, DNA QC, fragmentation, library preparation, quality check, sequencing in Illumina HiSeq, and Bioinformatics pipeline which includes *denovo* metagenomic assembly. For whole metagenome sequencing and further bioinformatics analysis, two samples S1 and S2 were outsourced to Agrigenome pvt Limited, Kochi. The raw reads obtained from the Illumina sequencing platform after Demultiplexing were subjected to the FastQC program (latest version.0.11.8) to check the quality of the reads before the Bioinformatics analysis. The total sequence read obtained after sequencing and QC was 37,947,065, out of which the sequence read in S1 was 19167516 and for S2 the sequence read was 18779549.

The 16S ribosomal RNA (rRNA) is composed of nine hypervariable regions interspersed with conserved regions. The bacterial 16S gene contains nine hypervariable regions (V1-V9) ranging from about 30-100 base pairs long that are involved in the secondary structure of the small ribosomal subunit. The 16S gene contains highly conserved sequences between hypervariable regions, enabling the design of universal primers and taxonomic classification. For 16S rRNA metagenomic analysis two samples were outsourced to PathCare Labs Pvt Ltd., Greater Hyderabad, Telangana. Two *napham* samples S3 and S4, which were more than three months old, were analyzed for bacterial diversity through 16S rRNA metagenomics.

De novo metagenome assembly was carried out for the sample by assembling contigs from the reads using the MetaSPAdes program. Further contigs were linked by the assembly algorithm to create scaffolds. Bad or misassemblies were removed from the result. Assembly was performed with default Kmer sizes 21, 33, and 55 using the de-bruijn graph method. In-house PERL and Python code were used to parse the fastq files for the downstream analysis. The total contigs obtained for S1 was 40317, 103397 for S2.

Annotator (MGA) for the prediction of open reading frames (ORFs). The predicted ORF of S1 was 2940704 and ORF for S2 was 532641. The ORF obtained from the samples was queried to the DIAMOND BLASTX program with an optimum e-value of 1e-5. Taxonomic profiling for all the metagenomics samples was performed using NCBI taxonomy data sets. The taxonomy tree was generated based on neighbour- joining method using MEGAN software. Taxonomic relative abundance was determined in the samples based on the contigs obtained.

In the taxonomic assignment, S1 summarized seven taxa and S2 eleven taxa that correspond to both Prokaryotes and Eukaryotes. According to the annotation, it was observed that Firmicutes, Actinobacteria, and Proteobacteria were the most abundant phyla in S1, and in S2 Firmicutes, Ascomycota, Actinobacteria & Proteobacteria were most dominant.

At the genus level, total 34 genera were obtained from S1 and 74 genera from S2. The most abundant genera found in S1 were *Staphylococcus* (36%), *Oceanobacillus* (15%), *Virgibacillus* (12.54%), *Brevibacterium* (9.44%), *Pediococcus* (5.83%), *Enterococcus* (4.79%), *Yaniella* (3.84%), *Bacillus* (3%), *Carnobacterium* (2.47%), *and Lactobacillus* (2.06%). In S2 the most abundant genera were Staphylococcus (30%) followed by *Enterococcus* (18.62%), *Lactobacillus* (11.63%), *Oceanobacillus* (6.47%), *Aspergillus* (6.35%), *Pediococcus* (3.96%), *Lactococcus* (3.94%), *Tetragenococcus* (2.83%), *Weissella* (2.4%), *Vagococcus* (2.38%).

Total 47 species were summarized in S1.The most abundant species in S1 was S*taphylococcus xylosus* which formed 14.17% of the total population. This was followed by *Oceanobacillus sojae* (12.45%), *Staphylococcus lentus* (7.96%), *Staphylococcus nepalensis* (7.78%), *Pediococcus pentosaceus* (7.74%), *Staphylococcus saprophyticus* (7.19%), *Yaniella halotolerans* (5.34%), Enterococcus *faecalis* (4.73%), *Brevibacterium linens* (4.39%) and *Carnobacterium* sp.ZWU0011 (3.11%).

Total 153 species were summarized in S2. The abundant species in S2 *Oceanobacillus oncorhynchi* (6.4%) followed by *Staphylococcus xylosus* (6.2%), *Virgibacillus alimentarius* (5.73%), *Staphylococcus lentus* (5.2%), *Lactobacillus brevis* (4.7%), *Lactobacillus plantarum* (4.6%), *Lactococcus lactus* (4.3%), *Pediococcus pentosaceus* (4.18%), *Staphylococcus saprophyticus* (4.1%) and *Staphylococcus nepalensis* (3.9%).

Firmicutes, Actinobacteria, and Proteobacteria were most abundant in both S3 and S4. Fermicutes alone forms 98.36 % of the total population in S3 and 99.4 % in S4. At the class level, Class Bacilli is most abundant in both S3 and S4. In S3, the most abundant Family is Staphylococcacea and forms 93% of the total Family, followed by Enterococcaceae (4.03%) and Micrococaceae (1.29%). In S4, Enterococcaceae (96.5%) is most abundant, followed by Streptococcaceae (1.36%) and Staphylococcaceae (0.54%). Total 80 genera in two samples were assigned from the sequence read, and out of that 64 were assigned in S3 and 80 in S4. The top five dominant genera detected in S3 were *Staphylococcus* (93.16%), *Enterococcus* (4.03%*), Yaniella* (1.29%*), Lentibacillus* (0.35%), *Pseudogracilibacillus* (0.21%) and *Lactobacillus* (0.004%). The top five dominant genera detected in S4 were *Enterococcus* (*96.58%),* *Lactococcus* (1.36%), *Staphylococcus* (0.41%), *Weissella* (0.37%), and *Lactobacillus* (0.27%).

To explore the functional potential of the micro-organisms in the microbiome of S1 and S2 during fermentation, gene or protein functions of all the ORF from DIAMOND BLASTX output were parsed using an in-house PERL script. The ORF obtained from the samples was queried to the DIAMOND BLASTX program with an optimum e-value of 1e-5. Further, functional annotation of all the Contigs is carried out by SEED Classification. MEGAN software was used to assign the function of each contig. The protein functions of each contig having the highest alignment score from DIAMOND BLASTX results were considered for functional assignment. In S1 4083 and S2, 4530 sequence reads were categorized into the SEED functional category. As the *napham* fermentation progressed from the first month to the second month, matching levels of the metagenomic sequence read to SEED functional categories increased due to the increase in bacterial abundance. The data showed that carbohydrate, amino acid and protein metabolism were key categories for *napham* fermentation. Carbohydrate metabolism yielded an average of 19.4 % of all matches. The protein metabolism yielded an average of 6.5% of all matches. Amino acids yielded at an average of 12.1%. The results showed that

Bibliography

Abu-Hassan, O., & Sulieman, H. A. (2011). Quality and microbial analysis of local salted-fermented paste product (Terkin). *World's Veterinary Journal*, *1*, 10-13.

Adams, M. R. (2013). Disciplines Associated with Food Safety: Food Microbiology. In Y. Motarjemi, G. Moy, & E. Todd (Eds.), *Encyclopedia of Food Safety* (1st ed.). Academic Press.

Ades, G. L., & Cone, J. F. (1969). Proteolytic activity of Brevibacterium linens during ripening of Trappist-type cheese. *Journal of Dairy Science*, *52*(7), 957-961.

Alm, F. (2012). Scandinavian anchovies and herring tidbits. In Borgstrom, G. (Ed.), *Fish As Food V3* (p. 195). Academic Press.

Amano, K. (1962). The influence of fermentation on the nutritive value of fish with special reference to fermented fish products of south-east Asia. In Heen, E., Kreuzer, R. *Fish in nutrition* (pp. 180-200). Fishing News (Books): London. .

Anal, A.K., Perpetuini, G., Petchkongkaew,A., Tan, R., Avallone, S., Tofalo, R., Nguyen,V.H., Chu-Ky, S., Ho, P.H., Phan, T.T., Waché, Y., (2020).Food safety risks in traditional fermented food from South-East Asia. *Food Control*, *109*, 106922. https://doi.org/10.1016/j.foodcont.2019.106922.

Anggo, A., Ma'ruf, W., Swastawati, F., & Rianingsih, L. (2015). Changes of Amino and Fatty Acids in Anchovy (Stolephorus Sp) Fermented Fish Paste with Different Fermentation Periods. *Procedia Environmental Sciences*, *23*(1), 58-63. https://doi.org/10.1016/j.proenv.2015.01.009

Anihouvi, V. B., Sakyi-Dawson, E., Ayernor, G. S., & Hounhouigan, J. D. (2007). Microbiological changes in naturally fermented cassava fish (Pseudotolithus sp.) for lanhouin production. *International journal of food microbiology*, *116*(2), 287-291.

Anihouvi, V. B., Kindossi, J. M., & Hounhouigan, J. D. (2012). Processing and quality characteristics of some major fermented fish products from Africa: a critical review. *Int. Res. J. Biol. Sci*, *1*(7), 72-84.

[AOAC] Assn. of Official Analytical Chemists. 2000. Coffee and tea. In: Official methods of analysis. 17th ed. Gaithersburg, Md.: AOAC.

Babaei, P. (2019). *In Silico Analysis of Microbial Communities Through Constraint-Based Metabolic Modelling: Investigation of the human gut microbiota and bacterial consortia in food fermentation.* (Thesis for the Degree of Doctor of Philosophy) Chalmers Tekniska Hogskola (Sweden).

Balachandran, K. K. &Vijayan, P. K. (1976). Processing aspects of Indian mackerel-a review. *Fishery technology* 13(2), 81-87.

Beddows, C. G. (1998). Fermented fish and fish products. *In Microbiology of fermented foods* (pp. 416-440).Springer, Boston, MA.

Beier, S., Tappu, R., & Huson, D. H. (2017). Functional analysis in metagenomics using MEGAN 6. In *Functional metagenomics: Tools and applications* pp. 65-74. Springer, Cham. https://doi.org/10.1007/978-3-319-61510-3_4.

Beltrán-Barrientos, L. M., Hernández-Mendoza, A., Torres-Llanez, M. J., González-Córdova, A. F., & Vallejo-Córdoba, B. (2016). Invited review: Fermented milk as antihypertensive functional food. *Journal of dairy science*, *99*(6), 4099-4110.

Bhat, Z. F., Kumar, S., & Bhat, H. F. (2015). Bioactive peptides of animal origin: a review. *Journal of food science and technology*, *52*(9), 5377-5392.

Biswas, K., Sharma, P., & Joshi, S. R. (2019). Co-occurrence of antimicrobial resistance and virulence determinants in enterococci isolated from traditionally fermented fish products. *Journal of Global Antimicrobial Resistance*, *17*, 79-83.

Björkroth, J. (2005). Microbiological ecology of marinated meat products. *Meat Science*, *70*(3), 477-480.

Bligh, E. G., & Dyer, W. J. (1959). A rapid method of total lipid extraction and purification. *Canadian journal of biochemistry and physiology*, *37*(8), 911-917.

Bokulich, N. A., Subramanian, S., Faith, J. J., Gevers, D., Gordon, J. I., Knight, R., ...&Caporaso, J. G. (2013). Quality-filtering vastly improves diversity estimates from Illumina amplicon sequencing. *Nature methods*, *10*(1), 57-59.

Boyacioglu, D., Nilufer, D., Capanoglu, E., (2010). Flavor compounds in foods. In Yildiz, F. (Ed.), *Advances in food biochemistry* (1st Edition, pp. 9–22). CRC pres. https://doi.org/10.1201/9781420007695

Buchfink, B., Xie, C., & Huson, D. H. (2015). Fast and sensitive protein alignment using DIAMOND. *Nature methods*, *12*(1), 59-60.

Burdock, G. A., & Carabin, I. G. (2004). Generally recognized as safe (GRAS): history and description. *Toxicology letters*, *150*(1), 3-18.

Cachaldora, A., Fonseca, S., Franco, I., & Carballo, J. (2013). Technological and safety characteristics of Staphylococcaceae isolated from Spanish traditional dry-cured sausages. *Food microbiology*, *33*(1), 61-68.

Caggianiello, G., Kleerebezem, M., & Spano, G. (2016). Exopolysaccharides produced by lactic acid bacteria: from health-promoting benefits to stress tolerance mechanisms. *Applied microbiology and biotechnology*, *100*(9), 3877-3886.

Campbell□Platt, G. (1980). African locust bean (Parkia species) and its West African fermented food product, dawadawa. *Ecology of food and nutrition*, *9*(2), 123-132.

Caporaso, J. G., Kuczynski, J., Stombaugh, J., Bittinger, K., Bushman, F. D., Costello, E. K., ...&Huttley, G. A. (2010). QIIME allows analysis of high-throughput community sequencing data. *Nature methods*, *7*(5), 335.

Chai, K. F., Voo, A. Y. H., & Chen, W. N. (2020). Bioactive peptides from food fermentation: A comprehensive review of their sources, bioactivities, applications, and future development. *Comprehensive Reviews in Food Science and Food Safety*, *19*(6), 3825-3885.

Chang, C. M., Ohshima, T., & Koizumi, C. (1994). Changes in the composition of free amino acids, organic acids and lipids during processing and ripening of 'Hatahata□zushi', a fermented fish product of sandfish (*Arctoscopus japonicus*) and boiled rice. *Journal of the Science of Food and Agriculture*, *66*(1), 75-82.

Chaudhary, S. (2019) Chemical Practices in Ancient India. *International Journal of Applied Social Science*. *6*(8), 2108-211.

Chistoserdova, L. (2009). Functional metagenomics: recent advances and future challenges. *Biotechnology and Genetic Engineering Reviews*, *26*(1), 335-352.

Choi, K. Y., Lee, T. K., & Sul, W. J. (2015). Metagenomic analysis of chicken gut microbiota for improving metabolism and health of chickens—a review. *Asian-Australasian journal of animal sciences*, *28*(9), 1217.

Choorit, W., & Prasertsan, P. (1992). Characterization of proteases produced by newly isolated and identified proteolytic microorganisms from fermented fish (Budu). *World Journal of Microbiology and Biotechnology*, *8*(3), 284-286.

Chowdhury, N., Goswami, G., Hazarika, S., Sharma Pathak, S., & Barooah, M. (2019). Microbial dynamics and nutritional status of namsing: a traditional fermented fish product of Mishing community of Assam. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *89*(3), 1027-1038. https://doi.org/10.1007/s40011-018-1022-9

Chukeatirote, E. (2015). Thua nao: Thai fermented soybean. *Journal of Ethnic Foods*, *2*(3), 115-118.

Compeau, P. E., Pevzner, P. A., & Tesler, G. (2011). How to apply de Bruijn graphs to genome assembly. Nature biotechnology, 29(11), 987-991.

Csutak, O., & Sarbu, I. (201). Genetically Modified Microorganisms: Harmful or Helpful? In Holban A., M., Grumezescu A., M., (Eds.), *Handbook of Food Bioengineering, Genetically Engineered Foods* (pp. 143–175). Academic Press. https://doi.org/10.1016/B978-0-12-811519-0.00006-6.

Curtis, R.I., 1991. Garum and Salsamenta. Production and Commerce in Materia Medica. In: *Studies in Ancient Medicine* (p. 3). Brill, Leiden.

Dai, S., Pan, M., El□Nezami, H. S., Wan, J. M., Wang, M. F., Habimana, O., ... & Shah, N. P. (2019). Effects of lactic acid bacteria□fermented soymilk on isoflavone metabolites and short□chain fatty acids excretion and their modulating effects on gut microbiota. *Journal of food science*, *84*(7), 1854-1863.

Deatraksa, J., Sunthornthummas, S., Rangsiruji, A., Sarawaneeyaruk, S., Suwannasai, N., & Pringsulaka, O. (2018). Isolation of folate-producing *Weissella* spp. from Thai fermented fish (Plaa Som Fug). *LWT*, *89*, 388-391.

Dincer, T., Cakli, S., Kilinc, B., & Tolasa, S. (2010). Amino acids and fatty acid composition content of fish sauce. *Journal of Animal and Veterinary Advances*, *9*(2), 311-315.

Dirar, H. A. (1984). Kawal, meat substitute from fermented *Cassia obtusifolia* leaves. *Economic Botany*, *38*(3), 342-349. doi:10.3168/jds.2015-10054

Dominy, N. J. (2015). Ferment in the family tree. *Proceedings of the National Academy of Sciences*, *112*(2), 308-309.

Duc, L. H., Hong, H. A., Barbosa, T. M., Henriques, A. O., & Cutting, S. M. (2004). Characterization of Bacillus probiotics available for human use. *Applied and environmental microbiology*, *70*(4), 2161-2171.

Durak-Dados, A., Michalski, M., & Osek, J. (2020). Histamine and other biogenic amines in food. *Journal of Veterinary Research*, *64*(2), 281-288.

Durazzi, F., Sala, C., Castellani, G., Manfreda, G., Remondini, D., & De Cesare, A. (2021). Comparison between 16S rRNA and shotgun sequencing data for the taxonomic characterization of the gut microbiota. *Scientific reports*, *11*(1), 1-10.

Edgar, R. C. (2004). MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic acids research*, *32*(5), 1792-1797.

Edgar, R. C., Haas, B. J., Clemente, J. C., Quince, C., & Knight, R. (2011). UCHIME improves sensitivity and speed of chimera detection. *Bioinformatics*, *27*(16), 2194-2200.

Edgar, R. C. (2013). UPARSE: highly accurate OTU sequences from microbial amplicon reads. *Nature methods*, *10*(10), 996.

El Sheikha, A. F., Ray, R., Montet, D., Panda, S., & Worawattanamateekul, W. (2014). African fermented fish products in scope of risks. *International Food Research Journal*, *21*(2).

El Soda, M., & Awad, S. (2014). CHEESE | Role of Specific Groups of Bacteria. In *Encyclopedia of Food Microbiology* (Second Edition, pp. 416–420). Elsevier. https://doi.org/10.1016/B978-0-12-384730-0.00061-6

Endo, A., Irisawa, T., Dicks, L., & Tanasupawat, S. (2014). Fermented Foods. Fermentations of East and Southeast Asia. In Batt, C.A. & Tortorello, M.L. (Eds.) *Encyclopedia of food microbiology* (pp. 846-850). London, UK: Academic press. https://doi.org/10.1016/b978-0-12-384730-0.00119-1.

Essuman, K. F. (1992). *Fermented fish in Africa: a study on processing, marketing and consumption* (No. 329). Food & Agriculture Org. https://agris.fao.org/agris-search/search.do?recordID=XF9545063

Fan, Y., Xue, Y., Li, Z., Hou, H., & Xue, C. (2017). Analyzing the flavor compounds in Chinese traditional fermented shrimp pastes by HS-SPME-GC/MS and electronic nose. *Journal of Ocean University of China*, *16*(2), 311-318.

Fanning, S., L. J. Hall, M. Cronin, A. Zomer, J. MacSharry, D. Goulding, M. O. Motherway, F. Shanahan, K. Nally, G. Dougan. 2012. Bifidobacterial surface-exopolysaccharide facilitates commensal-host interaction through immune modulation and pathogen protection. *Proceedings of the National Academy of Sciences*, *109*(6), 2108-2113.

Farhad, M., Kailasapathy, K., & Tamang, J. P. (2010). Health aspects of fermented foods. In Tamang, J.P., & Kailasapathy, K. (Eds.). *Fermented Foods and Beverages of the World* (1st ed.). CRC Press. https://doi.org/10.1201/EBK1420094954

Farnworth, E.R. (. (Ed.). (2008). Handbook of Fermented Functional Foods (2nd ed.). CRC Press. https://doi.org/10.1201/9781420053289

Federation, W. E., & APH Association. (2005). Standard methods for the examination of water and wastewater. *American Public Health Association (APHA): Washington, DC, USA*.

Feng, L., Tang, N., Liu, R., Gong, M., Wang, Z., Guo, Y., ... & Chang, M. (2021). The relationship between flavor formation, lipid metabolism, and microorganisms in fermented fish products. *Food & Function*. *12*(13), 5685-5702.

Foissy, H. (1974). Examination of Brevibacterium linens by an electrophoretic zymogram technique. *Microbiology*, *80*(1), 197-205.

Food and Drug Administration. (2001). Guidance for industry: bioanalytical method validation. *http://www. fda. gov/cder/Guidance/4252fnl. pdf*.

Fry, J. C. (2004). Culture-dependent microbiology.In *Microbial diversity and bioprospecting* (pp. 80-87).American Society of Microbiology.

Fujii, T., Nikkuni, S., & Iida, H. (1992). Chemical Composition and Putrescible Potential of Commercial" Shottsuru", Japanese Fish Sauce. *Nippon Shokuhin Kogyo Gakkaishi*, *39*(8), 702-706.

Fukui, Y., Yoshida, M., Shozen, K. I., Funatsu, Y., Takano, T., Oikawa, H., ... & Satomi, M. (2012). Bacterial communities in fish sauce mash using culture-dependent and-independent methods. *The Journal of general and applied microbiology*, *58*(4), 273-281.

Fung, D. (2013). 15 Rapid methods for measurement and enumeration. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*, *9*, 404.

Ganasen, P., & Benjakul, S. (2010). Physical properties and microstructure of pidan yolk as affected by different divalent and monovalent cations. *LWT-Food Science and Technology*, *43*(1), 77-85.

Gelman, A., Drabkin, V., & Glatman, L. (2000). Evaluation of lactic acid bacteria, isolated from lightly preserved fish products, as starter cultures for new fish-based food products. *Innovative Food Science & Emerging Technologies, 1*(3), 219-226.

Giraffa, G. (2004). Studying the dynamics of microbial populations during food fermentation. *FEMS Microbiology Reviews*. *28*(2), 251-260.

Giyatmi & H.E. Irianto. (2017). Enzymes in Fermented Fish. In Se-Kwon Kim & Toldrá F., (Ed.), *Advances in Food and Nutrition Research* (Vol. 80, pp. 199–216). Academic Press. https://doi.org/10.1016/bs.afnr.2016.10.004

Gomes, F. C., Lacerda, I. C., Libkind, D., Lopes, C., Carvajal, E. J., & Rosa, C. A. (2009). Traditional foods and beverages from South America: microbial communities and production strategies. *Industrial Fermentation: Food Processes, Nutrient Sources and Production Strategies*, 79-114.

Grecz, N., Wagenaar, R. O., & Dack, G. M. (1959). Inhibition of *Clostridium botulinum* by culture filtrates of Brevibacterium linens. *Journal of bacteriology*, *78*(4), 506.

Guan, L., Cho, K. H., & Lee, J. H. (2011). Analysis of the cultivable bacterial community in jeotgal, a Korean salted and fermented seafood, and identification of its dominant bacteria. *Food microbiology*, *28*(1), 101-113.

Ha, C. W., Lam, Y. Y., & Holmes, A. J. (2014). Mechanistic links between gut microbial community dynamics, microbial functions and metabolic health. *World Journal of Gastroenterology: WJG*, *20*(44), 16498.

Haas, B. J., Gevers, D., Earl, A. M., Feldgarden, M., Ward, D. V., Giannoukos, G., ... & Human Microbiome Consortium. (2011). Chimeric 16S rRNA sequence formation and detection in Sanger and 454-pyrosequenced PCR amplicons. *Genome research*, *21*(3), 494-504.

Hákarl: Iceland's Rancid Fermented Shark Delicacy. (2019). [Travel food atlas]. Retrieved May 3, 2020, fromhttps://travelfoodatlas.com/hakarl-iceland-smelly-fermented-shark-delicacy/

Han, S. C., Kang, G. J., Ko, Y. J., Kang, H. K., Moon, S. W., Ann, Y. S., & Yoo, E. S. (2012). Fermented fish oil suppresses T helper 1/2 cell response in a mouse model of atopic dermatitis via generation of CD4+ CD25+ Foxp3+ T cells. *BMC immunology*, *13*(1), 1-12.

Hess, M., Sczyrba, A., Egan, R., Kim, T. W., Chokhawala, H., Schroth, G., ...& Rubin, E. M. (2011). Metagenomic discovery of biomass-degrading genes and genomes from cow rumen. *Science*, *331*(6016), 463-467.

Http://ccb.jhu.edu/software/FLASH/.

Http://drive5.com/uchime/uchime_download.html.

Http://drive5.com/uparse/.

Http://metagene.nig.ac.jp/.

Http://qiime.org/scripts/split_libraries_fastq.html.

Http://scikitbio.org/docs/latest/generated/generated/skbio.diversity.alpha.chao1.html #skbio.diversity.alpha.chao1.

Http://www.drive5.com/usearch/manual/uchime_algo.html.

Https://www.illumina.com/science/technology/next-generation-sequencing/sequencing-technology.html.

Huda, N. (2012). Indonesian fermented fish product. In *Handbook of Animal-Based Fermented Food and Beverage Technology* (2nd ed., pp. 717-738). CRC Press.

Hwang, J., Kim, J. C., Moon, H., Yang, J. Y., & Kim, M. (2017). Determination of sodium contents in traditional fermented foods in Korea. *Journal of Food Composition and Analysis*, *56*, 110-114.

Hwanhlem, N., Buradaleng, S., Wattanachant, S., Benjakul, S., Tani, A., & Maneerat, S. (2011). Isolation and screening of lactic acid bacteria from Thai traditional fermented fish (Plasom) and production of Plasom from selected strains. *Food Control*, *22*(3-4), 401-407.

Ijong, F. G., & Ohta, Y. (1995). Amino acid compositions of bakasang, a traditional fermented fish sauce from Indonesia. *LWT-Food Science and Technology*, *28*(2), 236-237.

Indriati, N., Setiawan, I.P.D. & Yulneriwarni,Y.,(2006).Antibacterial potential of Lactic acid Bacteria from Peda, Jambal Roti, and Bekasam. *Gadjah Mada University Fisheries Journal*, *8*(2), 153-159.

Irianto, H. E., & Irianto, G. (1998). Traditional fermented fish products in Indonesia. *RAP Publ*, *24*.

Ishige, N. (1993). Cultural aspects of fermented fish products in Asia. In Lee, C.H., Steinkrauss, K.H. and Alan Reilly, P.J., (Eds.). *Fish fermentation Technology* (pp.13-32) United Nations University Press. Tokyo.

Ishimwe, N., Daliri, E. B., Lee, B. H., Fang, F., & Du, G. (2015).The perspective on cholesterol□lowering mechanisms of probiotics. *Molecular nutrition & food research*, *59*(1), 94-105.

Jaffrès, E., Prévost, H., Rossero, A., Joffraud, J. J., & Dousset, X. (2010). Vagococcus penaei sp. nov., isolated from spoilage microbiota of cooked shrimp (*Penaeus vannamei*). *International journal of systematic and evolutionary microbiology*, *60*, 2159-2164.

Je, J. Y., Park, P. J., Jung, W. K., & Kim, S. K. (2005). Amino acid changes in fermented oyster (*Crassostrea gigas*) sauce with different fermentation periods. *Food chemistry*, *91*(1), 15-18.

Jemil, I., Abdelhedi, O., Mora, L., Nasri, R., Aristoy, M. C., Jridi, M. , Hajji, M., Toldrá, F., & Nasri, M. & Nasri, M. (2016). Peptidomic analysis of bioactive peptides in zebra blenny (Salaria basilisca) muscle protein hydrolysate exhibiting antimicrobial activity obtained by fermentation with Bacillus mojavensis A21. *Process Biochemistry*, *51*(12), 2186-2197.

Jeong, S. H., Lee, J. H., Jung, J. Y., Lee, S. H., Park, M. S., & Jeon, C. O. (2013). *Halomonas cibimaris* sp. nov., isolated from jeotgal, a traditional Korean fermented seafood. *Antonie van Leeuwenhoek*, *103*(3), 503-512.

Jeyaram, K., Singh, T. A., Romi, W., Devi A. R., Singh, W. M., Dayanidhi H., Singh, N. R., and Tamang, J. P. (2009). Traditional fermented foods of Manipur. *Indian Journal of Traditional Knowledge*, *8*(1), 115-121.

Jiang, J. J., Zeng, Q. X., Zhu, Z. W., & Zhang, L. Y. (2007). Chemical and sensory changes associated Yu-lu fermentation process–A traditional Chinese fish sauce. *Food Chemistry*, *104*(4), 1629-1634.

Jiang, J. J., Zeng, Q. X., Zhu, Z. W., & Zhang, L. Y. (2007). Chemical and sensory changes associated Yu-lu fermentation process–A traditional Chinese fish sauce. *Food Chemistry*, *104*(4), 1629-1634.

Jun, J. W., Giri, S. S., Kim, H. J., Chi, C., Yun, S., Kim, S. G Kang, J. W., & Park, S. C. (2017). Complete Genome Sequence of the Novel Bacteriophage pSco-10 Infecting Staphylococcus cohnii. *Genome announcements*, *5*(47). doi: 10.1128/genomeA.01032-17.

Jung, J. Y., Lee, S. H., Kim, J. M., Park, M. S., Bae, J. W., Hahn, Y., ... & Jeon, C. O. (2011). Metagenomic analysis of kimchi, a traditional Korean fermented food. *Applied and environmental microbiology*, *77*(7), 2264-2274.

Jung, J. Y., Lee, S. H., Lee, H. J., & Jeon, C. O. (2013). Microbial succession and metabolite changes during fermentation of saeu-jeot: traditional Korean salted seafood. *Food microbiology*, *34*(2), 360-368.

Jung, M. J., Roh, S. W., Kim, M. S., & Bae, J. W. (2010). Lentibacillus jeotgali sp. nov., a halophilic bacterium isolated from traditional Korean fermented seafood. *International journal of systematic and evolutionary microbiology*, *60*(5), 1017-1022.

Justé, A., Thomma, B. P. H. J., &Lievens, B. (2008). Recent advances in molecular techniques to study microbial communities in food-associated matrices and processes. *Food microbiology*, *25*(6), 745-761.

Katz, S. E. (2012). *The art of fermentation: an in-depth exploration of essential concepts and processes from around the world*. (pp. 9-17)Chelsea green publishing.

Kavitake, D., Kandasamy, S., Devi, P. B., & Shetty, P. H. (2018). Recent developments on encapsulation of lactic acid bacteria as potential starter culture in fermented foods–A review. *Food Bioscience*, *21*, 34-44.

Kleekayai, T., Harnedy, P. A., O'Keeffe, M. B., Poyarkov, A. A., CunhaNeves, A., Suntornsuk, W., & FitzGerald, R. J. (2015). Extraction of antioxidant and ACE inhibitory peptides from Thai traditional fermented shrimp pastes. *Food chemistry*, *176*, 441-447.

Kim, H., Kim, J., Shin, S. G., Hwang, S., & Lee, C. (2016). Continuous fermentation of food waste leachate for the production of volatile fatty acids and potential as a denitrification carbon source. *Bioresource technology*, *207*, 440-445.

Kim, J., Jung, M. J., Roh, S. W., Nam, Y. D., Shin, K. S., & Bae, J. W. (2011). *Virgibacillus alimentarius* sp. nov., isolated from a traditional Korean food. *International journal of systematic and evolutionary microbiology*, *61*(12), 2851-2855.

Kindstedt, P. (2012). *Cheese and Culture A History of Cheese and its Place in Western Civilization* (pp. 63–80). Chelsea Green Publishing.

Kobayashi, T., Kimura, B., & Fujii, T. (2000). Strictly anaerobic halophiles isolated from canned Swedish fermented herrings (Surströmming). *International journal of food microbiology*, *54*(1-2), 81-89.

Kobayashi, T., Taguchi, C., Kida, K., Matsuda, H., Terahara, T., Imada, C., Moe, N.K.T. & Thwe, S.M (2016). Diversity of the Bacterial Community in Myanmar Traditional Salted Fish Yegyo Ngapi. *World journal of microbiology & biotechnology*, *32*(10), 166.

Koesoemawardani, D., & Hidayati, S. (2018). Amino acid and fatty acid compositions of Rusip from fermented Anchovy fish (*Stolephorus* sp). In *IOP Conference Series: Materials Science and Engineering* (Vol. 344, No. 1, p. 012005). IOP Publishing.

Kolawole, O. D., Williams, S. B., & Awujola, A. F. (2010). Indigenous fish processing and preservation practices amongst women in Southwestern Nigeria. *Indian Journal of Traditional Knowledge*, *9*(4), 668-672.

Koo, O. K., Lee, S. J., Chung, K. R., Jang, D. J., Yang, H. J., & Kwon, D. Y. (2016). Korean traditional fermented fish products: jeotgal. *Journal of Ethnic Foods*, *3*(2), 107-116.

Kopermsub, P., & Yunchalard, S. (2010). Identification of lactic acid bacteria associated with the production of plaa-som, a traditional fermented fish product of Thailand. *International journal of food microbiology*, *138*(3), 200-204.

Korakli, M., Gänzle, M. G., & Vogel, R. F. (2002). Metabolism by bifidobacteria and lactic acid bacteria of polysaccharides from wheat and rye, and exopolysaccharides produced by Lactobacillus sanfranciscensis. *Journal of applied microbiology*, *92*(5), 958-965.

Kormin, S., Rusul, G., Radu, S., & Ling, F. H. (2001).Bacteriocin-producing lactic acid bacteria isolated from traditional fermented food. *The Malaysian journal of medical sciences: MJMS*, *8*(1), 63.

Kuda, T., Izawa, Y., Ishii, S., Takahashi, H., Torido, Y., & Kimura, B. (2012). Suppressive effect of *Tetragenococcus halophilus*, isolated from fish-nukazuke, on histamine accumulation in salted and fermented fish. *Food Chemistry*, *130*(3), 569-574.

Kuda, T., Kawahara, M., Nemoto, M., Takahashi, H., & Kimura, B. (2014). In vitro antioxidant and anti-inflammation properties of lactic acid bacteria isolated from fish intestines and fermented fish from the Sanriku Satoumi region in Japan. *Food research international*, *64*, 248-255.

Kulski, J. K. (2016). Next-Generation Sequencing — An Overview of the History, Tools, and “Omic” Applications. In (Ed.), Next Generation Sequencing - Advances, Applications and Challenges, (pp. 3-60). IntechOpen. https://doi.org/10.5772/61964

Kumar, S., & Nayak, B. B. (2015). Health benefits of fermented fish. *Health Benefits of Fermented Foods and Beverages.* (pp. 475-488). CRC Press, Boca Raton.

Lacey, J., & Magan, N. (1991). Fungi in cereal grains: Their occurrence and water and temperature relationships. In Chelkowski, J. (Ed.), *Developments in Food Science* (pp. 77–118). Elsevier.

Lee, C. H., (1993) Fish fermentation technology in Korea. In Lee, C.H., Steinkrauss, K.H. & Alan Reilly, P.J., (Eds.) *Fish fermentation technology* (pp 187-201). United Nations University Press, Tokyo.

Lee, S. H., Jung, J. Y., & Jeon, C. O. (2015). Bacterial community dynamics and metabolite changes in myeolchi-aekjeot, a Korean traditional fermented fish sauce, during fermentation. *International Journal of Food Microbiology*, *203*, 15-22.

Lee, Y. G., Lee, K. W., Kim, J. Y., Kim, K. H., & Lee, H. J. (2004). Induction of apoptosis in a human lymphoma cell line by hydrophobic peptide fraction separated from anchovy sauce. *Biofactors*, *21*(1-4), 63-67.

Liang, C., Sarabadani, Z., &Berenjian, A. (2016).An overview on the health benefits and production of fermented functional foods. *Journal of Advanced Medical Sciences and Applied Technologies*, *2*(2), 224-233.

Lindon, J. C., Nicholson, J. K., & Holmes, E. (Eds.). (2018). *The handbook of metabolic phenotyping*. Elsevier.

Lopetcharat, K., Choi, Y. J., Park, J. W., & Daeschel, M. A. (2001). Fish sauce products and manufacturing: a review. *Food Reviews International*, *17*(1), 65-88.

Lozupone, C. A., Stombaugh, J., Gonzalez, A., Ackermann, G., Wendel, D., Vázquez-Baeza, Y., ... & Knight, R. (2013). Meta-analyses of studies of the human microbiota. Genome research, 23(10), 1704-1714.

Lule, V., Singh, R., Behare, P., & Tomar, S. K. (2015). Comparison of exopolysaccharide production by indigenous Leuconostoc mesenteroides strains in whey medium. *Asian J Dairy Food Res*, *34*, 8-12.

Mackie, I. M., Hardy, R., & Hobbs, G. (1971). Fermented fish products FAO Fisheries Report No. 100. *Food and Agricultural Organisation of the United Nations.* Rome.

Magoč, T., &Salzberg, S. L. (2011). FLASH: fast length adjustment of short reads to improve genome assemblies. *Bioinformatics*, *27*(21), 2957-2963.

Mah, J. H., & Hwang, H. J. (2009). Inhibition of biogenic amine formation in a salted and fermented anchovy by *Staphylococcus xylosus* as a protective culture. *Food Control*, *20*(9), 796-801.

Mahdihassan, S. (1972). The earliest distillation units of pottery in Indo-Pakistan. *Pakistan Archaeology*, *8*, 159-68.

Mahdihassan, S. (1981). Parisrut the earliest distilled liquor of Vedic times or of about 1500 BC. *Indian journal of history of science*, *16*(2), 223-229.

Mahony, J., Casey, E., & van Sinderen, D. (2020). The Impact and Applications of Phages in the Food Industry and Agriculture. *Viruses*, *12*(2).

Majumdar, R. K., & Basu, S. (2010). Characterization of the traditional fermented fish product Lona ilish of Northeast India. *Indian Journal of Traditional Knowledge*, *9*(3), 453-458.

Majumdar, R. K., Bejjanki, S. K., Roy, D., Shitole, S., Saha, A., & Narayan, B. (2015). Biochemical and microbial characterization of Ngari and Hentaak-traditional fermented fish products of India. *Journal of food science and technology*, *52*(12), 8284-8291.

Majumdar, R. K., Roy, D., Bejjanki, S., & Bhaskar, N. (2016). An overview of some ethnic fermented fish products of the Eastern Himalayan region of India. *Journal of Ethnic Foods*, *3*(4), 276-283.

Majumdar, R. K., Roy, D., Bejjanki, S., & Bhaskar, N. (2016). Chemical and microbial properties of shidal, a traditional fermented fish of Northeast India. *Journal of Food science and Technology*, *53*(1), 401-410.

Majumdar, R. K., & Gupta, S. (2020). Isolation, identification and characterization of Staphylococcus sp. from Indian ethnic fermented fish product. *Letters in Applied Microbiology*, *71*(4), 359-368.

Manchester, K. L. (2007). Louis Pasteur, fermentation, and a rival. *South African Journal of Science*, *103*(9-10), 377-380.

Markowitz, J. S., Straughn, A. B., & Patrick, K. S. (2003). Advances in the pharmacotherapy of attention□deficit□hyperactivity disorder: Focus on methylphenidate formulations. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, *23*(10), 1281-1299.

Martínez-Álvarez, O., López-Caballero, M. E., Gómez-Guillén, M. C., & Montero, P. (2017). Fermented seafood products and health. In *Fermented foods in health and disease prevention* (pp. 177-202), Academic Press..

McGovern, P. E., Zhang, J., Tang, J., Zhang, Z., Hall, G. R., Moreau, R. A., & Wang, C. (2004). Fermented beverages of pre-and proto-historic China. *Proceedings of the National Academy of Sciences*, *101*(51), 17593-17598.

Mendivil, C. O. (2020). Dietary Fish, Fish Nutrients, and Immune Function: A Review. *Frontiers in Nutrition*, *7*. doi=10.3389/fnut.2020.617652

Metcalfe, L. D., & Schmitz, A. A. (1961). The rapid preparation of fatty acid esters for gas chromatographic analysis. *Analytical Chemistry*, *33*(3), 363-364.

Millar, B. C., Xu, J., & Moore, J. E. (2007).Molecular Diagnostics of Medically ImportantBacterial Infections. *Current issues in molecular biology*, *9*(1), 21.

Minoche, A. E., Dohm, J. C., & Himmelbauer, H. (2011). Evaluation of genomic high-throughput sequencing data generated on Illumina HiSeq and genome analyzer systems. *Genome biology*, *12*(11), 1-15.

Mizutani, T., Kimizuka, A., Ruddle, K., & Ishige, N. (1992). Chemical components of fermented fish products. *Journal of Food Composition and Analysis*, *5*(2), 152-159.

Mohamed, E., & Hamadani, L. (2013). Changes in Minerals Content of Traditionally fermented Nile-Fish Productin Sudan. *Chemistry*, *75*(2), 155-158.

Mohammed, H. M. H. (2010). Nutritive value of fresh and salted fermented fish (*Alestes dentex*) Terkin. *Food Science and Technology*.

MOLINOS, A. C., GÁLVEZ, A., RAJ, A., CHAUHAN, A., GUPTA, A. D., CHYE, F. Y., ... & BIRA, Z. M. (2016). Indigenous Fermented Foods of south Asia. *Indigenous Fermented Foods of South Asia*, *7*(1).

Moon, J. S., Kim, Y., Jang, K. I., Cho, K. J., Yang, S. J., Yoon, G. M., ... & Han, N. S. (2010). Analysis of biogenic amines in fermented fish products consumed in Korea. *Food Science and Biotechnology*, *19*(6), 1689-1692.

Mumford, S. L., Schisterman, E. F., Siega-Riz, A. M., Gaskins, A. J., Wactawski-Wende, J., & VanderWeele, T. J. (2011). Effect of dietary fiber intake on lipoprotein cholesterol levels independent of estradiol in healthy premenopausal women. *American journal of epidemiology*, *173*(2), 145-156.

Muzaddadi, A. U., & Basu, S. (2012). Shidal-a traditional fermented fishery product of North East India.*Indian Journal of Traditional Knowledge*, *11*(2), 323-328.

Nampoothiri, K. M., Beena, D. J., Vasanthakumari, D. S., & Ismail, B. (2017). Health benefits of exopolysaccharides in fermented foods. In *Fermented foods in health and disease prevention* (pp. 49-62).Academic Press.

Narzary, Y., Brahma, J., Brahma, C., & Das, S. (2016). A study on indigenous fermented foods and beverages of Kokrajhar, Assam, India. *Journal of Ethnic foods*, *3*(4), 284-291.

Narzary, Y., Das, S., Goyal, A. K., Lam, S. S., Sarma, H., & Sharma, D. (2021). Fermented fish products in South and Southeast Asian cuisine: indigenous technology processes, nutrient composition, and cultural significance. *Journal of Ethnic Foods*, *8*(1), 1-19.

National Research Council (US) (1992) Panel on the Applications of Biotechnology to Traditional Fermented Foods. *Applications of Biotechnology to Fermented Foods: Report of an Ad Hoc Panel of the Board on Science and Technology for International Development*. National Academies Press (US).

National Research Council. (1989). Protein and amino acids. In *Recommended Dietary Allowances: 10th Edition*. National Academies Press (US).

Nejati, F., C. G. Rizzello, R. Di Cagno, M. Sheikh-Zeinoddin, A. Diviccaro, F. Minervini, and M. Gobbetti.(2013). Manufacture of a functional fermented milk enriched of Angiotensin-I Converting Enzyme (ACE) inhibitory peptides and g-amino butyric acid (GABA). LWT-*Food Science and Technology* 51 (1):183–89. doi:10.1016/j.lwt.2012.09.017.

Nerquaye-Tetteh, G., Eyeson, K. K., & Tete-Marmon, J. (1978). Studies on Bomone, a Ghanaian fermented fish product. *Ghana journal of agricultural science*.

Nghia D, N., Si Trung, T., & Van Dat, P. (2017). "Nuoc Mam" Fish Sauce in Vietnam: A Long History from Popular Seasoning to Health Benefit Bioactive Peptides. *Annals of Food Processing and Preservation*, *2*(2).

Nguyen, B. (2017). *Development of a Rapid Detection and Quantification Method for Yeasts and Molds in Dairy Products* (Masters Thesis). University of Nebraska-Lincoln. Food Science and Technology. 99pp.

Njoku, H. O., & Okemadu, C. P. (1989). Biochemical changes during the natural fermentation of the African oil bean (*Pentaclethra macrophylla*) for the production of Ugba. *Journal of the Science of Food and Agriculture*, *49*(4), 457-465.

Noguchi, H., Taniguchi, T., & Itoh, T. (2008). MetaGeneAnnotator: detecting species-specific patterns of ribosomal binding site for precise gene prediction in anonymous prokaryotic and phage genomes. *DNA research*, *15*(6), 387-396.

Nout, M. J. R. (2014). Food technologies: fermentation. In *Encyclopedia of Food Safety, Volume 3: Foods, Materials, Technologies and Risks* (pp. 168-177). Waltham, Academic Press.

Nurk, S., Meleshko, D., Korobeynikov, A., & Pevzner, P. A. (2017). metaSPAdes: a new versatile metagenomic assembler. *Genome research*, *27*(5), 824–834.

Nygaard, A. B., Tunsjø, H. S., Meisal, R., & Charnock, C. (2020). A preliminary study on the potential of Nanopore MinION and Illumina MiSeq 16S rRNA gene sequencing to characterize building-dust microbiomes. *Scientific Reports*, *10*(1), 1-10.

Odunfa, S. A. (1981). Microbiology and amino acid composition of Ogiri—a food condiment from fermented melon seeds. *Food/Nahrung*, *25*(9), 811-816.

Olympia, M. (1992). Fermented fish products in the Philippines. In *National Research Council (US) Panel on the Applications of Biotechnology to Traditional Fermented Foods. Applications of Biotechnology to Fermented Foods: Report of an Ad Hoc Panel of the Board on Science and Technology for International Development.* (pp. 131–139). Washington (DC): National

Academies Press (US).

Ohshima, T., & Giri, A. (2014). Fermented foods| Traditional fish fermentation technology and recent developments. In book: *Encyclopedia of Food Microbiology* (pp.852-869).

Osimani, A., Ferrocino, I., Agnolucci, M., Cocolin, L., Giovannetti, M., Cristani, C., ... & Aquilanti, L. (2019). Unveiling hákarl: a study of the microbiota of the traditional Icelandic fermented fish. *Food microbiology*, *82*, 560-572.

Owens, J. D., & Mendoza, L. S. (1985). Enzymically hydrolysed and bacterially fermented fishery products. *International Journal of Food Science & Technology*, *20*(3), 273-293.

Paludan-Müller, C., Madsen, M., Sophanodora, P., Gram, L., & Møller, P. L. (2002). Fermentation and microflora of plaa-som, a Thai fermented fish product prepared with different salt concentrations. *International Journal of Food Microbiology*, *73*(1), 61-70.

Pan, D., & Mei, X. (2010). Antioxidant activity of an exopolysaccharide purified from Lactococcuslactis subsp. lactis 12. *Carbohydrate polymers*, *80*(3), 908-914.

Panthee, S., Paudel, A., Blom, J., Hamamoto, H., & Sekimizu, K. (2019). Complete genome sequence of Weissella hellenica 0916-4-2 and its comparative genomic analysis. *Frontiers in microbiology*, *10*, 1619.

Parkouda, C., Nielsen, D. S., Azokpota, P., Ouoba, L.I.I., Amoa-Awua, W. K., Thorsen, L., Hounhouigan, J. D., Jensen, J.S., Tano-Derah, K., Diawara, B., & Jakobsen, M. (2009). The microbiology of alkaline-fermentation of indigenous seeds used as food condiments in Africa and Asia. *Critical Reviews in Microbiology*, *35*(2), 139-156.

Parvathy, U. (2018). Drying and salting of Fish. ICAR-Central Institute of Fisheries Technology.

Pearman, W. S., Freed, N. E., & Silander, O. K. (2020). Testing the advantages and disadvantages of short-and long-read eukaryotic metagenomics using simulated reads. *BMC bioinformatics*, *21*(1), 1-15.

Pérez-Cobas, A. E., Gomez-Valero, L., & Buchrieser, C. (2020). Metagenomic approaches in microbial ecology: an update on whole-genome and marker gene sequencing analyses. *Microbial Genomics*, *6*(8).

Peralta, E. M., Hatate, H., Kawabe, D., Kuwahara, R., Wakamatsu, S., Yuki, T., & Murata, H. (2008). Improving antioxidant activity and nutritional components of Philippine salt-fermented shrimp paste through prolonged fermentation. *Food Chemistry*, *111*(1), 72-77.

Phithakpol, B. (1987). Plaa-raa traditional Thai fermented fish. In *Proceedings of Conference on Foods and their Processing in Asia* (pp. 182-188).

Phithakpol, B. (1993). Fish fermentation technology in Thailand. In Lee, C.H., Steinkrauss, K.H. and Alan Reilly, P.J., (Eds.). *Fish fermentation Technology*. (pp 155-166).United Nations University Press, Tokyo.

Pillai, V. K., Valsan, A. P., & Nayar, M. R. (1956). Studies on the chemical quality of cured fish products from the west coast of India. *Indian Journal of Fisheries*, *3*(1), 43-58.

Prajapati, J. B., & Nair, B. M. (2003).The history of fermented foods. *Handbook of fermented functional foods* (pp.1-24). CRC Press.https://doi.org/10.1201/9781420053289

Prajapati, J. B., & Nair, B. M. (2003). History of fermented foods. In E. R. Farnworth (Ed.), *Handbook of Fermented Functional Foods (Functional Foods and Nutraceuticals ; 5)*,(pp. 1-24). CRC Press.

Putro, S. (1993). Fish fermentation technology in Indonesia. In Lee, C.H., Steinkrauss, K.H. and Alan Reilly, P.J., (Eds.). *Fish fermentation Technology*, (pp. 107-28).*United Nations University Press*, Tokyo.

Raccach, M. (1987). Pediococci and Biotechnology. *CRC Critical Reviews in Microbiology*, *14*(4), 291–309. https://doi.org/10.3109/10408418709104442

Ranganathan, S., Nakai, K., & Schonbach, C. (2018). *Encyclopedia of Bioinformatics and Computational Biology: ABC of Bioinformatics*. Elsevier.

Rao, S. V., Nayar, M. R., & Valsan, A. P. (1958). Preliminary investigations on the pit curing of fish in India. *Indian Journal of Fisheries*, *5*(1), 160-169.

Rapsang, G. F., & Joshi, S. R. (2012). Bacterial diversity associated with tungtap, an ethnic traditionally fermented fish product of Meghalaya. *Indian Journal of Traditional Knowledge*, *11*(1), 134-138.

Rattagool, P., Adams, M.R. & Cook, R.D. (1985). Fermented fish products of South East Asia. *Trop Sci*, *25*, 61-73.

Rattray, F. P., & Fox, P. F. (1999). Aspects of enzymology and biochemical properties of Brevibacterium linens relevant to cheese ripening: a review. *Journal of dairy science*, *82*(5), 891-909.

Reuter, J. A., Spacek, D. V., & Snyder, M. P. (2015).High-throughput sequencing technologies. *Molecular cell*, *58*(4), 586-597.

Roh, S. W., Kim, K. H., Do Nam, Y., Chang, H. W., Park, E. J., & Bae, J. W. (2010). Investigation of archaeal and bacterial diversity in fermented seafood using barcoded pyrosequencing. *ISME Journal*, *4*(1), 1-16.

Romapati, D. K (2016). *Molecular approaches to study the microbial communities associated with a traditional fermented fish product of Manipur ngari and their functionality*. (Thesis for the Degree of PhD). Gauhati University (India).

Ruddle, K. (1987). The Ecological Basis for Fish Fermentation in Freshwater Environments of Continental Southeast Asia: with Special Reference to Burma and Kampuchea. *Bulletin of the National Museum of Ethnology*, *12*(1), 1-48.

Ruddle, K., & Ishige, N. (2005).Fermented fish products in East Asia. *International Resource Management Institute (IRMI) Research Study*, *1*.

Ruddle, K., & Ishige, N. (2010). On the origins, diffusion and cultural context of fermented fish products in Southeast Asia. *Globalization, food and social identities in the Asia Pacific region*, 1-17.

Ryan, J. T., Ross, R. P., Bolton, D., Fitzgerald, G. F., & Stanton, C. (2011). Bioactive peptides from muscle sources: meat and fish. *Nutrients*, *3*(9), 765-791.

Saisithi, P. (1987). Traditional fermented fish products with special reference to Thai products. *Asian Food J.*, *3*, 3-10.

Saisithi, P. (1994). Traditional fermented fish: fish sauce production. In *Fisheries processing* (pp. 111-131). Springer, Boston, MA.

Saithong P., Panthavee W., Boonyaratanakornkit M., & Sikkhamondhol C., (2010) Use of a starter culture of lactic acid bacteria in plaa-som, a Thai fermented fish. *Journal of bioscience and bioengineering 110*(5): 553-557.

Samson, J. E., & Moineau, S. (2013). Bacteriophages in food fermentations: new frontiers in a continuous arms race. *Annual review of food science and technology*, *4*, 347-368.

Sanchez, P. (1999). Microorganisms and Technology of Philippine Fermented Foods. *Japanese Journal Of Lactic Acid Bacteria*, *10*(1), 19-28. doi: 10.4109/jslab1997.10.19

Şanlier, N., Gökcen, B. B., & Sezgin, A. C. (2019). Health benefits of fermented foods. *Critical reviews in food science and nutrition*, *59*(3), 506-527.

Sanni, A. I., Asiedu, M., & Ayernor, G. S. (2002). Microflora and chemical composition of momoni, a Ghanaian fermented fish condiment. *Journal of Food Composition and Analysis*, *15*(5), 577-583.

Santos, M. S. (1996). Biogenic amines: their importance in foods. *International journal of food microbiology*, *29*(2-3), 213-231.

Sarkar, P. K., & Nout, M. R. (Eds.). (2014). *Handbook of indigenous foods involving alkaline fermentation*. CRC Press.

Sarkar, P. K., Tamang, J. P., Cook, P. E., & Owens, J. D. (1994). Kinema—a traditional soybean fermented food: proximate composition and microflora. *Food Microbiology*, *11*(1), 47-55.

Sarojnalini, C. H., & Vishwanath, W. (1995). Nutritional characteristics of the two fermented fish products: Hentak and Ngari of Manipur. *Journal of the Indian Fisheries Association*, *25*, 75-81.

Sarojnalini, C. H., & Suchitra, T. (2009). Microbial profile of starter culture fermented fish product'Ngari'of Manipur. *Indian J Fish*, *56*(2), 123-127.

Scholz, M. B., Lo, C. C., & Chain, P. S. (2012). Next generation sequencing and bioinformatic bottlenecks: the current state of metagenomic data analysis. *Current opinion in biotechnology*, *23*(1), 9-15.

Schwan, R. F., & Wheals, A. E. (2004). The microbiology of cocoa fermentation and its role in chocolate quality. *Critical reviews in food science and nutrition*, *44*(4), 205-221.

Schwingshackl, L., & Hoffmann, G. (2012). Monounsaturated fatty acids and risk of cardiovascular disease: synopsis of the evidence available from systematic reviews and meta-analyses. *Nutrients*, *4*(12), 1989-2007.

Siddegowda, G. S., Bhaskar, N., & Gopal, S. (2017). Fermentative properties of proteolytic pediococcus strains isolated from salt fermented fish hydrolysate prepared using freshwater fish rohu (Labeo rohita). *Journal of Aquatic Food Product Technology*, *26*(3), 341-355.

Sim, K. Y., Chye, F. Y., & Anton, A. (2015). Chemical composition and microbial dynamics of budu fermentation, a traditional Malaysian fish sauce. *Acta Alimentaria*, *44*(2), 185-194.

Singh, T. A., Devi, K. R., Ahmed, G., & Jeyaram, K. (2014).Microbial and endogenous origin of fibrinolytic activity in traditional fermented foods of Northeast India. *Food Research International*, *55*, 356-362

Sitdhipol, J., Tanasupawat, S., Tepkasikul, P., Yukphan, P., Tosukhowong, A., Itoh, T., ... & Visessanguan, W. (2013). Identification and histamine formation of Tetragenococcus isolated from Thai fermented food products. *Annals of microbiology*, *63*(2), 745-753.

Skåra, T., Axelsson, L., Stefánsson, G., Ekstrand, B., & Hagen, H. (2015). Fermented and ripened fish products in the northern European countries. *Journal of Ethnic Foods*, *2*(1), 18-24.

Smriga, M., Mizukoshi, T., Iwahata, D., Eto, S., Miyano, H., Kimura, T., & Curtis, R. (2010). Amino acids and minerals in ancient remnants of fish sauce (garum) sampled in the "Garum Shop" of Pompeii, Italy. *Journal Of Food Composition And Analysis*, *23*(5), 442-446. https://doi.org/10.1016/j.jfca.2010.03.005

Soetan, K. O., Olaiya, C. O., & Oyewole, O. E. (2010). The importance of mineral elements for humans, domestic animals and plants-A review. *African journal of food science*, *4*(5), 200-222.

Sonsa-Ard, N., Rodtong, S., Chikindas, M. L., & Yongsawatdigul, J. (2015). Characterization of bacteriocin produced by Enterococcus faecium CN-25 isolated from traditionally Thai fermented fish roe. *Food Control*, *54*, 308-316.

Stahnke, L. H. (1994). Aroma components from dried sausages fermented with *Staphylococcus xylosus*. *Meat science*, *38*(1), 39-53.

Steinkraus, K. (1995). *Handbook of Indigenous Fermented Foods revised and expanded*. CRC Press. https://doi.org/10.1201/9780203752821

Steinkraus, K. (Ed.). (2004). *Industrialization of indigenous fermented foods, revised and expanded*. CRC Press, Boca Raton. https://doi.org/10.1201/9780203022047

Steinkraus, K. H. (1993). Comparison of fermented foods of the East and West. In Lee, C.H, Steinkrauss, K.H., & Reilly, P.J. (Eds.), *Fish fermentation Technology* (pp. 107–128). United Nations University Press.

Stratton, J. E., Hutkins, R. W., & Taylor, S. L. (1991). Biogenic amines in cheese and other fermented foods: a review. *Journal of food protection*, *54*(6), 460-470.

Subba Rao, G. N. (1967). Fish processing in the Indo-Pacific area. *Regional Studies No. 4. FAO Regional office for Asia and the Far East*, 231.

Sumague, M. J., & Mabesa, R. C. (1994). *Role of microorganisms in fermented fish products*. In Regional Training Workshop on Advances in Microbial Processes for the Utilization of Tropical Raw Materials in the Production of Food Products, Laguna (Philippines).

Sumi, H., Hamada, H., Tsushima, H., Mihara, H., & Muraki, H. (1987). A novel fibrinolytic enzyme (nattokinase) in the vegetable cheese Natto; a typical and popular soybean food in the Japanese diet. *Experientia*, *43*(10), 1110-1111.

Sunesen, L.O., Stahnke, L.H., (2003). Mould starter cultures for dry sausages - selection, application and effects. *Meat Science*, *65*(3), 935-948.

Surayot, U., Wang, J., Seesuriyachan, P., Kuntiya, A., Tabarsa, M., Lee, Y., & You, S. (2014). Exopolysaccharides from lactic acid bacteria: structural analysis, molecular weight effect on immunomodulation. *International journal of biological macromolecules*, *68*, 233-240.

Tamang, J. P. (2009). *Himalayan fermented foods: microbiology, nutrition, and ethnic values*. CRC press.

Tamang, J. P. (2010). Diversity of fermented foods. In Tamang, J. P., & Kailasapathy, K. (Eds.) *Fermented foods and beverages of the world* (pp. 41-84).CRC press.

Tanasupawat, S., & Komagata, K. (1995). Lactic acid bacteria in fermented foods in Thailand. *World Journal of Microbiology and Biotechnology*, *11*(3), 253-256.

Takenaka, S., Nakabayashi, R., Ogawa, C., Kimura, Y., Yokota, S., & Doi, M. (2020). Characterization of surface Aspergillus community involved in traditional fermentation and ripening of katsuobushi. *International journal of food microbiology*, *327*, 108654.

Thapa, N., Pal, J., & Tamang, J. P. (2004). Microbial diversity in ngari, hentak and tungtap, fermented fish products of North-East India. *World Journal of Microbiology and Biotechnology*, *20*(6), 599-607.

Thapa, N., Pal, J., & Tamang, J. P. (2006). Phenotypic identification and technological properties of lactic acid bacteria isolated from traditionally processed fish products of the Eastern Himalayas. *International journal of food microbiology*, *107*(1), 33-38.

Thapa, N., Pal, J., & Tamang, J. P. (2007). Microbiological profile of dried fish products of Assam. *Indian J Fisheries*, *54*(1), 121-125.

Thapa, N. (2016). Ethnic fermented and preserved fish products of India and Nepal. *Journal of Ethnic Foods*, *3*(1), 69-77.

Thongsanit, J., Tanasupawat, S., Keeratipibul, S., & Jatikavanich, S. (2002). Characterization and identification of Tetragenococcus halophilus and Tetragenococcus muriaticus strains from fish sauce (Nam-pla). *Japanese journal of lactic acid bacteria*, *13*(1), 46-52.

Thongthai et al., 1992; Thongthai, C., McGenity, T. J., Suntinanalert, P., & Grant, W. D. (1992). Isolation and characterization of an extremely halophilic archaeobacterium from traditionally fermented Thai fish sauce (nam pla). *Letters in applied microbiology*, *14*(3), 111-114.

Timberg, L., Koppel, K., Kuldjärv, R., & Paalme, T. (2014). Ripening and sensory properties of spice-cured sprats and sensory properties development. *Journal of Aquatic Food Product Technology*, *23*(2), 129-145.

Toivola, A., Yarrow, D., Van Den Bosch, E., Van Dijken, J. P., & Scheffers, W. A. (1984). Alcoholic fermentation of D-xylose by yeasts. *Applied and Environmental Microbiology*, *47*(6), 1221-1223.

Tok, E., and B. Aslim. 2010. Cholesterol removal by some lactic acid bacteria that can be used as probiotic. *Microbiology and Immunology*, *54* (5), 257–264.

Tokita, F., & Hosono, A. (1968). Production of volatile sulfur compounds by Brevibacterium linens. Japanese Journal of Zootechnical Science, 39, 127-132.

Tominaga, T., An, S. Y., Oyaizu, H., & Yokota, A. (2009). Oceanobacillus soja sp. nov. isolated from soy sauce production equipment in Japan. *The Journal of general and applied microbiology*, *55*(3), 225-232.

Tyn, M. T. (1993). Trends of fermented fish technology in Burma. In Lee, C.H., Steinkrauss, K.H. and Alan Reilly, P.J., (Eds.), *Fish fermentation Technology* (pp. 129-153). United Nations University Press.

Udomsil, N., Rodtong, S., Choi, Y. J., Hua, Y., & Yongsawatdigul, J. (2011). Use of Tetragenococcus halophilus as a starter culture for flavor improvement in fish sauce fermentation. *Journal of Agricultural and Food Chemistry*, *59*(15), 8401-8408.

Ugwuanyi, J. O. , & Okpara, A. N. (2019). Current Status of Alkaline Fermented Foods and Seasoning Agents of Africa. In (Ed.), New Advances on Fermentation Processes. IntechOpen. https://doi.org/10.5772/intechopen.87052

Um, M. N., & Lee, C. H. (1996). Isolation and identification of Staphylococcus sp. from Korean fermented fish products. *Journal of Microbiology and Biotechnology*, *6*(5), 340-346.

Usinger L, Reimer C, Ibsen, H., (2012). Fermented milk for hypertension. *Cochrane Database Systematic Reviews* (4): CD008118. doi: 10.1002/14651858.CD008118.pub2. PMID: 22513955.

Verma, S. K., Singh, H., & Sharma, P. C. (2017). An improved method suitable for isolation of high-quality metagenomic DNA from diverse soils. *3 Biotech*, *7*(3), 1-7.

Van Neer, W. & Parker, S.T. (2008). First archaeozoological evidence of haimation, the invisible garum. Journal of Archeological Science, 35(7), 1821-1827.

Wang, J., & Fung, D. Y. (1996). Alkaline-fermented foods: a review with emphasis on pidan fermentation. *Critical Reviews in Microbiology*, *22*(2), 101-138.

Wang, J., & Fung, D. Y. (1996). Alkaline-fermented foods: a review with emphasis on pidan fermentation. *Critical Reviews in Microbiology*, *22*(2), 101-138.

Wang, Q., Garrity, G. M., Tiedje, J. M., & Cole, J. R. (2007). Naive Bayesian classifier for rapid assignment of rRNA sequences into the new bacterial taxonomy. *Appl. Environ. Microbiol.*, *73*(16), 5261-5267.

Wang, Yanping, Chao Li, Peng Liu, Zaheer Ahmed, Ping Xiao, and XiaojiaBai. (2010). "Physical characterization of exopolysaccharide produced by Lactobacillus plantarum KF5 isolated from Tibet Kefir." *Carbohydrate Polymers*, *82*(3), 895-903.

Wongkhalaung, C. (2004). Industrialization of Thai fish sauce (Nam pla). In

Steinkraus, K. H. (Ed.), *Industrialization of indigenous fermented foods* (2nd ed., pp. 647–705). Marcel Dekker Inc.

Wu, Y. C., Kimura, B., & Fujii, T. (2000). Comparison of three culture methods for the differentiation of Micrococcus and Staphylococcus in fermented squid shiokara. *Fisheries science*, *66*(1), 142-146.

Wullschleger, S., Jans, C., Seifert, C., Baumgartner, S., Lacroix, C., Bonfoh, B., ... & Meile, L. (2018). Vagococcus teuberi sp. nov., isolated from the Malian artisanal sour milk fènè. Systematic and applied microbiology, 41(2), 65-72.

Xiang, H., Sun-Waterhouse, D., Waterhouse, G. I., Cui, C., & Ruan, Z. (2019). Fermentation-enabled wellness foods: A fresh perspective. *Food Science and Human Wellness*, *8*(3), 203-243.

Yankah, V. V. (1988). Studies on momone: a Ghanaian fermented fish product. *B. Sciences thesis. Department of Nutrition and Food Science, University of Ghana–Legon*.

Yuen, S. K., Yee, C. F., & Anton, A (2009). Microbiological characterization of, an indigenous Malaysian fish sauce. *Biotechnology*, *1*, 2.

Yongsawatdigul, J., Rodtong, S., & Raksakulthai, N. (2007). Acceleration of Thai fish sauce fermentation using proteinases and bacterial starter cultures. *Journal of Food Science*, *72*(9), M382-M390.

Youssef, N., Sheik, C. S., Krumholz, L. R., Najar, F. Z., Roe, B. A., & Elshahed, M. S. (2009). Comparison of species richness estimates obtained using nearly complete fragments and simulated pyrosequencing-generated fragments in 16S rRNA gene-based environmental surveys. *Applied and environmental microbiology*, *75*(16), 5227-5236.

Yumoto, I., Hirota, K., Nodasaka, Y., & Nakajima, K. (2005). Oceanobacillus oncorhynchi sp. nov., a halotolerant obligate alkaliphile isolated from the skin of a rainbow trout (*Oncorhynchus mykiss*), and emended description of the genus Oceanobacillus. *International journal of systematic and evolutionary microbiology*, *55*(4), 1521-1524.

Zhang, L., Liu, C., Li, D., Zhao, Y., Zhang, X., Zeng, X., & Li, S. (2013). Antioxidant activity of an exopolysaccharide isolated from *Lactobacillus plantarum*C88. *International Journal of Biological Macromolecules*, *54*, 270-275.

Zhao, C. C., & Eun, J. B. (2020). Shotgun metagenomics approach reveals the bacterial community and metabolic pathways in commercial hongeo product, a traditional Korean fermented skate product. *Food Research International*, *131*, 109030.

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