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STUDY ABOUT BIOFUEL PRODUCTION FROM FISH WASTE AND ITS POTENTIAL IN KERALA

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ABSTRACT

Kerala is blessed with a coastline of 590km and have a wide range of aquatic species in it. A large number of fish processing plants are operating in the state and their wastes are generally dumped into local water bodies degrading the quality of water. Fish wastes have an enormous potential to be a source of energy (biofuel) and also to be an animal feed. Total fish production in Kerala is about 5.44 lakh tonnes in 2019 of which approximately about one-third is the fish waste that is about 18,000 tons. From this amount of fish wastes about 90,655 liters of fish oil can be produced and finally 90,000 liters of biofuel is the approximate amount we can produce annually. And also due to high lipid content in fish wastes and low microbial content they are an excellent choice to be the feedstock of various animal feeds.

1. INTRODUCTION

1.1 Fish Wastes & Bio-Fuels

A large volume of fish wastes is produced daily in the Indian subcontinent. This abundant waste source could serve as an economic feedstock for bioenergy generation. Around 30-40 % of fish is consumed fresh whereas 60-70 % is being processed for human consumption and other purposes. However, not all parts of fish are eaten and substantial parts are discarded. The discarded fish parts include caudal fin, anal fin, pelvic fin, dorsal fin, operculum, overlapping scales, and eye. Therefore, the subcontinent regions worldwide have a vast potential for the generation of value-added products from fish wastes e.g. waste fish oil. In reality, however, the waste fish parts are usually discarded and considered to be of low utility and thus are found of limited applications. Since the fish markets are scattered all over the country, the waste parts are usually disposed of as solid waste with no proper application. Alternatively, these wastes could be channelized into local biofuel plants as an economic feedstock for high-quality biofuel production. Biofuels are globally known as a sustainable alternative fuel for petroleum-based diesel. The advantages delivered by blending biofuel with diesel are numerous including renewability, carbon neutrality, reduced emission of toxic pollutants, and better lubricity of the blended fuel. On the other hand, there are some disadvantages such as comparatively higher emission of oxides of nitrogen; generally higher production cost, and less oxidation stability than diesel. Despite all these drawbacks, the advantages mentioned earlier are still attractive enough to guarantee the continued production and supply of biofuel to be used in compression ignition (CI) engines. (Yogesh *et.al.* 2014)

1.2 Fish Processing Industry in Kerala

Being surrounded by oceans, fishing has been one of the major occupations of people in Kerala. Conventional fishing technologies have evolved over years and nowadays fish processing industries are one of the major sources of income generation. But fish processing is not limited to a single step it must undergo several steps before the product is ready to be sold in the market. Fishes are caught from the deep sea and are sorted by size and species. This sorting is followed by the removal of heads, tails, scales, and entrails. After removing the fin from the remaining parts are washed thoroughly and are further processed for packing. The removed parts are considered fish waste. Most of the advanced fish processing units have their waste treatment plants but micro-processing plants are dumping the wastes to nearby water resources which ultimately results in water pollution.

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1.3 SEAFOOD PROCESSING COMPANIES IN KERALA

There are several seafood processing companies in Kerala, in which a wide species of fishes are caught, processed, and sold. These are some of the companies in Kerala

- Indian Marine Industries, Kochi
- Penver Products Limited, Alappuzha
- Choice Trading Corporation Private Limited, Ernakulam
- Mangala Marine Exim India Private Limited, Ernakulam
- Armstrong Industries, Alappuzha
- International Creative Foods Limited, Kochi
- Amalgam Enterprises, Kochi
- Integrated Rubian Exports Limited, Alappuzha
- Malayalam Edibles India Limited, Kottayam
- Revieraa Marine Private Limited, Kochi
- Cochin Condiments Private Limited, Idukki
- Geo Sea Foods Private Limited, Kochi
- West Coast Refrigeration And Food Engineering Private Limited, Kochi
- Roshan Foods Private Limited, Kochi
- Wender S Foods Private Limited, Kollam
- Marine India Exports Private Limited, Kochi
- Tritee Seafood Exports Private Limited, Kochi
- Geo Seafoods, Kochi
- Veronica Marine Exports Private Limited, Kollam
- Gks Business Associates Private Limited, Alappuzha
- Ocean Wealth Exports, Alappuzha
- Uniroyal Marine Exports Limited, Kozhikode
- Geoaquatic Products Private Limited, Kochi

1.4 INDUSTRIAL PARKS IN KERALA

1) KINFRA SEAFOOD PARK AROOR

Kerala industrial infrastructure development cooperation aims at converging resources available to develop industrial growth in Kerala. The specialty of KINFRA is that it offers a single-window clearance facility, attractive incentives, and excellent expansion opportunities. KINFRA seafood park contains quality control labs pre-processing centers and effluent treatment plants. The quality control labs in KINFRA have high-efficiency types of equipment

2) KSIDC Mega Food Park

This mega food park primarily focuses on the seafood processing sector. They have grant assistance from the central government (Ministry of Food). Their main objective is to create a modern enabling infrastructure for setting up the food processing industry. The main components of KSIDC mega park are the central processing center, primary process center, and collection center. The centra; processing center contains an industrial shed, cold storage, freezer facility, debony room, Q&C, and food testing lab. Locations for primary processing centers are chosen based on the availability of raw material, and infrastructure. The activities done here are peeling, cleaning, sorting, and grading.

1.5 Fish Markets in Kerala

India is the second-largest fish producing nation in the world. Also, India ranks 2nd position in aquaculture. The state of Kerala is gifted with rich resources of marine and freshwater resources. These water bodies are inhabited by a wide variety of aquatic flora and fauna. Also, there are different ethnic groups in contact with fishing. Total fish production in Kerala was 5.44 lakh tonnes in which 3.88 lakh tonnes accounted for marine fish and 1.56 lakh tonnes by inland fish production. Out of Kerala's total population, about 31% of the state population is considered to be fish workers. Alappuzha is the district with the largest fish worker population followed by Trivandrum and Ernakulam. (THE NEW INDIAN EXPRESS 30th JUNE 2020)

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2.0 RESEARCH OBJECTIVES

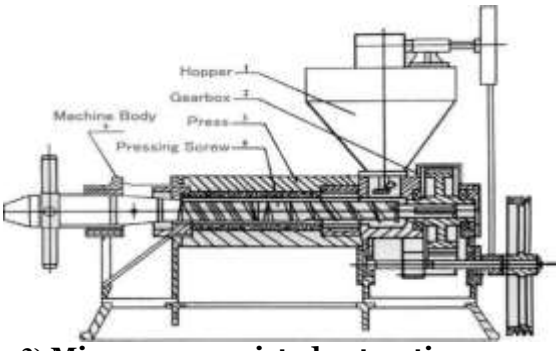
- To identify the easiest method to extract fish oil from fish waste
- To identify the simplest method to convert fish waste to biofuel
- To identify different ways to utilize crushed fish waste after extracting fish oil.

3. LITERATURE REVIEW

3.1 Study of Methods to Extract Fish oil from Fish waste

1) By using a mechanical expeller

The oil extraction is done mechanically with an oil expeller press. The expeller powered by a 5hp electric motor was set into operation The interrupted helical screw drum conveyed, crushed, squeezed, and pressed the fishes to extract the oil. The oil and water phases (containing water-soluble proteins as well) are separated from the solid phase (press cake). The fluid extracted and the press cake was collected and weighed separately. Clarification of oil was done to separate the oil from its entrained impurities. The fluid extracted out of the press is a mixture of fish oil, water, cell debris, and non-oily solids. The fluid is allowed to stand undisturbed to settle by gravity so that the oil, being lighter than water, will separate and rise to the top. The clear oil is obtained and separated. (Kwasi Poku 2002)



2) Microwave-assisted extraction method

Microwave-assisted extraction was carried out using distilled water and hexane/isopropanol mixture with ratio 3:2 (v/v) as extraction solvents. 2 g of fish waste was mixed with 1 g sodium sulphate and soaked in 42 ml of the extraction solvent. Then the mixture was subjected to microwave power at 800 Watt. At this power, the sample was irradiated for 2, 3, 5, 7, and 10 min when using water as a solvent and 1-4 mins when using the organic solvent. After that, the mixture was filtered using filter paper. 5 ml hexane was added to separate the filtrate mixture. The upper layer was taken and dried. After that, lipid weight was measured. In Hara and Radin method distilled water and hexane: isopropanol with ratio 3:2 (v/v) were employed as extraction solvents . 2 g of sample was added to 36 ml solvent and homogenize for 30 seconds. After homogenization, the mixture was filtered into a round bottom flask. The residual on the filter paper was rinsed twice with an additional 10 ml hexane which was also filtered into the same round bottom flask. 24 ml aqueous sodium sulphate was added to the filtrate. The aqueous sodium sulphate was prepared by mixing 30 ml water and 1 g sodium sulphate. After the addition of the aqueous sodium sulphate solution, two layers were formed. The lipids were in the upper layer, pipetted out, and dried to obtain the lipid weight. (M A Rahimi *et al.* 2017)

3) An experimental setup using a pressure cooker.

This is a conventional method that uses the pressure built inside a pressure cooker to pressurize and expel the oil content from the fish wastes. This method is generally cheap, easier, and not very time-consuming. But the residue after extracting the oil will remain solid and the oil will be in a mixed state with the water inside the pressure cooker. The water-oil mixture can be separated by using a separating funnel.

3.2 Study of the process of converting fish oil to biofuel.

1) Transesterification

Transesterification is a chemical reaction used for the conversion of triglycerides (fats) contained in oils, (Feedstocks) into usable biodiesel. Biofuel produced by the process of transesterification has a much lower viscosity, making it capable of replacing petroleum diesel in diesel engines. However, during the transesterification reaction, a certain amount of water is produced as a byproduct which causes ester hydrolysis along with soap, as a result, it becomes hard to purify products by separating the catalyst. (Hideki *et al.* 2001)

a) Transesterification using acid catalyst

Homogeneous Lewis acid (H2SO4) and carboxylates (PbCH3COOH) have been used as catalysts for biofuel production from oil even if it has a high. Several heterogeneous acids were also used (ion-exchange resin, metal oxides, heteropolyacids, etc. However, three main drawbacks reported for the use of carboxylates catalyst are its work under high

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temperature and pressure (T > 190°C, P > 20 bar); purification of the product is costly and not economical for industrial application. Supported sodium and potassium on larger surface area zeolite and alumina had given up to 85% conversion of fame which is still lower as compared to a solid base catalyst. (Sadia *et al.* 2017)

b) Base catalyzed transesterification

Presently, various alkali-based catalysts have been utilized as homogeneous and heterogeneous transesterification. Base catalyzed transesterification is substantially less time consuming than acid-catalyzed transesterification and it is regularly used for commercial purposes . Numerous solid alkali base metal oxides and their substrate have been used for homogeneous catalyzed transesterification. The benefit of alkali base catalysis requires a little amount in catalysis NaOH or KOH are generally utilized as catalysts for transesterification of triglycerides at atmospheric pressure and temperature. Evacuation of these catalysts is troublesome and it adds additional cost to the final product. It was reported in may researches that alkaline metal is less expensive than metal alkoxides, however, the action of alkaline metal alkoxides (CH3ONa for the methanolysis) is more dynamic as a catalyst, then soluble metal hydroxides (KOH and NaOH since the previous) give a high yield in a short time than the last mentioned. (L.D. Metacalffe *et al.* 1981)

3.3 Methods by which fish waste can be used after oil expulsion

a) Fish waste as animal feed.

The use of fish waste as animal feed is an area of interest for many people because of environmental and public benefits. It also reduces the cost of synthesized animal feed. Pellets are prepared from heads, skeletons, tails, and intestines. The test results suggested that the food items made from fish waste contain low microbial content and good lipid source.

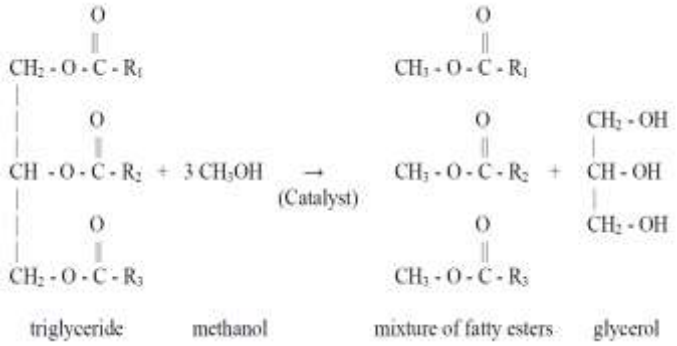
b) Biogas production

There is a high potential for anaerobic digestion of fish wastes. An experiment was conducted to find out the ability of fish waste to produce biogas. 4 plastic digestors were taken and provided the mixture of cow dung and fish waste in a series of ratios ranging from 1:0 to 1:1.5. The highest yield 2l/kg was obtained when cow dung and fish waste were mixed in the ratio 1:1.2. when the fish waste alone was used the yield was 150ml/kg and it took about 10 days to start biogas preparation. (Bodius Salam *et al.* 2009)

4. RESEARCH ANALYSIS

4.1 Easiest method for producing fish oil from fish waste

The method was nothing but conventional extraction using a pressure cooker. This method saves a lot of time and also a cost-effective method to follow. The fish waste was initially cleaned thoroughly and water was added to such a level that the fish waste sinks in it. After pressurizing it for about 15 minutes. A layer of oil and water mixture can be obtained. These mixtures can be separated using a separating funnel. Also, the main advantage of this method is that it requires less space, time, and resources. About 10ml fish oil was extracted initially as a test procedure and finally, we extracted about 1L of fish oil by this method. Considering a single fish 60% of it is consumable and the rest is considered as wastes. These include the head, scales, fins, etc.



4.2 Simplest method to convert fish oil to biofuel.

The simplest way to convert fish oil to biofuels transesterification, using the base as a catalyst. Presently, various alkali-based catalysts have been utilized as homogeneous and heterogeneous transesterification. Base catalyzed transesterification is substantially less time consuming than acid-catalyzed transesterification and it is regularly used for commercial purposes. Numerous solid alkali base metal oxides and their substrate have been used for homogeneous catalyzed transesterification. The benefit of alkali base catalysis requires a little amount in catalysis. Esters in the presence of a base such as an alcoholate anion form an anionic intermediate which can dissolve back to the original ester or form the new ester. The most useful basic transesterified agents are sodium or potassium methoxide in anhydrous methanol. The main

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advantage of base-catalyzed transesterification over acid one is that it is fast and can be conducted at low temperatures(303-308K) and pressure(0.1Mpa). By the transesterification of 1L of fish oil, 0.9 L of biofuel can be obtained.

4.3 Usage of oil expelled fish waste.

Since the fish waste contains high lipid content and low microbial content it is very advantageous to use the same as animal feed. The fish wastes contain high lipid content due to unsaturated fatty acids. Also since fish waste contains liver glycogen contents increased hematocrit values and faster growth rates were observed in animals. So as a result quality food can be bought at a very low price as it is primarily a waste product of oil extraction units.

5. CONCLUSION

Energy is an essential factor in improvising the life quality of individuals. Fish waste which was considered a solid waste can be utilized for multiple benefits. They have a high potential to provide energy in the form of biodiesel. Thus lowering emissions from diesel engines. They can also be used to produce animal feed which has high lipid and protein contents. Biofuel can be produced from fish oil by the process of transesterification using a base catalyst. The easiest method to derive fish oil from fish waste is treating it in a pressure cooker under ambient temperature. The mixture of oil and water thus obtained can be simply separated through a separating funnel. 0.9l of biodiesel was obtained from 1 l of fish oil and 10ml of fish oil was obtained from 1 kg of fish waste. Since Kerala produces 5.44 lakh tons of fishes annually about 18 thousand tons of waste can be obtained from this. On this scale, about 90,655 liters of fish oil can be produced and about 90,000 liters of biofuel can be produced. This also suggests the possibility of a cooperative society to collect the fish wastes and converting them to biofuel and animal food, thus creating employment opportunities and solving the problem of waste management.

6. REFERENCES

1. Kwasi Poku, 2003, Small-Scale Palm *Oil Processing in Africa, Food and Agriculture Organization of United Nation Rome*
2. *Yogesh C. Sharma Bhaskar Singh & Devarapaga Madhu, 2014, 'Fast Synthesis of High-Quality Biodiesel from 'Waste Fish Oil' by Single Step Transesterification', Biofuel Research Journal 3 (2014) 78-80, viewed on 18 September 2020, from https://www.biofueljournal.com/article_6142_3dfa1cde451951df9e669677b90070bf.html.*
3. *Sadia Nasreen, Muhammad Nafees, Liaqat Ali Qureshi, Muhammad Shahbaz Asad, Ali Sadiq Syed Danial Ali., 2017, 'Review of Catalytic Transesterification Methods for Biodiesel Production', Journal of Bio Fuel, (abstract), viewed on 19 September 2020, from*
4. *https://www.intechopen.com/books/biofuels-state-of-development/review-of-catalytic-transesterification-methods-for-biodiesel-productio*
5. *'TN grabs the first position in fish production, Kerala in the third spot with 15.4% decline', THE NEW INDIAN EXPRESS 30th June 2020, p. 8.*
6. *M A Rahimi, Saleem Ethaib, Siti Mazlina Mustapa Kamal., 2017, 'Microwave-assisted extraction of lipid from fish waste', IOP Conference Series Materials Science and Engineering 206(1):012096, viewed on 22nd October 2020, from https://www.researchgate.net/publication/317798187_Microwave-assisted_extraction_of_lipid_from_fish_waste*
7. *Hideki Fukuda, Akihiko Kondo, Hideo Noda., 2001, ' Biodiesel fuel production by transesterification of oils', Journals of Bioscience and Bioengineering, viewed on 22nd October 2020, from https://www.sciencedirect.com/science/article/abs/pii/S1389172301802887#!*
8. *L.D. Metcalffe., 1981, 'Rapid Preparation of Fatty Acid Methyl Esters Using Organic Base-Catalyzed Transesterification',* Journal of Chromatographic Science, *Volume 19, viewed on 26th September 2020, from https://academic.oup.com/chromsci/article-abstract/19/10/530/329755*
9. *Bodius Salam, Md Rabul Islam Sarter., 2009, 'Biogas from anaerobic digestion from fish waste'. Intl. Conf. of Mechanical Engineering (ICME 2009), Dhaka, Bangladesh, December 26-28, 2009.*