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EXTRACTION OF GELATIN FROM FISH WASTE AND ITS APPLICATION IN BIODEGRADABLE PLASTIC FILMS

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ABSTRACT :-

Fish processing generates large amounts of waste material, including skin and bones, which typically environmental and contribution to the pollution. Plastic waste remains a critical environmental problem due to its nature and resistance to natural degradation. The present studytells both challenges by extracting gelatin from the waste tissues of *Labeo rohita* (Rohu) and utilizing it for the preparationof biodegradable plastic films. The extraction process involves thetreatment of fish waste with sodium hydroxide and hydrochloric acid, followed by thermal extraction at 50–60°C for 3 hours. The gelatin wascombined with glycerol as a plasticizer and cast into thin films. In contrast, films maintained in closed containers showed several changes except for minor drying and indicating the microbial activity andmoisture are essential for effective degradation. These findings demonstrate that the fish waste represents a valuable resource for developing environmentally sustainable packaging materials.

Keywords :- Fish waste, *Labeo rohita*, Gelatin extraction, Biodegradable plastic, Glycerol, Soil degradation.

INTRODUCTION :-

The growth of the fish-processing industry in recent years has produced large amounts of organic waste, including skin, bones, scales, fins, and other discarded fish parts. These materials are often discarded without proper treatment, which can cause water contamination, unpleasant odors, and the growth of harmful microorganisms. However, fish waste still has value because it contains valuable biomolecules such as collagen. Collagen can be used to produce several useful products. Therefore, the proper use of fish-processing waste is important for reducing pollution and making better use of natural resources **(Karim and Bhat, 2009)**.

Collagen is a structural protein found in large amounts in the supporting tissues of fish, especially in the skin and bones. It provides strength and helps maintain the structure of living tissues. During acid or alkaline pretreatment followed by heating, collagen is converted into gelatin. Gelatin is a colorless and biodegradable polymer with good film-forming properties. These properties make it useful in food, pharmaceutical, and packaging applications. **Gudmundsson and Hafsteinsson (1997)** reported that fish gelatin forms good films, although its gel strength is lower than that of mammalian gelatin. This property makes fish gelatin useful for flexible film applications.

Plastic pollution is a serious global environmental problem. Conventional plastics are mainly made from petroleum and resist natural degradation. As a result, they remain in ecosystems for long periods and can harm plants and animals. Over time, plastic materials break down into microplastic particles. These particles can enter food chains and may affect wildlife and human health. This situation has created a need for environmentally friendly alternatives to conventional plastics **(Tharanathan, 2003). Koli et al. (2012)** reported that the proper use of fish-processing waste can greatly reduce pollution while providing economic benefits to the fishing industry.

Biodegradable plastics made from natural polymers such as gelatin may provide a useful alternative to conventional plastics. Gelatin films are less harmful to the environment and can naturally break down without producing harmful residues. Adding plasticizers such as glycerol improves the flexibility and strength of these films. As a result, gelatin films may be useful in food packaging and related applications.

Bioplastics are made from renewable biological materials and can naturally break down without causing serious environmental damage. Among natural polymers, gelatin is a useful biodegradable material obtained from collagen in animal and fish tissues. Fish-processing activities produce large amounts of skin, bones, and scales, which can be reused for gelatin production. Using these materials can reduce pollution and create economic value from waste **(Karim and Bhat, 2009).**

Fish gelatin has natural film-forming properties and can be used to produce biodegradable plastic films. These films are non-toxic, environmentally friendly, and useful in food packaging and biomedical applications **(Gomez-Guillen et al., 2011)**. However, gelatin films are often brittle when used alone. For this reason, plasticizers such as glycerol are added to improve their flexibility and tensile strength. **Arvanitoyannis and Kassaveti (2008)** reported that mixing gelatin with other natural polymers or adding plasticizers can reduce the problems associated with low water resistance and moderate mechanical strength. **Benjakul and Morrissey (1997)** also showed that the quality of fish gelatin is strongly affected by extraction conditions, especially temperature and pH. These conditions influence the molecular weight distribution and film-forming properties of the gelatin.

Selection of Fish (*Labeo rohita)*

In this study, *Labeo rohita*, commonly known as Rohu, was chosen as the source of gelatin. This species is commonly found in freshwater ecosystems and is one of the most frequently consumed fish species in India. It belongs to the family *Cyprinidae* and is easily available at local fish markets at a low cost. The skin and bones of Rohu contain high levels of collagen, which makes them suitable for gelatin production. Because Rohu is widely available and affordable, it is a suitable choice for experimental work.

MATERIALS:

The materials used to prepare biodegradable bioplastic from fish waste are fish skin and bones of *Labeo rohita*, gelatin, glycerol, sodium hydroxide (NaOH), hydrochloric acid (HCl) and distilled water. Fish skin and bones were the main raw material and they contain collagen which helps in gelatin extraction and bioplastic preparation. Gelatin extracted from the fish waste improves the film formation and film strength of the bioplastic. Glycerol was added as a plasticizer to make the film flexible and less brittelof the films. Sodium hydroxide (NaOH) was used for alkali treatment to remove non-collagenous proteins and impurities from the fish waste. Hydrochloric acid (HCl) was used for acid treatment to soften the tissues and break down collagen. The laboratory equipment and glassware used in this research included beakers, measuring cylinders, hot plate with magnetic stirrer, filter cloth, aluminium foil, flat casting trays, weighing balance and plastic containers for degradation studies. These equipment was used to process, mix, heat, cast and drythe bioplastic mixture to obtain a uniform bioplastic film.

METHODOLOGY :-

Collection of Samples:

Fish waste consisting of the skin and bones of *Labeo rohita* was collected from local fish markets in Siddipet district, Telangana, which was transported to the laboratory. Rohu was selected because it is widely available and inexpensive. its skin and bones contain collagen suitable for gelatin extraction and bio plastic production.

Preparation of Fish Waste:

The collected fish waste was washed thoroughly with tap water three times, for 15 minutes each time to remove dirt, blood, mucus and other impurities. After washing, the material was drained and stored until further processing.

Alkali Treatment:

The washed fish waste was soaked in a solution containing of sodium hydroxide (NaOH) dissolved in distilled water for a time period at room temperature. This treatment removed proteins, fats,and other impurities from the fish waste. The material was then washed with distilled water until the wash reached a neutral pH .

Acid Treatment:

After alkali treatment, the material was soaked in an acid solution prepared by mixingof hydrochloric acid (HCI) withdistilled water for minutes at room temperature. This treatment softened the tissues and partially disrupted the collagen structure. The material was then washed several times with distilled water to remove excess acid.

Heating Process:

The treated fish waste was heated on a hot plate at 50 to 60°C for 3 hours with distilled water. During heating, the collagen in the fish tissue was partially hydrolyzed to form gelatin, which dissolved in the water. Heating produced a light-yellow solution.

Filtration and Drying:

The heated gelatin solution was filtered through a clean filter cloth to remove undissolved particles and tissue debris. The filtrate containing dissolved gelatin was collected, and gelatin solution was recovered. The solution was dried at room temperature for about two days to obtain solid gelatin.

Film Preparation:

The extracted gelatin was dissolved in distilled water in a beaker. Then, glycerol was added as a plasticizer to increase the flexibility of the film. The mixture was stirred continuously for about 5 minutes to obtain a uniform solution. It was then heated on a hot plate with continuous stirring for about 10 minutes until the solution became clear and free of lumps. The warm solution was poured slowly onto a clean, flat casting surface and spread evenly to form a thin, even layer. The cast films were dried at room temperature for two days. After drying, thin, flexible, and transparent films were obtained.

Biodegradation Studies:

The biodegradability of the gelatin films was tested under two conditions: moist soil and a closed container. A small piece of film was buried in moist soil at adepth of approximately 2 to 3 cm. A small amount of water was added daily to maintain soil moisture and microbial activity. The film was observed daily for 15 days, and physical changes such as softening, surface cracking, fragmentation, and disintegration were recorded.

Another film piece was placed in a closed plastic container without soil or added microorganisms. The container was kept at room temperature, and the film was observed daily for 25 days. Changes occurring without soil, added microorganisms, or moisture were recorded, including drying, stiffening, and surface cracking.

FLOWCHART:

Fish waste collectionNaOH treatment HCL treatment

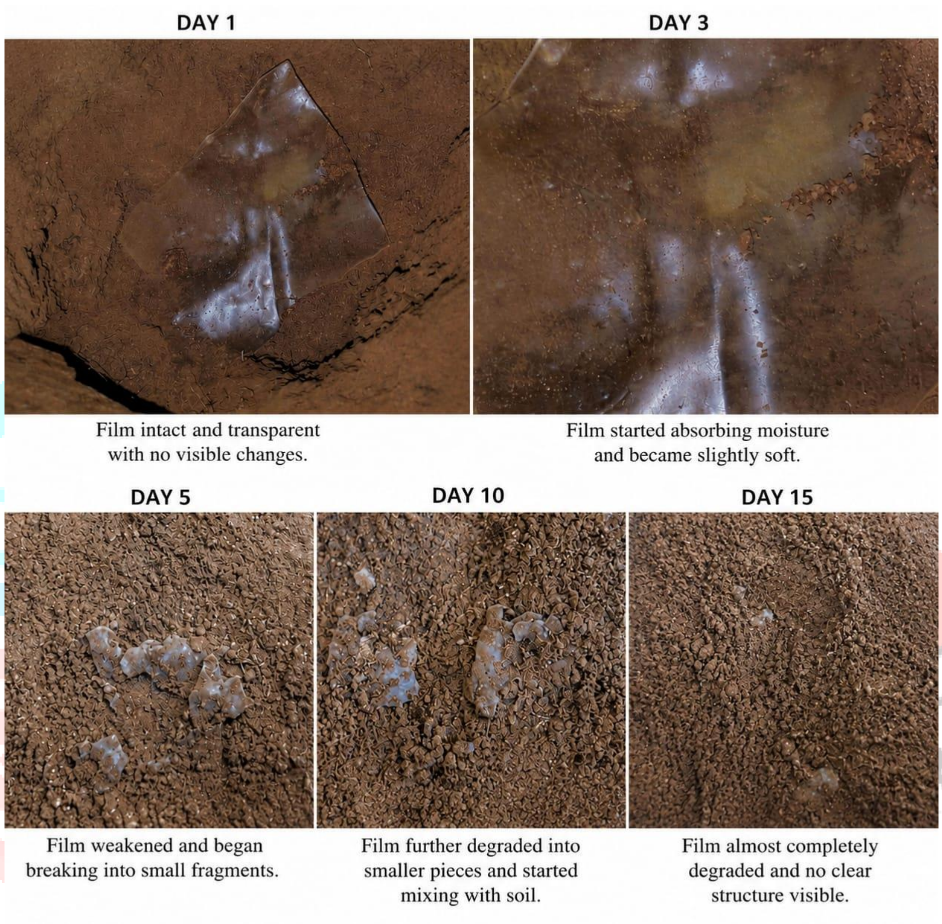
Bioplastic films. Film casting. Gelatin solution

RESULT:

The gelatin extracted from the fish waste successfully formed a thin, transparent, and flexible film when mixed with glycerol and dried. The film had a smooth surface and was easy to handle.

SOIL DEGRADATION OBSERVATIONS:

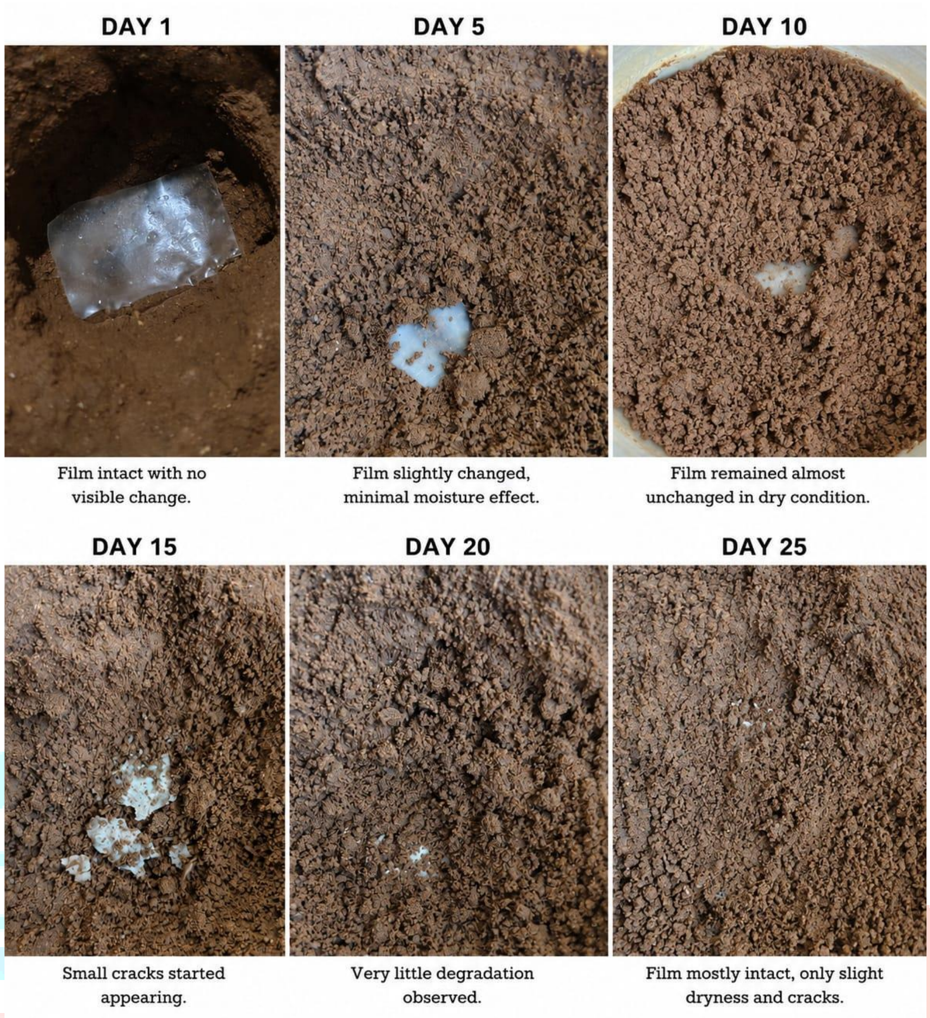
The film showed gradual physical changes after being buried in soil. During days 1 to 5, it absorbed moisture and became slightly softer, although no major damage was visible. Between days 5 and 10, it began to break intosmaller pieces. By the end of the observation period, most of ths film had broken down and mixed with the soil. These observation show that the film underwent visible degradation when exposed to moist soil. However, the experiment measured physical changes only, so the exact contribution of microorganisms, moisture, and other soil conditions could not be determined separately.



CONTAINER DEGRADATION OBSERVATIONS :

The film changed more slowly in the closed container. During the first 5 days, no visible changes were observed. Between days 5 and 10, the surface became slightly dry and stiff. From days 10 to 15, the film became harder, but no major cracking or fragmentation occurred. During the later part of the test, the film remained mostly intact, although minor surface cracks developed.

The container sample showed considerably less physical degradation than the soil sample. This difference may be related to the absence of soilcontact and the lack of added moisture.



DISCUSSION:

This study prepared a gelatin-based bioplastic film from fish waste and evaluated its biodegradation under two environmental conditions. The film showed different degradation patterns depending on the surrounding environment. It degraded more rapidly in soil than in a closed container, indicating that moisture, oxygen, and contact with soil microorganisms influenced the degradation process.

During the 15-day soil degradation test, the film underwent gradual physical changes. At the beginning of the experiment, no noticeable changes were observed. After several days, however, the film absorbed moisture from the soil and became softer. This behavior can be attributed to the hydrophilic nature of gelatin, which allows it to absorb water. As the exposure period increased, the film lost strength and developed small surface cracks.

Between Day 5 and Day 10, the film became thinner and weaker, suggesting that degradation had begun. From Day 10 to Day 12, the film structure deteriorated further and began to break into smaller pieces. By the end of the 15-day period, most of the film had disintegrated and become mixed with the surrounding soil.

The faster degradation observed in soil was probably associated with microbial activity. Soil contains microorganisms such as bacteria and fungi that can produce enzymes capable of breaking down protein-based materials such as gelatin into simpler compounds. Soil also provides moisture and oxygen, both of which support microbial growth and activity. The combined effect of these conditions created a more favorable environment for the breakdown of the gelatin film.

The film showed much slower changes in the closed-container test. Because it was not in direct contact with soil and had limited exposure to moisture, its degradation was considerably slower. No visible changes were observed during the first few days. Later, the film showed slight drying and the development of minor cracks. Although it became somewhat harder, no major fragmentation or structural breakdown occurred during the observation period.

These findings suggest that limited moisture and reduced microbial exposure slowed the degradation process in the container. Gelatin is biodegradable, but its breakdown depends on suitable environmental conditions. Therefore, biodegradability alone does not guarantee rapid degradation when moisture and microbial activity are limited.

The observations are consistent with previous studies. **Karim and Bhat (2009)** reported that gelatin obtained from fish waste is biodegradable and can break down under suitable environmental conditions. **Gomez-Guillen et al. (2011)** also described fish gelatin as a material with good film-forming properties and a high susceptibility to microbial degradation in natural environments. These reports support the faster degradation observed in the soil treatment.

Shah et al. (2008) reported that the degradation rate of biodegradable polymers is influenced by microorganisms, moisture, and oxygen. Their findings emphasize the role of environmental conditions in determining how quickly a biodegradable material breaks down. The results of the present experiment follow the same pattern, as the film degraded more rapidly in soil than in the closed container. **Tharanathan (2003)** also explained that natural polymers, including proteins and polysaccharides, can undergo enzymatic degradation through microbial activity.

Glycerol also influenced the physical properties of the film. As a plasticizer, it helped produce a smoother and more flexible material. Despite this increased flexibility, the film remained biodegradable under soil conditions. Similar results were reported by **Maria Lopez et al. (2018)**, who found that glycerol can improve the physical properties of gelatin films without eliminating their biodegradability.

Many previous studies have examined gelatin extraction and film preparation separately. The present work combines these processes by using fish waste as the starting material for producing a biodegradable film. This approach demonstrates a practical method for converting waste into a value-added material. The comparison between soil and closed-container conditions also provides useful information about how environmental factors affect the degradation of the film.

The results demonstrate that the gelatin-based film degraded more effectively under soil conditions than in a closed container. Soil provided greater access to moisture, oxygen, and microorganisms, which are important for microbial degradation. In the container, the reduced availability of these factors slowed the breakdown process. This finding shows that the disposal environment plays an important role in determining the degradation rate of biodegradable materials.

Overall, the study demonstrates the potential of fish waste as a raw material for producing gelatin-based biodegradable films. The film degraded under soil conditions, but its degradation rate depended strongly on the surrounding environment. Further research should focus on improving the film's strength, water resistance, and durability while maintaining its biodegradability. Such improvements could increase the possibility of using gelatin-based films as alternatives to some conventional plastic materials.

CONCLUSION:

Gelatin was extracted from fish waste and used to prepare a biodegradable film. The smooth and transparent sheet showed that gelatin can form a film. The degradation test showed that the film gradually decomposed in soil, indicating that it is biodegradable. In the container, however, only minor changes were observed because microorganisms and other environmental conditions were limited. These results show that moisture, air, and microbial activity are important for the biodegradation process.

The study only examined film preparation and degradation. Other properties, including mechanical strength, elasticity, and water resistance, were not evaluated. Therefore, a complete comparison with conventional plastics cannot yet be made. These findings suggest that natural polymers such as gelatin could be used to develop environmentally friendly materials. Further research is needed to improve their physical properties and determine whether they are suitable for real-world and large-scale use.

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