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Contents

Editorial Committee

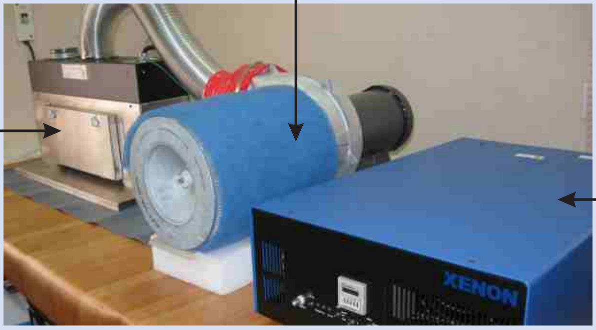
News from the Research Front

Pulsed Light Technology

Pulsed light technology, an emerging non-thermal technology for decontamination of food surfaces and food packages, is consisting of short time high-peak pulses of broad-spectrum white light. High intensity light is a synonymous term with pulsed UV light, pulsed light, broad spectrum white light and near infrared light. Pulse light technology is an alternative preservation technique to thermal treatment for killing microorganisms using short time high frequency of intense broad spectrum, rich UV light, which is the portion of the electromagnetic spectrum corresponding to the band between 200-280nm. Pulsed light is produced using technologies that multiply power many fold. It is used for the rapid inactivation of microorganisms on food surfaces, equipment, and food packaging materials.

The use of pulse light for the inactivation of microorganisms was intiated in Japan in the late 1970s. Later extensive work was done to sterilize pharmaceutical products. However, the technology was adopted by the food industry in 1996, only when Food and Drug Administration Authority approved the use of pulsed light technology for production, processing and handling of foods.

Electromagnetic energy is accumulated in a capacitor within fractions of a second and then released in the form of light within a short time (nanoseconds to milliseconds),



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method. The limited control of food heating still remains the main concern in pulse light technology. Sample heating is perhaps the most important limiting factor of pulse light for practical applications.

Contributions from CIFT

Central Institute of Fisheries Technology (CIFT), Cochin under the NAIP sub project “A value chain on oceanic tuna fisheries in Lakshadweep sea” procured a pulsed light preservation machine (RC-847). Extensive work was done on standardization and studies are being conducted on shelf life extension of chilled fish.

Some of the salient achievements

Pulsed light treatment done on Pearlspot (*Etroplus suratensis*) for 12 sec. with a total energy of 25 J/cm^2 showed a bacterial reduction of 2.6 log cfu/ml. The biochemical and sensory parameters were superior for pulsed treated samples. The storage study indicated a shelf life extension of six days for pulsed treated Pearlspot fillets when compared to control.

Pulse treatment was done in Yellowfin tuna (*Thunnus albacares*) steaks packed in 12µ polyester/300 gauge low-density polyethylene laminate, 300 gauge polyethylene and 300 gauge cast polypropylene respectively. Cast polypropylene was found to give maximum bacterial reduction. Yellowfin tuna steaks were packed in cast polypropylene pouches and pulsed treatment for different time duration were given. Pulse treatment for 6 sec. with an energy output of 11.5 J/cm^2 with a bacterial reduction of 1.83 log cfu/g was found to be acceptable microbiologically and with regard to sensory attributes.

Yellowfin tuna steaks were dip treated in 2% sodium acetate, 2% potassium sorbate and a combination of 2% sodium acetate-potassium sorbate solution. Samples were packed in 300 gauge cast polypropylene pouches and pulsed for 6 sec. The textural properties were better for pulsed light treated samples. The sensory and L*a*b* colour values of tuna steaks of pulse treated samples were better than dip and pulsed treated combinations. Shelf life extension of 13 days for pulsed treated and pulsed-dip combinations was obtained. However organoleptically the pulse treated samples were rated superior.

Conclusion

The research data available in the scientific literature clearly demonstrate the potential of pulsed light technology to inactivate pathogenic and spoilage microorganisms in food products or in food-contact materials. It remains one of the least-studied emerging technologies and much work still needs to be done in this area. Besides microbial-inactivation studies, systematic work is also necessary to investigate the impact of pulsed-light treatments on the nutritional and sensory properties of the treated foods. A detailed study on the effect of pulsed light for shelf life extension is not available at present. Studies done in fish are very little and thus a detailed work on fish preservation with pulsed light treatment is necessary. There is a need for optimizing the critical process factors to achieve the target inactivation level for specific food applications without affecting quality. Pulsed light equipment with good penetration and short treatment times need to be designed for commercial purposes. In addition, the applicability of pulsed light treatments on an industrial scale needs to be compared with other non-thermal or conventional thermal processes.

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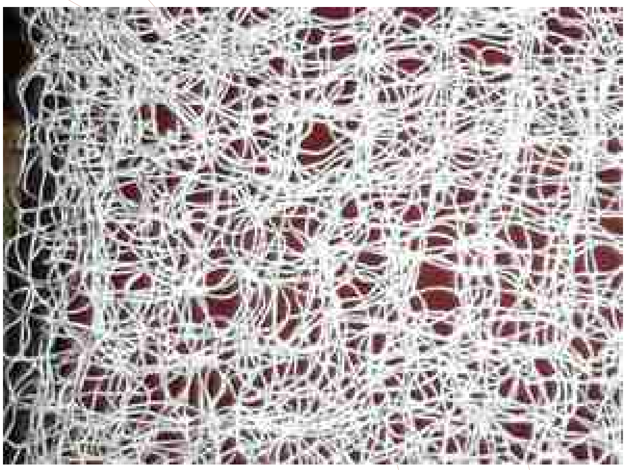
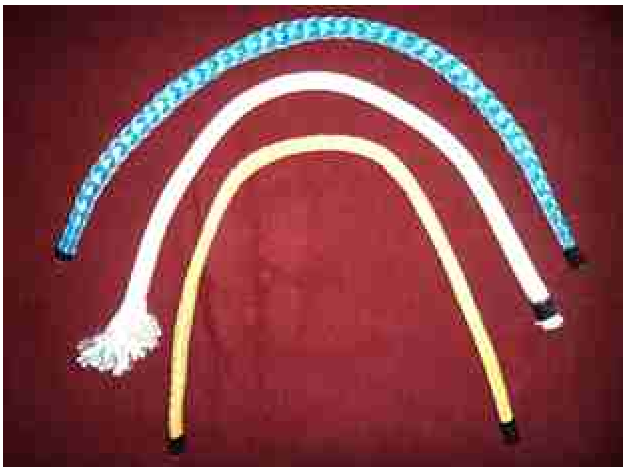
UHMWPE - The Strongest Fibre Enters the Fisheries Sector of India

The introduction of synthetic fibres has greatly influenced the efficiency and durability of fishing gear and also eased out the physical strain on the fishermen. In India, till 1950s, the basic materials used for fishing gear fabrication were natural fibres such as cotton, sisal and hemp for the webbing; and coir and jute for the ropes. By 1950s polyamide (PA) multifilament was introduced followed by high density polyethylene (PE) twisted monofilament and PA monofilament. Rope material was replaced by PE and polypropylene (PP).

In the fishing industry elsewhere, aramid fibres like Kevlar was a later introduction while the latest introduction to this sector is the ultra high molecular weight polyethylene (UHMWPE) fibres, also termed as high modulus polyethylene (HMPE) or high performance polyethylene (HPPE). The UHMWPE fibres made its impact on operation of purse seines, trawl nets and cages in the waters of New Zealand, Australia and North America (Anon, 2009a; Anon, 2009b). However, in the Indian fishing and culture industry, it is yet to be tested and proved for its suitability.



UHMWPE webbing



UHMWPE rope

UHMWPE fiber

UHMWPE is a type of polyolefin synthesized from monomer of ethylene. The fibre made by gel spinning has a high degree of molecular orientation resulting in very high tensile strength. The fibre is made up of extremely long chains of polyethylene, which attain a parallel orientation greater than 95% and a level of crystallinity of up to 85%. The extremely long chains have molecular weight usually between 3.1 and 5.7 million while HDPE molecule has only 700 to 1800 monomer units per molecule.

The material is produced by two different companies in two different brands *viz.*, Dyneema and Spectra. It was originally invented by DSM in the brand name Dyneema (Royal DSM N.V., The Netherlands) in 1974 and produced commercially in 1990. Spectra produced by Honeywell under a license from DSM, is chemically identical to Dyneema. Dyneema fibres produced in commercial grades, Dyneema SK60 and SK75 are specially designed for ropes, cordage, fisheries and textile applications. These fibres can be made into microfilament braided twine of minute diameter. Netting of single knot, double knot and knotless *viz.*, raschel can be made with UHMWPE fibres.

The material is 15 times stronger than steel (on a w/w basis) and up to 40% stronger than Kevlar which is an aramid fibre. The material has high strength, low density, no water absorption capacity, low elongation at break, high abrasion resistance, high resistance to UV radiation and high resistance to degradation by micro organisms and to most chemicals except oxidizing acids. Dyneema is considered as the strongest fibre in the world. A comparison of some important properties of PA, PE, PP and Dyneema SK75 is given in Table 1.

UHMWPE fibre offer applications in various fields such as fisheries, automobile and aircraft manufacturing, personal protection, *viz.*, in the manufacture of helmets,

Table 1. Comparative properties of synthetic fibres

Chemical/physical characteristics	Fibre					
	PA 6	**PA 6,6**	**PES**	**PP**	**PE**	**Dyneema SK75**
Tenacity (g/den)	9	9	9	7	5	40
Elongation at break (%)	23	20	14	18	20	3.5
UV rays resistance	Medium	Weak	Medium	Medium	Medium	Good
Specific weight	1.14	1.14	1.38	0.91	0.97	0.97
Melting point (°C)	215-220	255-260	250-260	160-175	125-135	144-152
Resistance to alkalis	Good	Good	Weak	Good	Good	Good
Acid resistance	Weak	Weak	Good	Good	Good	Good
Moisture absorption (%)	3.5-4.5	3.4-4.5	0.2-0.5	0	0	0

(Source: Badinotti, 2011)

vests, ballistic shields and cut-resistant gloves. In the medical field it is successful as surgical sutures and implants for total joint replacement *viz*., hip, knee and spine implants. It is also used for safety nets and cargo nets used in the construction and transport sector.

Commercial fisheries

The present day mechanized fishing operations are highly energy intensive and they exploit the limited reserve of the non-renewable fossil fuel. The mechanized and motorized fishing fleet of India has been estimated to consume about 1220 million litres of fuel annually (Boopendranath, 2006). In a typical bottom trawler, nearly 60% of the total drag is contributed by the netting (Wileman, 1984). The most important property of UHMWPE fibre is the requirement of a thinner material compared to PA and HDPE, thus developing less drag resulting in fuel efficiency. Due to the light weight property with minimum drag in the water, the material helps fishers to reduce fuel costs by 40%. New Zealand fishermen reported an average savings of one tonne of fuel per day while using twin-rig trawls made with Dyneema (Anon, 2009a). The trawls incorporating Dyneema products showed excellent geometric characteristics and a considerably reduced hydrodynamic drag (Sendlak, 2001). Sala *et al*. (2008) demonstrated that the replacement of knotless PA netting by Dyneema knotted netting in the wing portion along with use of larger meshes and reshaped wings in a demersal trawl for the Mediterranean fisheries resulted in 30% less fuel consumption and up to 40% more headline height, while assuming that fuel spent in trawling activities is 80% of the total fuel costs and 50% of the total expenses on a fishing trip as reported by Wileman (1984). The savings from the use of a demersal trawl incorporated with Dyneema netting in the wing portion replacing knotless nylon netting is 3% of the total spending costs. In addition to drag reduction, the trawls made with UHMWPE fibres especially in the codend maintain their shape and facilitate better filtering, reducing bycatch.

In purse seines, the use of UHMWPE facilitate faster sinking due to better filtering and reduced drag. Faster sinking reduce the chances of escape of the fish shoal. Nylon netting lose about 10-20% of its dry knot strength on immersion in water while UHMWPE netting do not absorb water. As there is no shrinkage due to wetting, the mesh size and shape are maintained during the operation. The netting twines made with Dyneema fibre can be reduced by up to a factor of 2 on thickness (diameter) basis and by a factor of 4 on weight basis.

UHMWPE is three times stronger than nylon of equal dimension and its abrasion resistance is also very good. Hence, the durability of the net is very high. Nylon purse seines lasts for about 2-3 years while UHMWPE netting ensures 2-3 times more life for the net. The Dyneema netting is very resistant to abrasion, tearing and cutting. Hemmingsson *et. al.* (2008) reported a seal-safe trap-net made of Dyneema netting in the pontoon trap fisheries along the Swedish Baltic coast. The high resistance of the material to fish bite can be pursued to prevent the damage to the netting by puffer fish prevalent in the coastal waters of India. UHMWPE ropes can be used in trawling to substitute wire ropes which helps in weight reduction and drag reduction and in fuel saving. A comparison of the properties of different synthetic fibre ropes is given in Table 2.

The Dyneema ropes were successful as warps,

Table 2. Properties of synthetic fibre ropes of 14 mm diameter

Properties	PA	PE	PES	PP	Dyneema
Breaking strength (kN)	31 (Very good)	23 (Good)	31 (Very good)	32 (Very good)	212 (Excellent)
Strength (g/den)	3.41 (Good)	2.72 (Not good)	2.36 (Poor)	4.49 (Very good)	17.40 (Excellent)
Elongation (%)	25 (Excellent)	16 (Good)	19 (Very good)	10 (Not good)	4 (Poor)
Elasticity (%)	19 (Good)	31 (Not good)	24 (Not good)	63 (Poor)	12 (Very good)
Resistance to abrasion (% loss in breaking strength)	19 (Good)	31 (Not good)	24 (Not good)	63 (Poor)	12 (Very good)
Length changes in water	Yes	No	No	No	No

Source: Ramose (1999)

replacing the steel warps used in large mesh pelagic trawls (Sendlak *et al*., 2001). By using UHMWPE ropes, the frequent oiling and greasing required for wire ropes can be avoided which would facilitate a clean and safe deck. It also helps in a clean catch devoid of oil and grease contamination. From the safety point of view, if UHMWPE rope breaks there won't be any backlash unlike in steel wire rope in which the backlash on snapping can be fatal. Since this material is unaffected by seawater, it lasts above 4-5 years against one year of wire rope (S.V. Raut, Personnel communication). Mending and repair of PA and PE nets during fishing often consume a lot of time and money, besides losing fishing days. As the new material is strong and abrasion resistant, the damage during fishing would be minimum.

The light weight property of the material facilitates more netting for same weight, and require less storage space onboard. The very high cost of the material is a disadvantage. However, more webbing for the same weight nullifies the increased cost, besides better durability, lower maintenance and fuel saving.

Recreational fisheries

The fibres are highly resistant to water with no elongation. It floats in water and is highly resistant to UV light, besides having very good abrasion resistance. These properties make the material ideal for recreational fishing *viz*., rod and reel fishing substituting nylon monofilament yarn. However, compared to nylon monofilament UHMWPE twine cuts deeper into the body of the fish making deep injury giving less chances of survival of the released catch (Barco *et al*., 2010).

Application in aquaculture

UHMWPE also finds good application in the aquaculture sector as a cage netting material due to the low diameter, favourable weight/strength ratio, low elongation and Nil shrinkage in water which helps the mesh size to remain stable during normal use of the netting. The high resistance of UHMWPE nets to UV light and abrasion make the nets last longer. Its strength allows the use of twines with smaller diameter aiding in use of larger cages without additional weight. With less outer surface for fouling to grow, the fouling growth would be less and the antifouling costs can be reduced by up to 50%. Annual maintenance cost is less and the nets are easier to handle.

On a weight-to-weight basis, cages made with Dyneema netting weighs only up to a third of the weight of a cage made of nylon twine, thus helping in reduced drag. On a comparative basis, cages made with Dyneema and nylon exposed to a current having a speed of 0.7 m/s, the residual volume was 54 and 34% respectively (Source: DSM Dyneema). As the twines are thinner, it improves water flow through the meshes resulting in a better exchange of nutrients and the filtering out of excreta making a cleaner and healthier environment for the fishes inside the cage. The improved water flow also helps in a reduced drag, thereby improving net stability. The material resists fish bites when farming biting fish species like cod, sea-bream etc. and also prevents attack of predators.

Studies conducted in India

Though this material has made its impact in the fishing and culture sectors elsewhere in the world, in the Indian fishing and aquaculture sector, it is yet to be tested and proved for its suitability. The material in the form of netting and rope is manufactured in India by Garware Wall Ropes Ltd, Pune under the trade name 'Plateena' with the raw material supplied by DSM, Netherlands.

The only report from Indian waters on the use of 'Plateena' rope as warp lines is on a trawler based at Visakhapatnam. It was reported to have resisted stormy weather for eight hours without any damage during the trials in 2011 when the net become stuck on the seabed (Anon, 2012).

Though the material is claimed to have many advantages, the very high cost involved is a major disadvantage. Hence, its feasibility in the Indian context as well as its performance need to be investigated and standardized. The Central Institute of Fisheries Technology, Cochin has taken up the initiative of testing the suitability of UHMWPE netting and ropes in the Indian context in collaboration with DSM, India and Garware Wall Ropes Ltd., Pune. The work is proposed under the project on "Green Fishing Systems for Tropical Seas" under the National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA).

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Hydroxyapatite from Fish Processing Waste

Hydroxyapatite is seen embedded in the organic matrix of collagen, normally associated with the natural materials such as bones and fish scales. The percentage of hydroxyapatite in fish scales and bones ranges from 40 to 45 (wt%). Hydroxyapatite and calcium phosphate based materials have attracted considerable interest in the field of tissue engineering and hydroxyapatite from fish scale provides an abundant source for novel bone and cartilage replacement. It is one of the few materials, classified as a bioactive natural material that supports bone in growth and integration and hence, popularly known as the 'second generation calcium supplement'. Carbonated calcium-deficient hydroxyapatite is the main mineral of which the dental enamel and dentin of animals and human beings are comprised. The Fish Processing Division of CIFT, Cochin has developed and standardized a novel low cost method for preparing hydroxyapatite from fish processing waste. The work was also been extended to validate the suitability of the prepared hydroxyapatite for various industrial and biomedical applications.

Preparation of hydroxyapatite from fish scale

Hydroxyapatite was prepared from fish scale by a heat treatment method at different combinations of temperatures and durations based on a statistically validated model. The final product was further characterized by FT-IR spectroscopy, X-ray diffraction, scanning electron microscopy and high resolution UV-VIS spectroscopy.

FT-IR spectroscopy

The FT-IR spectrum of hydroxyapatite was used to identify the functional groups on apatite that could be responsible for its active properties. FT-IR spectra of hydroxyapatite prepared at different time-temperature combinations indicated major peaks of phosphate and hydroxide bands at various intensities and a minor peak of carbonate group.

Scanning Electron Microscopy (SEM)

SEM images of hydroxyapatite heated at various temperatures showed crystalline particles with interconnected granular network pattern. Hydroxyapatite particle heated at higher temperatures yielded larger particles with lower impurities.

X-ray diffraction pattern

X-ray diffraction patterns of hydroxyapatite particles showed a gradual increase in the degree of sharpness of peaks with increasing temperature, indicating the formation of more crystalline particles at higher temperatures.

UV-VIS absorption spectra

The UV-VIS spectra of apatite heated at different temperatures clearly indicated the escapement of organic matter as well as higher absorption intensity between 600-700 nm wavelength ranges, confirming the homogeneity of apatite crystals.