Sun, Sand, Sea and Tuna- *A Glimpse of the Maldivian Tuna Industry*

The following article is a part of FIFP webinars conducted on 31st October 2020 on the topic 'Value addition in fishery industry' (Part1)

Note from the Chief Editor:

Main theme of the second in the series of FIFP webinars was 'Value addition in fishery industry' (Part1) conducted on 31st October 2020. In all, three presentations were made covering an overview of export of tuna from India; Our Tuna, Our Wealth, Our Future: Lessons from the Pacific; and Sun, Sand, Sea and Tuna- A glimpse of the Maldivian tuna industry. Mr C S Mohamed shares his experience of working in the Maldivian tuna industry. The article provides a glimpse of the Maldivian tuna fisheries that includes commercially important species available and sustainable fishing methods used for their capture; and how the fishermen handle and process tuna resources. An account of processing fresh/chilled products; frozen products; canned products; by-products; value-added products (VAP) is provided. As tuna is highly sensitive compared to many other fishes due to the change in meat color, common quality problems encountered in tuna processing are discussed. Some important certification schemes adopted by the processors are enlisted. Factors that have contributed in making Maldives commercially successful are highlighted in the article.

Introduction

The Maldives is an archipelago in the Indian Ocean, located south-west of the southern tip of India, the Minicoy Island. There are 26 atolls containing 1192 islets, of which 250 islands are inhabited with a total population of 3,39,761 (2014). A glimpse of the Maldives is enchanting, no wonder the first traveler called it a paradise on earth; sunny weather, white sandy beaches, blue pristine waters with an abundance of tuna in it! *Sun, sand, sea and tuna!* Fishing has long been the lifeblood of the Maldivian economy. Fishing industry was the dominant sector of the economy until 1985, when tourism overtook it in terms of its contribution to the GDP. But still, it serves as an important source of income for about 20% of the population, especially in the remote islands of the country.

As with other countries, Maldives has an Exclusive Economic Zone (EEZ) of 200 nautical miles. It covers about 900,000 square kilometers. This area, along with the inland areas, the lagoons, are the fishing grounds of the country. In comparison, India has an EEZ of 2305143 square kilometers with huge tuna resource potential, of which Lakshadweep covers an area of 400,000 square kilometers. The Andaman, Nicobar and Lakshadweep Islands comprise 30% of the EEZ but produce only 1% of the tuna (Source: Union Fisheries Department Secretary at the 23rd session of the Indian Ocean Tuna Commission (IOTC) held in Hyderabad). Tuna market is growing well on a global level with the market reaching $11.38 billion in 2017 and

is projected to grow to $13.75 billion by 2023. Despite a huge coastline and the EEZ, the country is yet to tap the tuna opportunity. India's part continues to be negligible, despite IOTC nations contributing 20% of the global catch. A major share of tuna exports from India (99.4%) is of low-value frozen skipjack tuna intended for canning (MPEDA 2017-18).

Commercially important species

The commercially important tuna species are Skipjack tuna (*Katsuwonus pelamis)* and Yellow fin tuna (*Thunnus albacares*). Maldives has been following environment-friendly fishing methods for thousands of years and the use of net is completely banned to protect marine mammals.

Skipjack tuna (*Katsuwonus pelamis*)

Yellowfin tuna (*Thunnus albacares*)

Fishing methods

Pole and line, and hand line are the two predominant fishing methods in the Maldives. Though long lining was started in 2010 to increase catch of oceanic tuna, the Maldives government decided to discontinue issuing licenses for long line vessels in 2019.

Maldives tuna is caught one-by-one and is dolphin-friendly, certified by the Earth Island Institute (EII) and Friend of the Sea (FOS) at the processor's level. Maldives skipjack tuna fishery is Marine Stewardship Council (MSC) certified, boosting its value in the international market. Most processors are MSC Chain-of-Custody (CoC) certified and are using ecolabel on the packaging.

The islands of Maldives have small wooden fishing boats, built domestically, which can carry 8-12 fishermen. Most of the boats were mechanized in 1980s with the addition of large fiber boats.

Handling tuna by Maldivian fishermen

Handling tuna onboard, right after the catch is critical in maintaining meat color, quality and histamine content. In the past, when fishing trips were normally short, the pole and line fishing boats landed catch without ice. However, during the last decade, extensive efforts have been taken by the government and processors to install more flake-ice plants. This has resulted in enhancing the quality of skipjack tuna with negligible rejections in the recent years.

Handling of Yellowfin tuna is quite different. The fish is stunned by hitting on the soft part of the head using a wooden hammer immediately after the catch is landed. Thereafter, the fish is gilled, gutted and bled before chilling in ice slurry onboard maintained at 0^{o} C. The fish is landed within 1-3 days with a Back Bone Temperature (BBT) of < 2^{o} C.

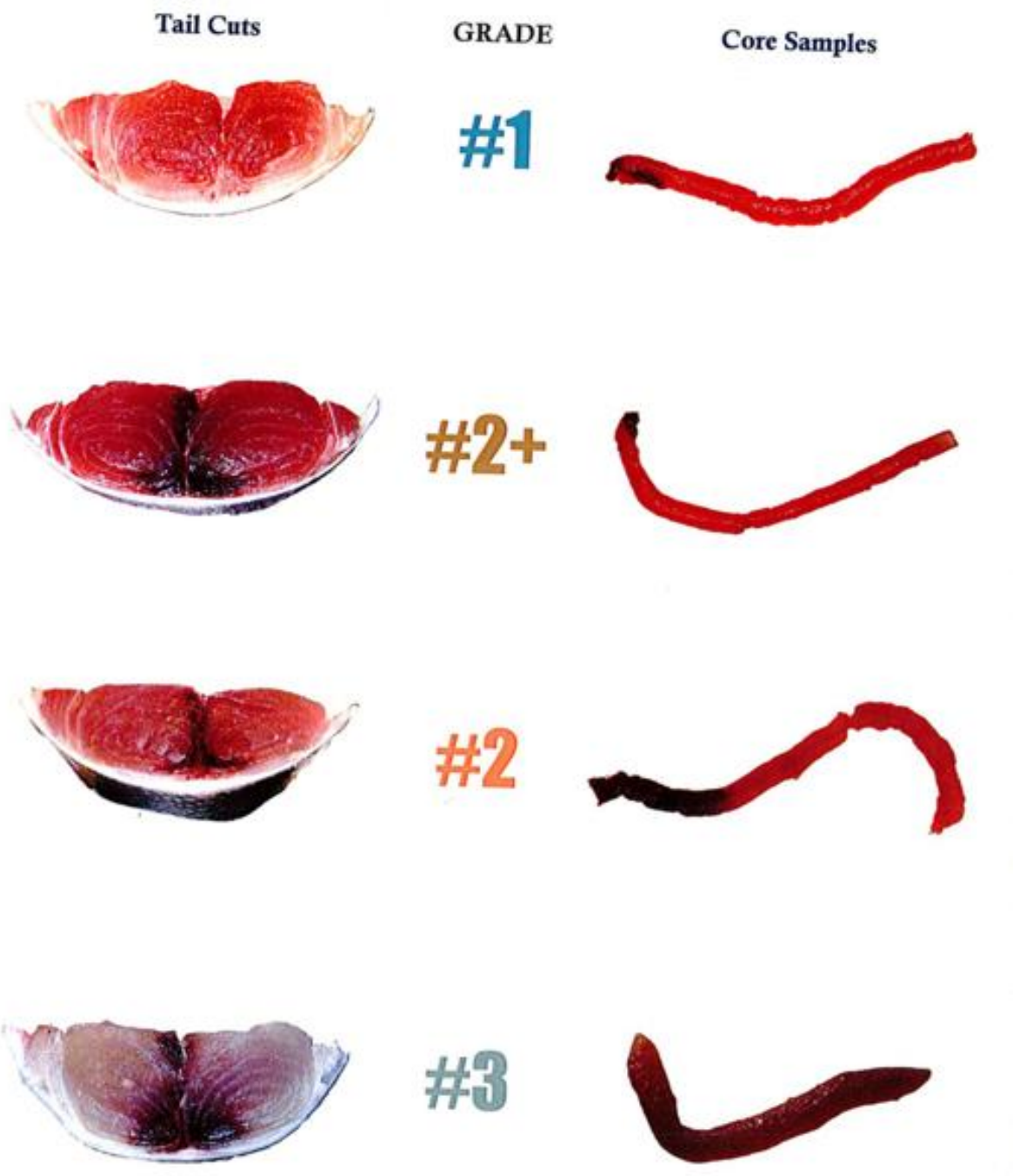
Ideally, tuna has to be killed by pithing with a metal spike and carefully bled by cutting the jugular vein without causing a deep incision on the loins by using special knives, while the heart is still beating. However, fishermen do not follow this procedure as it is time consuming. However, quality is maintained to a large extent by immediate stunning, gilling, gutting, bleeding and chilling onboard fishing boats. The short fishing trips are an added advantage. Interestingly, there

are no middlemen involved and fishermen can directly sell fish to the processing units located in islands with landing areas built within the factory premises.

Grading tuna

Grading Yellowfin tuna requires years of experience as meat color, texture and consistency decide the quality. Grading is done using a hollow metal rod inserted in to the flesh, without damaging loins but sufficient enough to take a core sample as shown in the picture below.

The following chart gives an indication of various quality grades



(*Tuna Grading and Evaluation, The complete Tuna Buyer's Handbook, Robert DiGregorio*)

Core samples are taken while purchasing fish from the fishermen and fish is segregated/allocated for Gilled & Gutted (GG), Headless & Gutted (HG), Loins etc. based on the quality of the meat. A piece cut from the tail region gives an indication of the core while packing GG sashimi-grade or HG tuna for export.

Yellowfin tuna is mainly exported to Europe, with some quantities of HGT finding its market in the US. Skipjack tuna is frozen for canning within the country and exported to SE Asian markets like Thailand. A part of which, usually unaccepted by the processing units, is used for traditional dry fish production in the islands, known as '*Maldive fish*'.

Fresh/chilled products

Fresh chilled products include Gilled & Gutted tuna (GG), Headless & Gutted Tuna (HGT), loins, chunks or center cuts. Commercial production of value-added products like steaks, saku blocks, cheek meat, head meat etc. is negligible though they are available.

GG/HG tunas are packed in thermal protective bags and 5-ply master cartons whereas, loins and chunks are vacuum packed in LDPE bags, stored in styrofoam boxes with gel-ice and maintained at 0 to 2° C throughout the process. Loins are either unwrapped, wrapped in cloth or wrapped in green paper based on buyers' requirements.

Gilled & Gutted Yellowfin Tuna

Headless & Gutted Yellowfin Tuna

Vacuum packed Yellowfin Tuna Loin

Vacuum packed Yellowfin Tuna loin wrapped in green paper

Vacuum packed Yellowfin Tuna Chunk

Vacuum packed Yellowfin Tuna Chunk wrapped in cloth.

Processing fresh/chilled products

As soon as the fish arrives at the factory, each fish is checked for temperature/quality, weighed and tagged for traceability. Random samples are taken for histamine analysis. They are thoroughly washed and kept in flake ice in insulated tubs until processing.

During preparation, the fish is cut into loins, blood meat trimmed off and bones carefully removed. Based on buyer's requirement, skin is either kept on or removed.

After this stage, the loins are filled in LDPE bags, with traceability information attached and moved into the packing section, where loins are vacuum packed, weighed, labelled and packed in styrofoam boxes with gel ice. The whole process is done in processing rooms maintained at <18 ^{o} C. Boxes are immediately moved into the chill room and kept at 0^{o} C until dispatch.

Frozen products

Skipjack tuna is frozen whole round or processed further as cooked and frozen loins in the cannery. Blast freezing is normally done. However, there are large-scale brine- frozen units in the country where huge quantity of skipjack tuna is frozen for canning. Cooked and frozen loins are exported as value-added raw material for canning.

Yellowfin tuna is frozen whole (GG), made into frozen loins or steaks based on the requirement or availability of fish. Frozen belly flap is a fast-moving frozen by-product.

Canned products

Skipjack tuna is either exported as frozen whole round or canned. Cans of 185/200g net weight with Easy Open Ends (EOE) and retort pouches of 1/3/5 kg net weight in brine or oil are available.

By-products

Tuna cubes

These are produced from the cut-pieces generated during the preparation of tuna loins. They are frozen and are ready- to-cook.

Dried tuna

Traditionally, tuna is sun-dried. However, smoked and dried tuna adds value, flavor and shelf-life. They are either hard-dried (*Hiki-Mas*) or semi-dried (*Valoh-Mas*). In Dhivehi language, 'Mas' means fish, which is comparable to *'Mas-min'* produced in the Lakshadweep islands but through a completely different process. One processing unit produces Katsuobushi for Japanese market.

Tuna fish paste

Tuna fish paste, locally known as *'Rihakuru'* is a traditional delicacy in the Maldives which is produced by concentrating tuna cooked water through evaporation. This product has a strong flavor and often has higher histamine levels. This is traditionally consumed with *'Roshi'* for breakfast.

Value Added Products (VAP)

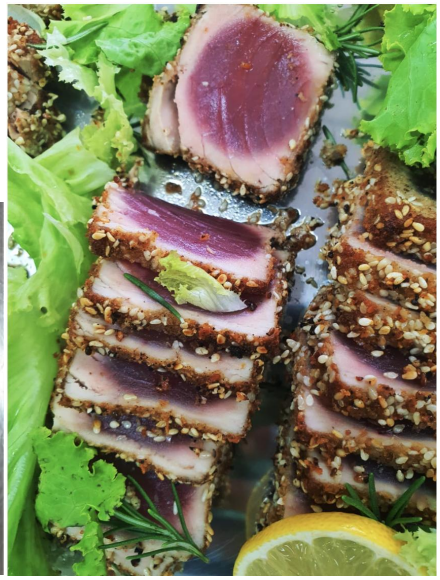
SAKU blocks

These are tuna loins cut into bars of approximately L 7”x W1”x H 1”, weighing 250-300g. This is a high-value product but the yield is only approximately 22-25%. This can be produced during peak seasons when there is plenty of raw material, either quick-frozen or super-frozen. This is also used for the preparation of encrusted and seared tuna.

Encrusted & Seared Tuna

Saku blocks applied with oil on the surface (Canola, Olive or Sun flower oil) are covered in sesame seeds mixture. Roasted sesame seed mixture (either black, white or mixed) is prepared in advance with different flavors as preferred by the customer. The product is cooked in an oven at 220-250 ° C for 5-7 minutes to sear the meat surface. The product is kept in a chiller before vacuum packing. Vacuum-packed

blocks are frozen at -40° C. The blocks must be of uniform size and shape to achieve perfect cooking all over the surface. The core of the block remains fresh/uncooked.

Miscellaneous products

No part of Yellowfin tuna is wasted. Tuna eyes, collar bones, cheek meat, head meat, trims and tail meat are all consumable and nutritious.





Quality problems in tuna processing

Tuna is highly sensitive compared to many other fishes due to the change in meat color affecting commercial value and formation of histamine in the meat resulting in rejections. The following are common quality problems in tuna processing.

High Histamine

Histamine is produced and gets accumulated when bacterial enzymes metabolize the naturally occurring histidine in tuna. This most often occurs when the fish is kept at temperatures above 40 Degrees Fahrenheit (> 4.4° C) for several hours. Freezing, cooking, smoking, curing and canning do not destroy the potential toxin and sensory examination is not sufficient in detecting elevated levels of histamine. It can definitively be detected by chemical testing. Legal limit for histamine varies from 50-100 PPM but most customers insist on histamine levels as low as 20 PPM especially in fresh/chilled products. Chilling tuna onboard immediately after catch followed by strict temperature control throughout the processing based on HACCP system is necessary to control this hazard.

Burnt Tuna Syndrome (BTS)

This condition makes the raw tuna meat appear paler or even burnt with soft texture. This change begins just prior to death and proceeds rapidly after death. It has long been thought and widely accepted that this condition is caused by increased body heat and high levels of lactic acid accumulated due to struggling. Recent studies have shown that BTS is actually caused by increased levels of catecholamine secretion and female fishes are more likely to burn because of the estrogen, which slows the dissipation of the catecholamine in the meat. BTS causes meat to appear soft and mushy. Killing and bleeding tuna immediately after catch reduces this defect.

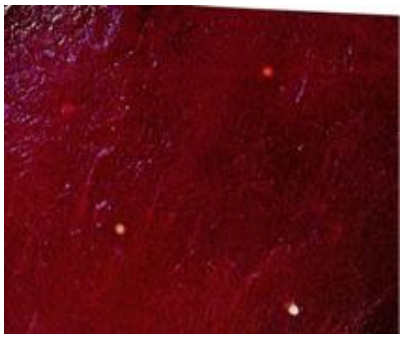
Brown discoloration

The bright pink color of tuna meat is due to the oxidation of Myoglobin into Oxymyoglobin, which is unstable and further oxidized into Metmyoglobin, which is brown in color. This process is often difficult to control under normal conditions. Packaging with different Oxygen Transmission Rates (OTR) helps in controlling oxidation. Carbon monoxide (CO) treatment converts myoglobin into Carboxymyoglobin, which is a more stable product, imparting cherry-red color to the meat. However, CO treated tuna is banned in many countries, including the EU

due to food safety concerns as the bright cherry-red color can mask a naturally spoiled meat and mislead consumers.

Parasites

Myxosporedian protozoan parasites, specifically the genus kudoa, infects wide range of host species. They primarily infect the muscle tissue, forming small creamy nodules or pseudocysts. These little white balls may completely infest the loins, causing considerable economic loss, especially in HGT, where it cannot be visually observed. Live fish is able to cope with this parasite but upon death, continued enzyme activity results in melting meat (myoliquifaction), commonly known as “sashi”. These parasites do not infect humans but cause considerable economic loss to the processor.

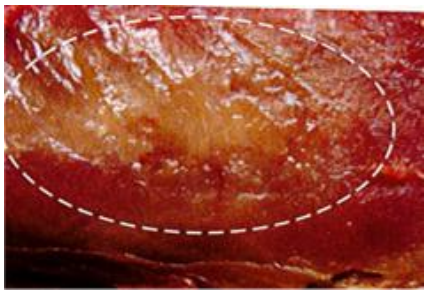


Iridescence

In some cases, when the loin is steaked or cut, there will be noticeable rainbow sheen on the cut surface. Tuna graders can notice this in the tail cut as well. Presence of rainbow decreases the value, especially in Sashimi market. The iridescence can be the result of interference involving refraction and reflection occurring in thin films of liquid on the surface of the cut. When tuna meat is cut transversely, the contents of the myofibrils-intracellular oil leak on to the cut surface. As tuna ages, the breakdown of the tissue protein structures leaks more oil on to the surface. The rainbow effect is a natural optical phenomenon and poses no health hazard. But it is considered very undesirable by tuna traders.

Tumors

Tumors in tuna can be caused by viral infections, environmental conditions, genetic abnormalities or without a known cause. They undermine the value and sometimes render the fish misfit for sale.



Injuries/ cookie cutter

Cookie cutter sharks attack tuna by ripping its mouth on the body, spinning 360 degrees, cutting off a perfect circle of flesh.

Honey comb meat

Honey comb meat is a specific defect found in pre-cooked tuna intended for canning. The meat appears to be perforated imitating honey comb. This is caused by steam/water passing through soft areas of the meat, caused by decomposition. Honey-combed meat normally has high histamine content, which is immediately rejected.

Green meat

Greening happens when the myoglobin in tuna reacts with other muscle components including Trimethylamine Oxide (TMAO) and cysteine. This pigmentation can also be formed by the reaction of myoglobin with hydrogen peroxide, a by-product of lipid and myoglobin oxidation.

Bruised meat
Caused by physical injuries, especially in pole and line fishing when tuna hits hard on the surface of the hull or fish hold. Fishermen often use a net to absorb the shock and prevent bruise. Bruised meat considerably reduces yield.

Certifications
Certification plays a very important role in international marketing. Apart from Food Safety Management certifications, there have been demands for sustainability certifications and ethical audits from customers. Some important certification schemes adopted by the processors in the Maldives are as follows;

-ISO 22000:2018
-Food Safety System Certification, FSSC 22000
-Global standard for Food Safety, BRCGS
-Environmental Management System, ISO 14001:2015
-MSC Chain of Custody Standard, Version 5
-Friend of the Sea, FOS-CoC
-Earth Island Institute Certificate-Dolphin Safe International Monitoring Program
-Supplier Ethical Data Exchange, SEDEX
-Social Accountability, SA 8000
-Fair Trade USA, Capture Fisheries Standard

What makes Maldives commercially successful?

Focus on tuna exports
The fishing industry exclusively depends on tuna exports. As net fishing is banned, the focus is on tuna caught by pole and line; and hand line. Live reef fish exports, using hook catch, exist but the quantity is marginal. Grouper farming/ sea cucumber farming etc. are opportunities currently being explored and promoted by the government through various support schemes.

Good infrastructure for chilling and processing
There are 15 EU approved facilities in the Maldives, of which 3 are canneries. They are well constructed with attached ice manufacturing facilities. All fishermen carry ice collected from these factories/ other ice plants in insulated boxes. It is not a huge operation but it is well managed.

Sustainable fishing methods like pole and line and hand line
Maldives tuna is well known in the international markets for its sustainable fishing methods and fisheries management practices. Being a small country, traceability is well managed and Illegal, Unreported and Unregulated fishing (IUU) is completely prohibited. 'Pole and line tuna' and 'caught one by one' are well perceived slogans by the customers. Maldives Skipjack tuna fishery is MSC certified.

Good quality and availability
Quality of Maldives tuna is well accepted in the international tuna market. Tuna is available throughout the year, though catches go down during June-July Monsoon period. There is no seasonal fishing ban in the Maldives.

Good connectivity with major international markets

Being a well-known tourist destination, Maldives has good air connectivity via Dubai, Abu Dhabi, Oman, Singapore, Sri Lanka and Istanbul. Male' Sea Port has connectivity with all tuna importing countries via Colombo.

Goodwill/ popular among Europeans

Maldives is well known as a tourist destination with one of the world's top 10 diving spots. It is well known as a clean, environmentally friendly country with friendly people, sunny weather, sandy beaches and tuna!

Conclusion

Fishing industry in the Maldives is entirely dependent on tuna exports. Skipjack tuna (*Katsuwonus pelamis)* and Yellowfin tuna (*Thunnus albacares*) are the two main commercially important species. Handling tuna onboard, right after the catch is critical in maintaining meat color, quality and histamine content. Yellowfin tuna is processed for Gilled & Gutted (GG), Headless & Gutted (HG) and Loins based on the quality of the meat. Skipjack tuna is either exported as frozen whole round or canned whereas Yellowfin tuna is frozen whole, loins or steaks based on the requirement or availability of fish. Tuna cubes, dried tuna and fish paste locally called *Rihakuru,* a traditional delicacy are the main byproducts. Value-added products include Saku blocks, Encrusted & seared tuna. Common quality problems in tuna processing are high histamine; burnt tuna syndrome; brown discoloration; parasites; iridescence; tumors; injuries; honey-comb meat; green meat; and bruised meat. Yellowfin tuna is mainly exported to Europe while Skipjack is exported to SE Asian markets. Focus on tuna exports; good infrastructure for chilling and processing; sustainable fishing methods like pole & line and hand line; good quality and availability; good connectivity with major international markets; and goodwill/ popularity among Europeans are some of the factors that have contributed in making Maldives commercially successful.

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