ABSTRACT

Globally, there is a growing need for diverse value-added food items. Value Addition refers to "any additional activity that in one way or another changes the nature of a product thus adding to its value at the time of sale". Three distinct traditional fish preservation procedures identified in Jammu & Kashmir are smoking, sun drying, and pickling collectively called as Curing. Cured fish consumption is higher in locations with restricted access to fresh fish, such as interior markets and hilly areas. This is also the most economical technique of preservation because no expensive technology is employed. In India, around 20% of the fish collected is preserved through curing. Sun drying is the most extensively used traditional method of preservation, by reducing the moisture content of the fish, which inhibit the activities of bacteria and fungi. Smoked fish are known locally as fari, sun-dried fish as hugaad, and pickled fish as gaad anchaar. Fisherwomen often work as vendors, which is not economically sustainable. Because they must sell the catch within a day, they may have to sell it at a low price that does not pay their expenses. To prevent this and increase income, businesses can add value to fish goods. some value-added fish products are, fish pickle, sauce, pasta, fish cutlets, fish balls, noodles and Ready-To-Eat Fish Curry. Value addition can increase profitability in the fish processing sector, which is becoming increasingly competitive and expensive. Fish-based goods in convenient ready-to-eat formats are in high demand. Effective marketing of new value-added products requires careful consideration of appearance, packaging, and display. The retail package should be clean, sharp, and transparent, with appealing contents for consumers. This evaluation intends to transition in J&K from producing safe and high-quality fishery products for local use to export.

Keywords: Curing, Fishery products, Marketing, Packaging, Value addition
INTRODUCTION

Fish is one of the best sources of high nutritional value protein, high in essential amino acids such as lysine and methionine, high in calorific value and good digestibility, high in biological and growth promoting value. Fish also contains omega-3 fatty acids such as eicosapentanoic acid (EPA), eicosapeniac acid (DHA), vitamin A, vitamin D, vitamin B6, and vitamin B12, as well as minerals such as iron (iron, zinc, iodine), selenium (selenium), potassium (potassium), and sodium (which are necessary for normal development) and may prevent coronary artery disease (CAD), hypertension (hypertension), diabetes (diabetes), arthritis (arthritis), inflammatory and autoimmune disorders and cancer. The post-harvest losses in fisheries are getting increased day by day due to the unavailability of the commercial valued fishes in adequate quantity as per demand, harvesting of low-valued, small sized, higher fat content, and unconventional irregular fish species having less market demand due to unattractive color, flavor, and texture. As a result, they are often used for animal feed or byproduct production, or may even in some cases; these fish are thrown back into the sea. Although these by-catch or small size fishes have less market value, due to their high protein content they can act as a rich protein source especially in developing continents like India where there is the visible below poverty zone. Thus, to prevent post-harvest fishery losses, conservation and proper utilization of such fishes and shellfishes by collecting them as raw materials and transfer them into value-added products is the most promising approach (Asik et al., 2021). Each year, a significant portion of the overall catch is discarded as by-catch or processing leftovers, which include trimmings, fins, frames, heads, skin, viscera, and so on. Furthermore, a substantial amount of processing byproducts, such as crustacean and shellfish shells, collect at marine bioprocessing plants. Recognizing the limited marine resources and increasing environmental pollution has highlighted the need for improved use of by-products. Marine byproducts contain valuable protein and lipid fractions, minerals, enzymes, and a variety of other components. The majority of byproducts are utilized for feed production, specifically fish meal/oil, although this is a low-profit activity. There are numerous approaches to better utilize fish and shellfish waste, including the development of novel culinary ingredients, Nutraceuticals, medicines, biomedical materials, fine chemicals, and other value-added items. In recent years, extensive study has been performed to investigate the potential use of various byproducts. This contribution focuses on the properties and applications of key constituents such as protein, fat, chitin and its derivatives, enzymes, carotenoids, and minerals derived from marine byproducts (Shahidi et al., 2019).

Value-added fishery products can help rural fishery operators and their families increase their daily income and improve their living standards by transitioning from traditional practices to safe and high-quality production and processing. Value-added fish products may include i) mince or Mince-based products ii) battered, breaded, or coated items; iii) surimi-based products. Fish mince, also known as minced fish, is the meat of the fish that has been comminuted to remove scales, skin, and bones. The advantage of mince-based products is that they mask the identity of the original fish from which they are created, therefore customers may accept mince or mince-based products even if the original fish would have been unpalatable as whole fish. Battering and breading increase consumer happiness by boosting the nutritional value, organoleptic properties, and look of the products, making them popular among other consumer items. Coating adds value to products by increasing their bulk. This also allows for more efficient use of low-cost or underutilized fish. Coating is defined as the batter and/or breading that adheres to a food product. Each coating ingredient contributes to the product’s functionality and qualities in
a unique way. The typically utilized ingredients include polysaccharides, proteins, lipids, spices, and water. Batter is a liquid mixture of water, flour, starch, and seasonings used to coat fish before breading. There are two types of batter: sticky and tempura batter. The adhesive batter is a fluid made of flour and water. Tempura batter is a puff-type batter with raising/leavening ingredients. This creates a crisp, consistent layer on the meal. Wet batter is applied to predusted areas, and surplus batter can be removed with a current of air. The batter mix influences the amount of bread picked up and the flavor of the finished product. Breading involves adding a dry mixture of flour, starch, and coarse spices to battered food products before cooking. Traditionally, battered fish is coated with dry bread crumbs before being turned over. Adding a layer of bread crumbs, whether fine or coarse, enhances the product’s structure and flavor. For soft items, the crump depth should be sufficient to prevent damage during subsequent processing (Sreelakshmi, 2020).

Surimi is a Japanese term for mechanically deboned fish mince made from white fleshed fish that has been washed, refined, and mixed with cryoprotectants to extend its frozen shelf life. It is used as an intermediate in the production of a variety of value-added products with enhanced texture, flavor, and appearance (Datta, 2013). Recent developments in fish processing technology are oriented towards technology updation, diversification and quality assurance. These have led, among others, to a great demand for fish based convenience products in ready-to-eat or ready-to-cook forms. There are several factors, which have influenced this demand. One is the increasing affluence and the consequential changes that have influenced the eating habits, particularly in the western countries, which have resulted in the demand for diversely processed value products based on fish. There is also an increasing trend of eating away from home and this has triggered the growth of fast food trade serving value added fish based products.

In today’s fast-paced world, consumers prioritize expediency above complicated culinary techniques. By-products and low-value species can be utilized to create three key product categories: (1) plant fertilizers, (2) livestock feeds, and (3) value-added and specialized foods for human consumption. In general, converting by-products to fertilizers adds the least value to them, whereas developing specialty foods adds the most value. It is estimated that if specific components are recovered from industrial by-products and employed to make food products, their value will increase fivefold (Gildberg, 2002).

PRODUCTS FROM FISH WASTES

Fish meal and fish oil from fish processing wastes

Previously considered biowaste, fish processing by-products now have added value. These wastes have the ability to produce high-value products like hydroxyapatite, collagen, enzymes, proteins, and fish oils. Fish meal is the most often used protein source in feed formulations because to its high protein content, essential amino acids, fatty acids, and minerals. Fish meal is made from entire fish or byproducts of fish processing factories. The aqua feed sector is facing a shortage of fish meal due to increasing demand. Fish meal is a key protein source in cattle and poultry diets, leading to competition for supply between the aquaculture and livestock industries (Kushani et al., 2022). Fish skin waste contains collagen and gelatine, which are widely used in the food, cosmetic, and biomedical industries. The Fish’s internal organs contain several enzymes with strong catalytic activity
even at low doses. The enzymes found in fish include pepsin, trypsin, chymotrypsin, and collagenase. Enzymes are commercially isolated from fish viscera on a huge scale. They have superior catalytic characteristics, are efficient at lower temperatures, are less sensitive to substrate concentrations, and are more stable throughout a broad pH range. Fish processing byproducts contain fish oil. The amount depends on the fat content of the specific species. Typically, fish includes 2-30% fat. Approximately 50% of waste created during fish processing can be converted into high-quality oil for human consumption or biodiesel generation. Proteins isolated from fish muscle show several bioactivities, including antihypertensive, antithrombotic, immunological modulatory, and antioxidative characteristics. The bioactive peptides from the fish muscle have anticoagulant and antiplatelet characteristics, allowing them to block coagulation factors in the intrinsic pathway (Ghaly et al., 2013). Exploring novel methods for extracting and purifying high-value items from fish waste could increase the value of what is currently considered trash in the fish processing industry (Pedro et al., 2019).

**Collagen and gelatine from fish bones**

Hockey fish bones (*Johnius belangerii*) comprise around 30.54% (wk) organic matter, consisting of 28.04% protein, 1.94% fat, and 0.56% carbohydrate, while the inorganic mineral content is approximately 69.46% (bk). consists mostly of 59.69% calcium (Ca) and 35.81% phosphorus. The use of fish bones as a source of dietary calcium is one of the approaches to meet food calcium requirements while enhancing the economic value of fish bone waste. Fish bone waste has the potential to be employed as a calcium source in the human body, as well as in the production of food products that are well accepted in the community. Fishbone flour is made from fish bone waste from the processing industry and has the highest calcium concentration of any fish body, as calcium, phosphorus, and carbonate are the primary constituents of fish bones. Calcium phosphate accounts for up to 14% of total bone structure in fish bones. Gelatin is a polypeptide combination formed by hydrolysis of collagen found in skin, bone, and animal connective tissue. Gelatin has unique properties, including the ability to expand in cold air, convert reversibly from a colloidal form to a gel, impact a material’s viscosity and melting point, and protect colloidal systems (Suyono et al., 2022). Because of its unique qualities, gelatin serves numerous purposes, including emulsifier, thickening agent, stabilizer, matrix material for implants, alternative plastic (edible film), and binder. The food sector also employs fish bones to extract collagen and gelatine (Coppola et al., 2020). This gelatine can be used to thicken, emulsify, stabilize, or clarify products (Shen et al., 2019). Fish gelatine, like gelatine derived from terrestrial animals, is isolated from type I collagen. Fish bone flour has been utilized in various research to fortify culinary preparations. For example, Uthai (2021) reported using salmon fish bone powder as a substitute for wheat flour in the production of noodles, resulting in an increase in protein content in the final product. Although there were some texture and visual differences, the addition of 15% fish bone flour had no effect on overall acceptability. Similar research found that fortified goods
with fish bone flour included more calcium and phosphorus (Abdel-Moemin, 2015). Furthermore, because fish gelatin has a lower melting point than pork gelatin, they can add value to new goods by releasing a large amount of taste. Collagens derived from fish scales, skin, and bone have been widely employed as scaffolds and transporters due to their good bioactive qualities; they are biocompatible and quickly biodegradable, have minimal antigenicity, and may support cell growth (Phanat et al., 2010; Cho et al., 2014). Fish gelatin is known to have good film-forming qualities; it can be used to create a clear, nearly colorless, water-soluble, and long-lasting film (Avena-Bustillos et al., 2006; Gómez-Guillén et al., 2009; Jiang, 2010). Because of its low gel melting temperature, gelatin from cold-water fish can be utilized in frozen or cold-storage items that are consumed soon after melting or being removed from the refrigerator.

**Packaging material and leather from fish scales and skin**

Biodegradable films have gained popularity due to their advantages over conventional synthetic films. Biodegradable films are made with renewable, environmentally beneficial components. Films can serve as barriers to gas, moisture, solute movement, and scent, as well as transporters for food antibacterial and antioxidant agents. Research is focused on generating high-quality biodegradable films that can compete with plastics. Using waste items as film source materials saves money and reduces pollution. Gelatin is a biocrossmolecule protein polymer with colorless, transparent, brittle, edible, and flavorless properties. Thermal hydrolysis is used to remove gelatin from collagen in animal and fish skin, bones, and connective tissue. Gelatin is a functional biopolymer with excellent film-forming properties, including good carbon dioxide and oxygen barrier qualities, transparency, water solubility, and high extensibility. Fish gelatin is becoming increasingly popular due to social, cultural, and religious reasons (Arpi et al., 2018). Fish leather manufacturing reduces pollution and protects marine habitats, leading to healthier and more productive oceans. Promoting fish leather has potential for both environmental and economic benefits in coastal areas. Recovering fish leather from trash takes fewer resources and has a smaller carbon impact compared to cattle production. Fish leather has a smaller environmental impact than normal leather and does not require additional land, water, fertilizers, or pesticides for production (Elisa Palomino and Defeo, 2018)

**Enzyme extraction from fish viscera**

Underutilized fish and waste from seafood processing include numerous new enzymes that can be extracted using traditional procedures. Their unique qualities make them suitable for various applications, including food processing. These applications include protein changes, PUFA in lipids, extending shelf life, biosensors, and evaluating fishery goods directly for quality. Fish internal organs, or viscera, account for around 5% of the fish’s weight (Varsha Likhar and Chudasama, 2020). The fish gastrointestinal system secretes several enzymes for their digestive purpose (Kim et al., 2006). Proteases, such as pepsin, trypsin, chymotrypsin, and collagenase, are the most commonly extracted marine enzymes for commercial purposes (Ferraro et al., 2010). This group includes enzymes that catalyze
the breakdown of proteins into polypeptides (Shahidi et al., 2001). Proteases play a crucial role in several biochemical, physiological, and regulatory processes in cells and organisms. They are essential for food digestion. Lipases, also known as triacylglycerol acylhydrolases, hydrolyze tri-, di-, and monoglycerides into glycerol and fatty acids when there is abundant water. In water-limited conditions, they enhance ester production. Proteases can create peptides with therapeutic benefits, including antihypertensive, antiamnesiac, mineral-binding, immunodulatory, antioxidant, antibacterial, and antithrombotic properties. Lipases have numerous applications, including detergent and food additives, environmental remediation, biotransformation, and molecular biology. Other enzymes have potential applications in food processing and biotechnology (Likhar and Chudasama, 2020).

**BIOACTIVE PEPTIDES**

Bioactive peptides extracted from fish have been shown to have antimicrobial, antiviral, antitumor, antioxidative, antihypertensive, anticoagulative, analgesic, anxiolytic, antidiabetic, and appetite-inhibiting properties (Kim and Wijesekara, 2010; Khora, 2013; Cheung et al., 2015). The first natural Antimicrobial peptides isolated from fish was paradaxin. Later, paradaxin was commercially produced. AMPs have been isolated from numerous fish species in diverse conditions. AMPs derived from black-barred halfbeak gelatin and hydrolysates demonstrated antibacterial activity against three Gram-negative bacteria (*Klebsiella pneumonia*, *Salmonella enterica*, and *Salmonella typhi*) and three Gram-positive bacteria (*Micrococcus luteus*, *Staphylococcus aureus*, and *Bacillus cereus*). Some AMPs isolated from fish species have antifungal properties. Piscidin 2, released by Hybrid Striped Bass, has been shown to break fungi’s plasma membranes. Epinecidin from rockfish was discovered to be efficient against *Candida albicans*, a human fungal pathogen. Recently, a peptide fraction from Cod bones with a molecular weight of around 10 kDa has been found to exhibit strong antioxidative activity, unlike fractions with molecular weights of 3, 5, and 30 kDa. Protein hydrolysates isolated from the skeletons of Yellowfin sole (*Limanda aspera*) showed antioxidant action. Sardines were originally found to have antihypertensive peptides. Sardine fish peptides shown antihypertensive effects in both in vitro and in vivo investigations on a spontaneously hypertensive rat (SHR) cell line (Ayusman et al., 2022). Hsu et al. extracted two peptides (12.06 and 11.24 kDa) from Tuna fish muscle tissue using papain and protease enzymes. These peptides demonstrated anticancer activity in the MCE-7 cell line. Both peptides inhibited MCF-7 cells in a dose-dependent manner.

**Antimicrobial peptides**

Fish generate AMPs as part of their immune system. Fish AMPs include piscidin, defensin, hepcidin, cathelicidin, and histone-based peptides. They have demonstrated a wide range of antimicrobial activities on bacteria, yeasts, moulds, parasites, and viruses that are pathogenic or hazardous to fish and humans (Masso-Silva and Gill Diamond, 2014).
**Anti-oxidative peptides**

Antioxidative peptides derived from fish proteins typically have 2 to 16 amino acid residues (Chalamaiah et al., 2012). Their antioxidant activity is mostly determined by the amino acid sequence, content, and hydrophobicity. Peptides with high antioxidant activity typically contain more hydrophobic amino acids and the following amino acid residues: histidine, proline, methionine, cysteine, tyrosine, tryptophan, and phenylalanine (Je et al., 2007; Ren et al., 2008; Bougatef et al., 2010; You et al., 2010; Farvin et al., 2016). Enzymatic hydrolysis has been used to separate antioxidant peptides from several fish components and species, including the head, frames, bones, scales, and viscera. The antioxidative characteristics of Yellow stripe trevally, Selaroides leptolepis, were discovered to be dependent on the degree of hydrolysis of fractions and the kind of enzyme utilized. Using Flavourzyme for enzymatic hydrolysis produced a 1.77 kDa peptide fraction with increased antioxidant activity. Fish peptides with a fraction of 2.44 kDa showed similar antioxidant effects when tested with Alcalase enzyme. FPH has demonstrated promising effects in preventing food degradation induced by lipid peroxidation. Peptides can help extend the shelf life of foods, especially those containing haemoglobin or free iron, which can cause lipids to rancidity.

**VALUE ADDED FISH PRODUCTS**

**Frozen fish fillets**

Whole fish, gutted fish, fillets, and so on can be frozen and stored for longer periods of time to preserve these species. Many types of freshwater fish, including as rainbow trout, shellfish, catla, rohu, and tilapia fillets, can be frozen for domestic consumption and exported to developed countries in block frozen and IQF formats. These fillets are mostly utilized to make coated products. Fish fillets can also be used to make ready-to-serve value-added goods like fish sauce and fish salads. Skinless and skin-on fillets of lean/medium fat white flesh fish have a huge commercial potential. freshwater fish fillets are often utilized to make coated items. During fish processing into fillets (the most common cut of fish), up to 70% of the total fish weight is lost, which includes heads (9-12%), viscera (12-18%), skin (1-3%), bones (9-15%), and scales. This vast volume of by-products has a great potential for making animal feed, fishmeal, oil, or plant fertilizer, but it is usually discarded.

**Fish cutlet**

Fish cutlets are made by combining cooked fish mince with cooked potato, fried onion, and species, among other ingredients. It is then molded into the required shape, with each weighing around 40 g. The formed cutlets are battered, breaded, and flash fried for twenty seconds. The bread crumbs are distributed evenly across the product, and surplus crumbs are removed with an air blower. Before cooking, breaded fish is coated with breadcrumbs, which gives it a crunchy quality. Battered fish, on the other hand, is dipped in a liquid batter (often a combination of flour, water, and occasionally other ingredients before frying, resulting in a thicker, more substantial coating). Both procedures can be used to create a crispy and delicious outer coating on fish.
**Fish balls**
Fish balls are typically made from minced low-cost fish. A variety of methods can be used to prepare balls. The simplest approach is to combine the fish mince with flour, salt, and spices. This mixture is then formed into balls and fried in a boiling 1% brine. The cooked balls are then coated in batter and breaded.

**Fish finger or Fish portion**
Fish fingers, or portions or sticks are regular sized portions cut from rectangular frozen blocks of fish flesh. They are normally coated with batter, and then crumbed before being flash fried and frozen. They may be packed in retail or catering-size packs.

**Fish sauce**
Fish sauce is a transparent brown liquid with a salty taste and a slight fish flavor. Fish sauce, with its distinct flavor and taste, is a popular cooking and dipping condiment. Fish sauce is made up of salt-soluble proteins, including amino acids and peptides. The flavor and scent are mostly attributed to halophilic bacteria used in its microbiological development. Fish sauce is commonly used as a condiment in cuisine. Fish sauce includes all necessary amino acids, including lysine. Fish sauce contains several vitamins and minerals. Fish sauce has high levels of vitamin B12, as well as minerals like salt, calcium, magnesium, iron, manganese, and phosphorus.

**CONCLUSION**
The fish processing sector prioritizes value addition to maximize foreign exchange earnings. India, as the world's second largest consumer market and one of the fastest developing countries, presents a promising opportunity for the processed seafood business. Diversify seafood value addition based on market requirements. Value added commodities include live seafood and ready-to-eat convenience goods. Value addition involves exploring new ways to utilize fishing by-catch. India's skilled workforce and dominance in agri-commodities provide an advantage for capturing a large seafood market across many commodities. As fresh water aquaculture grows, there is significant opportunity for developing high-value products from this sector. Utilizing fishing waste or low-cost fishes to create high-value products has become increasingly important in recent years. Byproducts can have diverse applications in industries such as medicine, food, and more. Simple, cost-effective procedures can create valued items that increase revenue for fisherman and related sectors in Jammu & Kashmir. Polluted materials from the fish processing industry are now employed to create useful goods with diverse applications. Instead of dumping, using undesired fish wastes as a low-cost feedstock in conjunction with typical fishing byproducts may be a preferable choice for producing value-added products as well as health supplements. This approach can assist control solid waste from fish enterprises while also boosting their economy.
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