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Back to top In a secondary fish processing plant, workers are involved in such tasks as the buttering, breading, stuffing and packaging of fish that has already been de-boned and filleted in a primary processing plant. All the operations are organized on a conveyor line. The buttered sole line and the scallops line were selected as the most representative operations in a secondary fish processing plant. Back to top In addition to some of the hazards listed above, pain or injury from physical overexertion, repetitive manual tasks, or working in awkward positions is very common. A case study is presented below. Please also see the OSH Answers on Conveyors – ergonomics for more information. Back to top Tasks on the buttered sole line consist of spreading, buttering, breading, packaging, and wrapping filet of sole. Such tasks as buttering and breading are automated. Therefore, we will look only at the spreading, packaging and wrapping tasks. What is Spreading? 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Food production involves transforming raw ingredients into products that are safe, edible, and appealing to consumers. The process can be divided into two main stages: primary processing and secondary processing. These stages are crucial for both preserving the food and making it suitable for consumption. The way ingredients are processed can affect their sensory properties (taste, texture, appearance) and their nutritional value.Primary Processing of FoodPrimary processing refers to the initial stage of food production, where raw ingredients (often harvested or collected from nature) are processed into forms suitable for consumption or further processing.Examples of Primary ProcessingCereals: Grains like wheat, oats, or rice are harvested and undergo cleaning, drying, and milling. For example, wheat is milled to produce flour.Fruits and Vegetables: Fresh produce like apples, carrots, or potatoes may be cleaned, peeled, chopped, or packaged. In some cases, they are frozen, dried, or canned.Meat: Animals like cows, pigs, and chickens are slaughtered, and the meat is cleaned, butchered, and packaged for sale.Dairy: Milk is collected from cows or goats and is pasteurised to kill harmful bacteria. It can then be processed into various products such as cheese, butter, or yoghurt.Impact on Sensory and Nutritional Properties Sensory Properties:Appearance: Primary processing can affect the appearance of food. For example, vegetables may lose their vibrant colour when frozen or dried.Texture: Some primary processing methods, like freezing or drying, can alter the texture of food. For example, frozen vegetables may become softer or more watery upon cooking.Flavour: The natural flavours of food may be enhanced or diminished during primary processing. For instance, pasteurisation of milk can slightly alter its flavour, and drying fruit concentrates its sweetness. Nutritional Properties:Vitamins and Minerals: Primary processing can lead to nutrient losses. For example, washing and peeling fruits and vegetables can cause some water-soluble vitamins, like vitamin C and folate, to be lost. Similarly, drying can reduce some nutrients, such as vitamin C.Preservation of Nutrients: Processes like freezing or canning can preserve some nutrients, but others, particularly heat-sensitive ones, may be reduced. For example, freezing fruits and vegetables shortly after harvesting helps preserve their vitamin content better than other methods like drying.Loss of Fibre: Some primary processing methods, such as refining grains to make white flour, remove the outer layers of the grain (the bran), which are rich in fibre.Secondary Processing of FoodSecondary processing is the next stage, where primary processed ingredients are further transformed into finished food products that are ready to be consumed or sold. This stage often involves cooking, mixing, and combining various ingredients to create a new product.Examples of Secondary ProcessingBaking: The transformation of flour, yeast, water, and other ingredients into bread or pastries.Canning: Primary processed foods like vegetables or fruits are further processed through canning, which involves sealing them in cans and heating to destroy bacteria.Ready Meals: Ingredients such as vegetables, meat, and sauces are pre-cooked and packaged together in ready meals for convenience.Snacks: Potatoes are sliced, fried, and flavoured to create crisps (chips), or grains can be puffed and flavoured to create snack products.Impact on Sensory and Nutritional Properties Sensory Properties:Flavour: Secondary processing often enhances or modifies the flavour of food. For example, bread rises and develops a characteristic aroma and texture through the process of fermentation and baking.Texture: Cooking techniques like frying, baking, or roasting can significantly change the texture of food. For example, deep frying potatoes transforms them from raw, starchy tubers into crispy crisps (chips).Appearance: Secondary processing methods like browning (e.g., baking or grilling) can give food a desirable golden colour, as seen in roasted vegetables or baked goods.Nutritional Properties:Fats and Oils: The addition of oils, fats, or sugar during secondary processing can increase the energy (calorie) content of food, but it may also contribute to unhealthy fat intake if consumed in excess. For example, frying vegetables in oil increases their fat content significantly.Added Sugar and Salt: Many processed foods, such as ready meals or canned soups, contain added sugars and salt to enhance flavour and preserve the food. This can lead to increased levels of salt and sugar in the diet, contributing to health issues like hypertension and obesity.Preservation of Nutrients: Cooking, especially at high temperatures, can degrade heat-sensitive nutrients like vitamins B and C. However, some nutrients, like lycopene in tomatoes, become more bioavailable after cooking.Fortification: Secondary processing may involve the addition of nutrients to improve the nutritional value of food. For example, breakfast cereals are often fortified with vitamins and minerals such as iron, folic acid, and vitamin D.How Processing Affects Sensory and Nutritional PropertiesProcessing has both positive and negative effects on the sensory and nutritional properties of food. The methods used in primary and secondary processing can alter the taste, texture, appearance, and nutritional content of food.Sensory PropertiesFlavour: Heat treatments like cooking or baking can bring out complex flavours in food. For example, roasting vegetables caramelises their natural sugars, making them sweeter. On the other hand, over-processing can cause the loss of delicate flavours, as seen in over-cooked vegetables that lose their original taste and texture.Texture: Processing methods like freezing can cause ice crystals to form inside foods, altering their texture. For example, frozen fruit may become mushy when thawed, while canned fruit can become soft and lose its firmness.Appearance: The visual appeal of food can change due to processing methods. For instance, fruits and vegetables that are frozen or dried may lose their bright colours due to exposure to air or heat. Conversely, some foods, like meat, develop an appealing browning during cooking processes like roasting or grilling.Nutritional PropertiesNutrient Loss: The longer food is exposed to heat, light, and air, the more likely it is that it will lose nutrients. For example, boiling vegetables can cause water-soluble vitamins like vitamin C to leach into the cooking water. This is why steaming is often preferred as a more nutrient-preserving cooking method compared to boiling.Preservation of Nutrients: Some processing methods, such as blanching before freezing, can help preserve nutrients in food. Similarly, fermenting food (such as making yogurt or sauerkraut) can enhance the nutritional value of foods by adding beneficial probiotics, which support gut health.Increased Nutrient Availability: Certain processing methods can make some nutrients more bioavailable. For example, cooking tomatoes increases the levels of lycopene, a powerful antioxidant, which is more easily absorbed by the body after heating.Fortification: Some processed foods are fortified with additional nutrients. For example, milk may be fortified with vitamin D, and cereals may be enriched with iron or B vitamins to help prevent deficiencies in the population.The primary and secondary processing stages of food production are vital for creating food that is safe, convenient, and appealing to consumers. While processing can enhance the sensory qualities of food, such as flavour, texture, and appearance, it can also have a significant impact on the nutritional properties. Nutrient loss, the addition of fats, sugars, or salts, and the potential for fortification all play important roles in determining the healthfulness of processed foods. Understanding how food processing affects both sensory and nutritional qualities is key to making informed decisions about diet and food choices. Back to top In a secondary fish processing plant, workers are involved in such tasks as the buttering, breading, stuffing and packaging of fish that has already been de-boned and filleted in a primary processing plant. 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For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Back to top In a secondary fish processing plant, workers are involved in such tasks as the buttering, breading, stuffing and packaging of fish that has already been de-boned and filleted in a primary processing plant. All the operations are organized on a conveyor line. The buttered sole line and the scallops line were selected as the most representative operations in a secondary fish processing plant. Back to top In addition to some of the hazards listed above, pain or injury from physical overexertion, repetitive manual tasks, or working in awkward positions is very common. A case study is presented below. Please also see the OSH Answers on Conveyors – ergonomics for more information. Back to top Tasks on the buttered sole line consist of spreading, buttering, breading, packaging, and wrapping filet of sole. Such tasks as buttering and breading are automated. 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Figure 3 - Packaging Prolonged standing, restricted flexibility of body position and repetitious twisting pose a risk for low back pain and lower leg discomfort. What is Wrapping? The wrapping of boxes is carried out by two workers using two sealing machines. Each worker processes about 3,000 boxes every shift (Figure 4). To complete the task, a worker has to: twist the body to the left to reach for the box on the conveyor twist the body to the right to insert box into cellophane bag press control button to activate sealer Figure 4 - Wrapping The task lasts approximately five seconds and is carried out while standing. What are the risk factors of Wrapping? The wrapping job poses a risk for repetitive motion injuries because of the poor layout of the work station, the fast pace of work dictated by the speed of the conveyor, and the design of the task, that does not allow workers to change activities throughout the whole shift. Workers are at risk for neck, shoulder and upper arm injuries because of restricted flexibility of body positions, highly repetitious movements of both arms above waist level and repetitive reaching sideways. Highly repetitive and forceful movements while handling one kilogram boxes with only one hand are potentially hazardous to the wrists. Prolonged standing and frequent twisting create hazards for low back and lower leg injuries. Back to top The scallops line consists of a variety of tasks with different levels of automation. Stuffing and rolling, wrapping and packaging are the most representative tasks for the scallops line. What is Stuffing? Stuffing consists of placing certain types of ingredients on a fillet (Figure 5) and then rolling the fillet into a ball shape (Figure 6). To complete the task, a worker has to: pick up a fillet and place it on the scale pick up a handful of stuffing and place it on the fillet roll the fillet place the stuffed fillet on the conveyor The task lasts approximately four seconds. Workers stand to perform this task for the entire shift. Figure 5 - Stuffing What are the risk factors of Stuffing? The stuffing job poses a risk for repetitive motion injuries because of the improper layout of the work station, limited control over the pace of work and a task design that does not allow workers to change activities throughout the work shift. Highly repetitive hand manipulation while stuffing puts workers at risk for injuries of the wrists. Figure 6 - Stuffing Highly repetitive movements of the upper limbs and sustained muscular tension in the neck and shoulder region create hazards for the neck, shoulders and arms. Prolonged standing and frequent twisting of the body create hazards for low back and lower leg injuries. What is Wrapping? Wrapping consists of putting the frozen fillet into a cellophane bag (Figure 7). The bag is opened by blowing air at it. To complete the task, a worker has to reach for a fillet from a revolving carousel put the fillet into the bag place the bag on a conveyor Figure 7 - Wrapping The task lasts approximately 1.5 seconds. Workers may perform this task for the entire shift. What are the risk factors of Wrapping? The extremely unsuitable layout of the workstation and the highly repetitive and fast movements required while wrapping make this task very hazardous for repetitive motion injuries. The neck and shoulder and every muscle and joint of the upper limbs are at risk. The low back is also at risk due to awkward body positions, asymmetric loading and frequent twisting. Prolonged standing in a stooped position due to the lack of foot clearance adds a risk for injury to the lower legs. What is Packaging? The packaging task consists of putting the individually wrapped fillet into boxes (Figure 8). To complete the task, a worker has to: reach for the fillet using both hands pick up the fillet from a revolving carousel place the fillets into boxes The task lasts approximately one second. Workers may perform this task for the entire shift. What are the risk factors of Packaging? Improper layout of the workstation, a fast pace of work and the task design create hazards for repetitive motion injuries. Figure 8 - Packaging The neck and shoulders, due to the sustained muscular load, are at the highest risk. Due to repetitive manipulation, the wrists are also at considerable risk

for injuries. Prolonged standing in a stooped position due to the lack of leg clearance makes packaging hazardous for low back and lower leg injuries. Back to top Poor workstation layouts, the conveyor-driven pace of work and the lack of variety of tasks through the work shift are the conditions that pose risks to develop repetitive motion injuries in a secondary fish processing plant. The Ergonomics section of OSH Answers has more information on RMI risk factors. One of the main risk factors is the repetitiveness of the work. To change the repetitive pattern of the work a worker needs to do different tasks. The assembly-line type of work in the secondary fish processing plant makes it difficult to build a variety of activities in the workers' duties. However, there are a few options to consider. Job rotation - Rotating jobs within one work shift can reduce the damaging effects of repetitive work. There are some benefits even where rotation occurs between similar tasks. The feeling of change reduces monotony and slows down the development of fatigue. Teamwork - The other possible approach is to use teamwork. Assigning the operation of the whole assembly line to a group of workers and giving them control of all aspects of the work improves attitude and work satisfaction which are important in preventing injuries. The recommendation for job rotation or team work applies to both the buttered sole and the scallops lines in the fish processing plant. If the re-designing of tasks is not possible, the implementation of 5 - 10 minute breaks every hour can lessen the impact of repetitive work. Awkward postures and movements due to unsuitable workstation designs are the second major area of concern. Back to top The buttered sole operation consists of: spreading packaging wrapping Spreading Workers involved in the spreading of fish are mainly exposed to repetitive movements and awkward body positions. To reduce awkward postures, provide shorter workers with platforms so that they can spread the fish with their arms below waist level. There should be enough foot clearance to allow workers to get as close as possible to the conveyor. Having a foot rest would allow workers to shift their body weight (Figure 9). Figure 9 - Spreading A sit/stand stool would reduce the stress on the legs and back due to prolonged standing. Also, wearing gloves when handling frozen fish would reduce the chance of losing manual dexterity from the cold. Packaging Workers involved in the packaging of the fish are exposed to repetitive movements and awkward body positions. To reduce awkward postures, it is necessary to rearrange the work materials (Figure 10). Tilting the container of fish would reduce bending the wrists and elevating the elbows. Placing the cartons in front of the worker would eliminate reaching sideways. Figure 10 - Packaging Shorter workers should use platforms so that they can pick up the fish with their arms at waist level. The work bench should have foot rests so that workers can shift their body weight. Anti-fatigue matting and a sit/stand stool would help to reduce the stress on the legs and back from prolonged standing. Wrapping Workers involved in the wrapping of boxes are exposed to repetitive and forceful movements and awkward body positions. To avoid using awkward postures, workers should pick up boxes with their arms at waist level. Shorter workers should use a platform. To reduce reaching sideways, it may be necessary to modify the flow of the conveyor (Figure 11). Figure 11 - Wrapping Workers should have enough foot clearance so that they can get close to the work bench. They should also have a foot rest to shift their body weight. Providing workers with anti-fatigue matting and a sit/stand stool would release stress on their legs and back due to prolonged standing. Back to top The scallops operation consists of: stuffing wrapping packaging Stuffing Workers involved in the stuffing of fillets are exposed to repetitive movements and awkward postures. To reduce awkward postures it is necessary to use platforms so that workers can use their arms at waist level. Reaching sideways can be reduced by rearranging the work materials. To avoid bending of the wrist, it is necessary to have the scale and the two containers at the same level as the work surface (Figure 12). Figure 12 - Stuffing Workers should have a foot rail to shift their body weight. Using a sit/stand stool and anti-fatigue matting would reduce the stress on the body due to prolonged standing. Wrapping Workers involved in the wrapping of the fillets are exposed to repetitive movements and awkward body positions. To eliminate the repetitive nature of the task requires a major engineering change - the aim would be to fully automate the task. However, the repetitive pattern of work can be changed by rotating workers to other tasks. It would also be beneficial to put into effect a break for every hour of work. This break should be used to relax the muscles. To reduce awkward body positions such as reaching, workers should have enough leg clearance so that they can get close to the work surface. The wrapping/sealing surface should be at the same height as the carousel (Figure 13). Provide shorter workers with platforms so that they can reach the scallops with their arms at waist level. A sit/stand stool would reduce the stress on the legs and back due to standing for a long time. Figure 13 - Wrapping Packaging Workers involved in the packaging of fillets are exposed to repetitive movements and awkward body positions. The repetitive pattern of work can be changed by rotating workers to other tasks. It would also be beneficial to put into effect a break every hour of work. This break should be used to relax the muscles. To reduce awkward body positions, workers should have enough leg clearance so that they can get close to the work surface (Figure 14). Workers should also have a foot rail to shift the weight of the body from one foot to the other. Platforms should be provided to shorter workers so that they can reach the scallops with their arms at, or below, waist level. A sit/stand stool would reduce the stress on the legs and back due to prolonged standing. Figure 14 - Packing Acknowledgement The Canadian Centre for Occupational Health and Safety in co-operation with the Government of Newfoundland and Labrador, Department of Employment and Labour Relations, Occupational Health and Safety Branch would like to acknowledge the participation of Burin Secondary Processing (A Division of Fishery Products International) who so freely gave their time and resources to assist us in the development of this case study. Fact sheet confirmed current: 2022-02-28 Fact sheet last revised: 2022-02-28 Fish and seafood processing and packaging is a valued industry in America. Many types of seafood products are available in the U.S., from shellfish captured in the ocean to freshwater fish from lakes. After fish is caught, it must be processed and packaged to reach consumers as an edible product. According to the National Oceanic and Atmospheric Administration (NOAA), Americans spent an estimated $102 billion for fishery products in 2017. Important species include salmon, halibut, tuna, lobster, shrimp, scallops, clams, crab, herring and oysters. Without the fish processing sector, many Americans wouldn’t have access to the seafood products they regularly enjoy. Processing is necessary to keep fish fresh long enough to reach the shelves in stores, restaurants and homes. What Is Fish Processing? Fish processing involves preparing fish and seafood for delivery to consumers. Once fish is harvested, it must undergo several steps before it’s ready to be sold in the market. The process includes gutting, filleting and packaging of the product. Fish is a highly perishable food, so it must be carefully handled from the moment it’s caught until it’s sealed in packaging material. Proper, efficient processing and packaging prevent deterioration and ensure a quality product. How Are Fish Processed? Fish processing generally involves the following steps: Sorting fish by size and species Loading fish into a machine to remove heads Moving fish to a cleaning machine to remove tails, scales and entrails Removing fins Washing thoroughly Fish processing may be done manually or by the use of processing machines. The details of the process can vary greatly depending on a company’s size and the fish species they handle. Manual vs. Automated According to the Food and Agriculture Organization of the United Nations (FAO), freshwater fish are often manually processed, with employees using a wide variety of knives. Workers must be highly skilled to manually process fish efficiently and safely. In general, manual processing is more common in small processing plants. Large plants require automated systems to yield abundant quantities quickly. Here’s a look at the different steps for both manual and automatic processes: Sorting and grading: Sorting fresh fish to classify species and check for damage and freshness is often a manual process. Grading fish size, on the other hand, is easily accomplished with machinery. Machine graders accurately and quickly sort fish. According to the FAO, automated grading is up to 10 times more efficient than manual grading. However, small plants often do not use automatic graders due to the cost of the machinery. Scaling: Scaling is another step that may be done manually, but it’s one of the hardest tasks because scales can be difficult to remove. Workers may scale fish using a hard brush or blade. Fish that are to be skinned or smoked do not need to be scaled. Some processing plants equip workers with electric handheld scalers. Electric scalers accelerate and simplify the process. De-heading: Freshwater fish may be de-headed manually. Usually, saltwater fish are de-headed on a machine. Manually de-heading large fish requires too much effort, and an automated de-heading machine must be used. De-heading machines typically use band saw blades, cylindrical knives or guillotine cutters. Gutting: The gutting of freshwater fish is also often done manually and is very labor-intensive. It includes cutting down the belly of the fish and removing the organs. A vacuum suction tool may be used to remove the entrails. Plants might utilize gutting machines to process certain species. Some machines provide an all-in-one solution and are capable of de-heading, cutting and removing the insides. Fin removal: Manual fin removal is a difficult process, particularly for large fish. An automated device made up of rotating disc knives accelerates the process. Slicing: Slicing fish into steaks is often done with a band saw. Large fish require mechanical slicing. There are many different types of slicing machines, such as ones that use several rotating circular knives. According to the FAO, a mechanical cutter can slice up to 40 fish a minute. Filleting and skinning: Plants might have a filleting machine that uses a rotating disc knife and conveyor belt to speed up the process. An automated tool for skinning consists of an oscillating knife powered by a small electric motor. Quality and Safety for Fish Processing One of the top concerns in the fish processing and packaging industry is spoilage. Fish quickly deteriorates, so steps must be taken immediately to extend shelf life. The process includes: Temperature control: Reducing the temperature to 32 degrees Fahrenheit slows down decomposition. Raw fish must be chilled in ice immediately after harvesting and be kept cool during the trip to the processing plant as well as throughout processing and distribution. Freezing is required to extend shelf life for a long time. Moisture control: Drying, salting and smoking reduces water content and makes a fish product suitable for consumption. Salting is a traditional method that’s often combined with drying and smoking. It’s also a low-cost way to preserve fish. Oxygen control: Fish may be vacuum-sealed to increase shelf life. Vacuum packaging deprives the fish product of oxygen, which prevents oxidation reactions and slows down spoilage. Microbial growth control: A processing plant might apply heat or increase acidity to kill bacteria and slow decomposition in fish products. Waste Management Waste management is another important aspect of fish and seafood processing. Treated fish waste can be turned into fish oil, animal feed, fertilizer and other value-added products. Fish waste must also be managed properly for environmental purposes. Fish plants generate large amounts of waste. It’s estimated that more than 50% of fish captured are not used as food. Fish waste mostly includes: Heads Bones Skin Internal organs Fish processing also produces large amounts of wastewater. Liquid waste, such as discarded water from washing stations, needs to be managed and disposed of properly. The liquids must be assessed to determine the best disposal method. Fish waste treatment may include methods such as hydrolysis, bioremediation, anaerobic digestion and filtration. Waste liquids undergo primary treatment, which removes materials that readily float or settle. Secondary treatment processes waste liquids after floating and settleable materials have been removed. Secondary treatment uses biological and chemical processes to change effluent and make it safer for the environment. Finished Products Packaging, labeling and distribution are the final stages of fish processing. Finished products may include: Fish fillets, steaks or loins Fish sticks or cakes Gutted whole fish, called drawn fish Scaled, gutted and ready-to-cook fish, or dressed fish Whole fish Shucked and cooked shellfish meat Fish roe Edible products are packed as refrigerated, frozen or canned items. Products can also be sold for further processing. Secondary processors use fresh or frozen fish and seafood products to add to other ingredients and create various salads, sandwiches and meals found in restaurants and stores. Seafood Packaging Types Packaging serves two main purposes: to attract customers and preserve products. Food processing plants have a wide range of packaging options to choose from, but it mostly depends on the type of product they manufacture. Common packaging types include: Stand-up pouches: Attention-grabbing stand-pouches offer convenience, reduce packaging costs and keep products fresh. Cans: Canning has been a long-used method to preserve processed fish. Tuna, salmon and sardines are commonly canned after processing. A tin can is sealed and heated to keep air out and preserve the food inside. Vacuum skin packaging: Vacuum skin packaging (VSP) forms a tight, clear film over a product to enhance its visual appeal and extend its lifespan. Multi-layer films: Multi-layer films create a tight seal to keep fish fresh. This type of packaging shows the product clearly, and the multiple layers help protect packages from punctures and abrasions. Individually quick frozen (IQF) packaging: IQF packaging is often used for frozen fish fillets and other frozen seafood products. IQF is usually available in bag format and may come in a variety of styles, such as the pillow shape or flat bottom. Packaging is often an automated process involving sophisticated machines that fill and seal product containers and bags. This process reduces the need for manual labor and speeds up the packaging stage. York Saw and Knife Co, Inc. Plays a Large Role in Seafood Processing and Packaging At York Saw and Knife Co, Inc., we proudly make blades used by automated machines that process fish and cut packaging. Our blades can be used for: De-heading, scaling, filleting, gutting and slicing machines Packaging cutting machines Custom solutions If you don’t see what you need for your fish and seafood processing plant, remember that we can make custom blades for just about any application. To learn more about our seafood processing knives or request a free quote, call us at 1-800-233-1969 or contact us online today. For businesses Mā ngā pakihi Food business Export Import Biosecurity Animals Agriculture Entertainment & Pop Culture Food Related Topics: food processing fish processing, preparation of seafood and freshwater fish for human consumption.fish processingWorkers processing fish on a conveyor belt. The word fish is commonly used to describe all forms of edible finfish, mollusks (e.g., clams and oysters), and crustaceans (e.g., crabs and lobsters) that inhabit an aquatic environment. Fish from the marine and freshwater bodies of the world have been a major source of food for humankind since before recorded history. Harvesting wild fish from fresh and marine waters and raising cultured fish in ponds were practices of ancient Egyptians, Greeks, and other Mediterranean peoples. Rudimentary processing techniques such as sun-drying, salting, and smoking were used by these ancient groups to stabilize the fish supply. Modern methods of processing and preservation have encouraged the consumption of many species of fish that are popular throughout the world. The majority of edible fish products are derived from the skeletal muscles (flesh), which represent more than 50 percent of the total body mass of these animals. The skeletal muscles of fish differ from those of mammals and birds in that they are largely composed of stacks of short bundles of muscle fibres called myomeres. The myomeres are separated by thin horizontal (myosepta) and vertical (myocommata) layers of connective tissue. The unique structure and thin connective tissue sheaths of fish muscle give the meat its characteristic soft, flaky texture. The skeletal muscles of fish are composed mostly of white, fast-twitch fibres. The high percentage of white fibres allows fish to swim with sudden, rapid movements and gives the meat its white colour. These fibres primarily metabolize glucose, a simple sugar released from muscle glycogen stores, for energy production through anaerobic (i.e., in the absence of oxygen) glycolysis. Therefore, white fibres contain relatively little myoglobin, the oxygen-binding protein that provides the red colour of muscles in other animals. The composition of fish may vary considerably—especially in their fat content—during certain growth periods and annual spawning or migration periods. In addition, the composition of fish bred in captivity (i.e., aquaculture fish) may vary according to their artificial diet. The table shows the nutrient composition of several types of fish.Nutrient composition of raw edible portion of fish species (per 100 g)species energy (kcal) water (g) protein (g) fat (g) cholesterol (mg) calcium (mg) iron (mg) riboflavin (mg) niacin (mg) Source: U.S. Department of Agriculture, Composition of Foods, Agriculture Handbook no. 8–11. catfish, channel (farmed) 135 75.38 15.55 7.59 47 9 0.50 0.075 2.304 cod, Atlantic 82 81.22 17.81 0.67 43 16 0.38 0.065 2.063 grouper, mixed species 92 79.22 19.38 1.02 37 27 0.89 0.005 0.313 haddock 87 79.92 18.91 0.72 57 33 1.05 0.037 3.803 halibut, Atlantic or Pacific 110 77.92 20.81 2.29 32 47 0.84 0.075 5.848 herring, Atlantic 158 72.05 17.96 9.04 60 57 1.10 0.233 3.217 mackerel, Atlantic 205 63.55 18.60 13.89 70 12 1.63 0.312 9.080 salmon, Atlantic 142 68.50 19.84 6.34 55 12 0.80 0.380 7.860 salmon, pink 116 76.35 19.94 3.45 52 — 0.77 — — trout, rainbow (wild) 119 71.87 20.48 3.46 59 67 0.70 0.105 5.384 tuna, bluefin 144 68.09 23.33 4.90 38 — 1.02 0.251 8.654 clam, mixed species 74 81.82 12.77 0.97 34 46 13.98 0.213 1.765 crab, blue 87 79.02 18.06 1.08 78 89 0.74 — — lobster, northern 90 76.76 18.80 0.90 95 — — 0.048 1.455 oyster, Pacific 81 82.06 9.45 2.30 — 8 5.11 0.233 2.010 scallop, mixed species 88 78.57 16.78 0.76 33 24 0.29 0.065 1.150 shrimp, mixed species 106 75.86 20.31 1.73 152 52 2.41 0.034 2.552 Fish are an excellent source of high-quality protein. Mollusks are generally lower in protein compared with finfish and crustaceans because of their high water content. The proteins found in fish are essentially the same as those found in the meat derived from other animals—that is, the sarcoplasmic proteins (e.g., enzymes and myoglobin), the contractile or myofibrillar proteins (e.g., actin and myosin), and the connective tissue proteins (i.e., collagen). Back to top In a secondary fish processing plant, workers are involved in such tasks as the buttering, breading, stuffing and packaging of fish that has already been de-boned and filleted in a primary processing plant. All the operations are organized on a conveyor line. The buttered sole line and the scallops line were selected as the most representative operations in a secondary fish processing plant. Back to top In addition to some of the hazards listed above, pain or injury from physical overexertion, repetitive manual tasks, or working in awkward positions is very common. A case study is presented below. Please also see the OSH Answers on Conveyors – ergonomics for more information. Back to top Tasks on the buttered sole line consist of spreading, buttering, breading, packaging, and wrapping filet of sole. Such tasks as buttering and breading are automated. Therefore, we will look only at the spreading, packaging and wrapping tasks. What is Spreading? The spreading task consists of scattering the frozen sole on the conveyor (Figure 1). Workers stand to perform this task for the entire shift. The conveyor is 82-104 cm high and 50 cm wide. To spread the fish on the conveyor, workers have to reach forward with their arms above waist level. They use the same movements over and over. Figure 1 - Spreading What are the risk factors of Spreading? Prolonged standing in a stooped position, repetitious reaching forward and twisting of the body put workers at high risk for low back injury. 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The assembly-line type of work in the secondary fish processing plant makes it difficult to build a variety of activities in the workers' duties. However, there are a few options to consider. Job rotation - Rotating jobs within one work shift can reduce the damaging effects of repetitive work. There are some benefits even where rotation occurs between similar tasks. The feeling of change reduces monotony and slows down the development of fatigue. Teamwork - The other possible approach is to use teamwork. Assigning the operation of the whole assembly line to a group of workers and giving them control of all aspects of the work improves attitude and work satisfaction which are important in preventing injuries. The recommendation for job rotation or team work applies to both the buttered sole and the scallops lines in the fish processing plant. If the re-designing of tasks is not possible, the implementation of 5 - 10 minute breaks every hour can lessen the impact of repetitive work. 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Figure 11 - Wrapping Workers should have enough foot clearance so that they can get close to the work bench. They should also have a foot rest to shift their body weight. Providing workers with anti-fatigue matting and a sit/stand stool would release stress on their legs and back due to prolonged standing. Back to top The scallops operation consists of: stuffing wrapping packaging Stuffing Workers involved in the stuffing of fillets are exposed to repetitive movements and awkward postures. To reduce awkward postures it is necessary to use platforms so that workers can use their arms at waist level. Reaching sideways can be reduced by rearranging the work materials. To avoid bending of the wrist, it is necessary to have the scale and the two containers at the same level as the work surface (Figure 12). Figure 12 - Stuffing Workers should have a foot rail to shift their body weight. Using a sit/stand stool and anti-fatigue matting would reduce the stress on the body due to prolonged standing. Wrapping Workers involved in the wrapping of the fillets are exposed to repetitive movements and awkward body positions. To eliminate the repetitive nature of the task requires a major engineering change - the aim would be to fully automate the task. However, the repetitive pattern of work can be changed by rotating workers to other tasks. It would also be beneficial to put into effect a break for every hour of work. This break should be used to relax the muscles. To reduce awkward body positions such as reaching, workers should have enough leg clearance so that they can get close to the work surface. The wrapping/sealing surface should be at the same height as the carousel (Figure 13). Provide shorter workers with platforms so that they can reach the scallops with their arms at waist level. A sit/stand stool would reduce the stress on the legs and back due to standing for a long time. Figure 13 - Wrapping Packaging Workers involved in the packaging of fillets are exposed to repetitive movements and awkward body positions. The repetitive pattern of work can be changed by rotating workers to other tasks. It would also be beneficial to put into effect a break every hour of work. This break should be used to relax the muscles. To reduce awkward body positions, workers should have enough leg clearance so that they can get close to the work surface (Figure 14). Workers should also have a foot rail to shift the weight of the body from one foot to the other. Platforms should be provided to shorter workers so that they can reach the scallops with their arms at, or below, waist level. A sit/stand stool would reduce the stress on the legs and back due to prolonged standing. Figure 14 - Packing Acknowledgement The Canadian Centre for Occupational Health and Safety in co-operation with the Government of Newfoundland and Labrador, Department of Employment and Labour Relations, Occupational Health and Safety Branch would like to acknowledge the participation of Burin Secondary Processing (A Division of Fishery Products International) who so freely gave their time and resources to assist us in the development of this case study. Fact sheet confirmed current: 2022-02-28 Fact sheet last revised: 2022-02-28 Process from catching to selling fish Humans have been processing fish since Neolithic times. This 16th-century fish stall shows many traditional fish products. The term fish processing refers to the processes associated with fish and fish products between the time fish are caught or harvested, and the time the final product is delivered to the customer. Although the term refers specifically to fish, in practice it is extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or fish farming. Larger fish processing companies often operate their own fishing fleets or farming operations. The products of the fish industry are usually sold to grocery chains or to intermediaries. Fish are highly perishable. A central concern of fish processing is to prevent fish from deteriorating, and this remains an underlying concern during other processing operations. Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish, and the manufacture of fish products. Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products for the retail and catering trades.[1] There is evidence humans have been processing fish since the early Holocene.[2] These days, fish processing is undertaken by artisan fishermen, on board fishing or fish processing vessels, and at fish processing plants. Tuna being processed with an Oroshi hocho tuna knife at the Tsukiji fishmarket. Fish is a highly perishable food which needs proper handling and preservation if it is to have a long shelf life and retain a desirable quality and nutritional value.[3] The central concern of fish processing is to prevent fish from deteriorating. The most obvious method for preserving the quality of fish is to keep them alive until they are ready for cooking and eating. For thousands of years, China achieved this through the aquaculture of carp. Other methods used to preserve fish and fish products include[4] ikejime method of fish slaughter the control of temperature using ice, refrigeration or freezing the control of water activity by drying, salting, smoking or freeze-drying the physical control of microbial loads through microwave heating or ionizing irradiation the chemical control of microbial loads by adding acids oxygen deprivation, such as vacuum packing. Usually more than one of these methods is used. When chilled or frozen fish or fish products are transported by road, rail, sea or air, the cold chain must be maintained. This requires insulated containers or transport vehicles and adequate refrigeration. Modern shipping containers can combine refrigeration with a controlled atmosphere.[4] Fish processing is also concerned with proper waste management and with adding value to fish products. There is an increasing demand for ready to eat fish products, or products that do not need much preparation.[4] Cleaning fish, 1887. By John George Brown. When fish are captured or harvested for commercial purposes, they need some preprocessing so they can be delivered to the next part of the marketing chain in a fresh and undamaged condition. This means, for example, that fish caught by a fishing vessel need handling so they can be stored safely until the boat lands the fish on shore. Typical handling processes are[3] transferring the catch from the fishing gear (such as a trawl, net or fishing line) to the fishing vessel holding the catch before further handling sorting and grading bleeding, gutting and washing chilling storing the chilled fish unloading, or landing the fish when the fishing vessel returns to port The number and order in which these operations are undertaken varies with the fish species and the type of fishing gear used to catch it, as well as how large the fishing vessel is and how long it is at sea, and the nature of the market it is supplying.[3] Catch processing operations can be manual or automated. The equipment and procedures in modern industrial fisheries are designed to reduce the rough handling of fish, heavy manual lifting and unsuitable working positions which might result in injuries.[3] Main article: Live fish trade An alternative, and obvious way of keeping fish fresh is to keep them alive until they are delivered to the buyer or ready to be eaten. This is a common practice worldwide. Typically, the fish are placed in a container with clean water, and dead, damaged or sick fish are removed. The water temperature is then lowered and the fish are starved to reduce their metabolic rate. This decreases fouling of water with metabolic products (ammonia, nitrite and carbon dioxide) that become toxic and make it difficult for the fish to extract oxygen.[3] Fish can be kept alive in floating cages, wells and fish ponds. In aquaculture, holding basins are used where the water is continuously filtered and its temperature and oxygen level are controlled. In China, floating cages are constructed in rivers out of palm woven baskets, while in South America simple fish yards are built in the backwaters of rivers. Live fish can be transported by methods which range from simple artisanal methods where fish are placed in plastic bags with an oxygenated atmosphere, to sophisticated systems which use trucks that filter and recycle the water, and add oxygen and regulate temperature.[3] See also: Fish preservation Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage.[5] To flourish, bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs. Preservation techniques can be classified as follows.[6] Ice preserves fish and extends shelf life by lowering the temperature See also: Refrigerating, Cold chain, and Freezing (food) If the temperature is decreased, the metabolic activity in the fish from microbial or autolytic processes can be reduced or stopped. This is achieved by refrigeration where the temperature is dropped to about 0 °C, or freezing where the temperature is dropped below -18 °C. On fishing vessels, the fish are refrigerated mechanically by circulating cold air or by packing the fish in boxes with ice. Forage fish, which are often caught in large numbers, are usually chilled with refrigerated or chilled seawater. Once chilled or frozen, the fish need further cooling to maintain the low temperature. There are key issues with fish cold store design and management, such as how large and energy efficient they are, and the way they are insulated and palletized.[6] An effective method of preserving the freshness of fish is to chill with ice by distributing ice uniformly around the fish. It is a safe cooling method that keeps the fish moist and in an easily stored form suitable for transport. It has become widely used since the development of mechanical refrigeration, which makes ice easy and cheap to produce. Ice is produced in various shapes; crushed ice and Flake Ice, plates, tubes and blocks are commonly used to cool fish.[3] Particularly effective is slurry ice, made from micro crystals of ice formed and suspended within a solution of water and a freezing point depressant, such as common salt.[7] A more recent development is pumpable ice technology. Pumpable ice flows like water, and because it is homogeneous, it cools fish faster than fresh water solid ice methods and eliminates freeze burns. It complies with HACCP and ISO food safety and public health standards, and uses less energy than conventional fresh water solid ice technologies.[8][9] Fish packed in ice Fish chilling with slurry ice. Fish cooling by pumpable ice Loading blocks of factory-made ice from a truck to an ice depot boat Ice delivered to boat down an Archimedes screw, Pittenweem Fish barn with fish drying in the sun – Van Gogh 1882 See also: Dried fish, Salted fish, and Smoked fish The water activity, aw, in a fish is defined as the ratio of the water vapour pressure in the flesh of the fish to the vapour pressure of pure water at the same temperature and pressure. It ranges between 0 and 1, and is a parameter that measures how available the water is in the flesh of the fish. Available water is necessary for the microbial and enzymatic reactions involved in spoilage. There are a number of techniques that have been or are used to tie up the available water or remove it by reducing the aw. Traditionally, techniques such as drying, salting and smoking have been used, and have been used for thousands of years. These techniques can be very simple, for example, by using solar drying. In more recent times, freeze-drying, water binding humectants, and fully automated equipment with temperature and humidity control have been added. Often a combination of these techniques is used.[6] Women drying fish, 1971 Dry fish market at Mohanganj Drying stockfish in Iceland Platforms, called fish flakes, where cod dry in the sun before being packed in salt Remains of Roman fish-salting plant at Neapolis Reconstruction of the Roman fish-salting plant at Neapolis Drying salted fish at Malpe Harbour Salt fish dip at Jakarta Heat or ionizing irradiation can be used to kill the bacteria that cause decomposition. Heat is applied by cooking, blanching or microwave heating in a manner that pasteurizes or sterilizes fish products. Cooking or pasteurizing does not completely inactivate microorganisms and may need to be followed with refrigeration to preserve fish products and increase their shelf life. Sterilised products are stable at ambient temperatures up to 40 °C, but to ensure they remain sterilized they need packaging in metal cans or retortable pouches before the heat treatment.[6] See also: Biopreservation and Fermented fish Microbial growth and proliferation can be inhibited by a technique called biopreservation.[10] Biopreservation is achieved by adding antimicrobials or by increasing the acidity of the fish muscle. Most bacteria stop multiplying when the pH is less than 4.5. Acidity is increased by fermentation, marination or by directly adding acids (acetic, citric, lactic) to fish products. Lactic acid bacteria produce the antimicrobial nisin which further enhances preservation. Other preservatives include nitrites, sulphites, sorbates, benzoates and essential oils.[6] Spoilage bacteria and lipid oxidation usually need oxygen, so reducing the oxygen around fish can increase shelf life. This is done by controlling or modifying the atmosphere around the fish, or by vacuum packaging. Controlled or modified atmospheres have specific combinations of oxygen, carbon dioxide and nitrogen, and the method is often combined with refrigeration for more effective fish preservation.[6] See also: Hurdle technology Two or more of these techniques are often combined. This can improve preservation and reduce unwanted side effects such as the denaturation of nutrients by severe heat treatments. Common combinations are salting/drying, salting/marinating, salting/smoking, drying/smoking, pasteurization/refrigeration and controlled atmosphere/refrigeration.[6] Other process combinations are currently being developed along the multiple hurdle theory.[11] "The search for higher productivity and the increase of labor cost has driven the development of computer vision technology,[12] electronic scales and automatic skinning and filleting machines."[13] Automatic knives for filleting fish Patent issued to Clarence Birdseye for the production of quick-frozen fish, 1930 Processing line for fish fingers Fish feed production in Norway Non edible fish scrap processing, 1884 Waste produced during fish processing operations can be solid or liquid. Solid wastes: include skin, viscera, fish heads and carcasses (fish bones). Solid waste can be recycled in fish meal plants or it can be treated as municipal waste.[14] Liquid wastes: include bloodwater and brine from drained storage tanks, and water discharges from washing and cleaning. This waste may need holding temporarily, and should be disposed of without damage to the environment. How liquid waste should be disposed from fish processing operations depends on the content levels in the waste of solid and organic matter, as well as nitrogen and phosphorus content, and oil and grease content. It also depends on an assessment of parameters such acidity levels, temperature, odour, and biochemical oxygen demand and chemical oxygen demand. The magnitude of waste management issues depends on how much waste volume there is, the nature of the pollutants it carries, the rate at which it is discharged and the capacity of the receiving environment to assimilate the pollutants. Many countries dispose of such liquid wastes through their municipal sewage systems or directly into a waterway. The receiving waterbody should be able to degrade the organic and inorganic waste components in a way that does not damage the aquatic ecosystem.[14] Treatments can be primary and secondary. Primary treatments: use physical methods such as flotation, screening, and sedimentation to remove oil and grease and other suspended solids.[14] Secondary treatments: use biological and physicochemical means. Biological treatments use microorganisms to metabolise the organic polluting matter into energy and biomass. "These microorganisms can be aerobic or anaerobic. The most used aerobic processes are activated sludge system, aerated lagoons, trickling filters or bacterial beds and the rotating biological contractors. In anaerobic processes, the anaerobic microorganisms digest the organic matter in tanks to produce gases (mainly methane and CO2) and biomass. Anaerobic digesters are sometimes heated, using part of the methane produced, to maintain a temperature of 30 to 35°C. In the physicochemical treatments, also called coagulation-flocculation, a chemical substance is added to the effluent to reduce the surface charges responsible for particle repulsions in a colloidal suspension, thus reducing the forces that keep its particles apart. This reduction in charge causes flocculation (ag

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Stewart KM (1994) "Early hominid utilisation of fish resources and implications for seasonality and behaviour" Journal of Human Evolution, 27: 229–245. United Nations Development Fund for Women (1993) Fish processing Food Technology Source Book Series (UNIFEM) Series, ISBN 978-1-85339-137-8. Wikimedia Commons has media related to Fish processing. University of California directory of academic and industry literature Fish Products Industry in Canada Retrieved from " Developed by: CCOHS (Canadian Centre for Occupational Health and Safety)Description: An example of applying ergonomics to food preparation in a fish processing plant. The resource briefly describes what a secondary fish processing plant does and some general hazards common to many workers in these plants. The resource details the demands and risks with two representative jobs (Buttered Sole and Scallops Line) by breaking the job into individual tasks and seeing how those tasks might put workers at risk for developing MSDs. Lastly, potential solutions are posed for the two jobs on a task-by-task basis.This is one of a series of 42 job-specific ergonomic applications created by this developer. You can access them by clicking on the “Back to Occupations and Workplaces” link at the top right of this resource.Keywords: fish, processing, plant, factory, conveyor, wrapping, packaging, repetitive, RSI, RMI, force, posture, duration, CCOHS