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**COURSE NAME: POST GRADUATE DIPLOMA IN HUMAN NUTRITION**

**ASSIGNEMENT 7**

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**PRINCIPLE OF FOOD PROCESSING AND STORAGE**

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**Question one**

**Explain why we need to know amount of water in a food as food processors**

Moisture content is a critical factor to consider in the food industry. The amount of water in a product affects the product’s **texture, shelf life, ease of processing,** and **cost to produce**. Snack foods, baked goods, pet food, and dried goods are just a few examples of products that are vulnerable to moisture content issues like these. In many cases, an easy loss-on drying (LOD) test will allow you to monitor the moisture content of these products ([Ranowsky](https://www.cscscientific.com/csc-scientific-blog/author/amanda-ranowsky). A. 2018).

Moisture content influences the [taste](https://www.foodqualityandsafety.com/article/designing-meat-flavor-texture/), [texture](https://www.foodqualityandsafety.com/article/designing-meat-flavor-texture/), weight, appearance, and shelf life of foodstuffs. Even a slight deviation from a defined standard can adversely impact the physical properties of a food material. For example, substances which are too dry could affect the consistency of the end product. Conversely, excess moisture may cause food material to agglomerate or become trapped in the piping systems during production. Also, the rate of microbial growth increases with total water content, possibly resulting in spoiled batches that need to be disposed of. However, water is also an inexpensive ingredient adding to the weight of the final product. Hence, obtaining an optimal analytical value for moisture is of great economic importance to a food manufacturer. For these reasons, food analysts engage in the delicate balancing of moisture and total solids to ensure consistent product quality, safety, and profitability (Appoldt. Y and Raihan. G, 2017),

Simple moisture analysis can be all it takes to improve the quality of your product. Let’s take a closer look at how moisture content affects each of these four product and production aspects.

**1) Moisture content and food texture**

Increased moisture content can make food products such as bread dough or fresh pasta sticky and difficult to manage. Products such as dry pet food can end up crumbly or mushy. On the other hand, if the product is too dry, lack of moisture can make it brittle, or hard as a rock. Determining the optimal moisture level for your product is critical for maintaining its ideal texture.

**2) Moisture content and shelf life**

Products that have higher moisture levels are prone to quick spoilage. Drying - otherwise known as reducing the amount of moisture in a product - has long been a popular method of preservation. Consider products such as dried fruits or dried meats. They are edible far longer in their dehydrated form than they would be fresh.

Lack of moisture can have a detrimental effect on food products too. Foods can become stale or harden to the point of inedibility if too much moisture is removed. Finding the right balance is key to maintaining the longest possible shelf life for your product.

**3) Moisture content and ease of processing**

This aspect is closely related to the issue of optimal food texture, because it is often the product’s texture that affects how well it will move through the processing line. A sticky dough, for instance, will be more difficult to distribute into individual portions than a drier, more malleable dough.

Sometimes, moisture content can affect the size of a product, such as with pet food pellets. These pellets soften and increase in size with the addition of water. If the processing line included a die with holes shaped for regular-sized pellets, the water-infused pellets would be too big to go through the holes. There would also be a risk of agglomeration in their softened state.

**4) Moisture content and cost of processing**

In addition to the increased costs that would result from delays in processing, such as those described above, there is another way that moisture content can affect the cost of processing. In some cases, ingredients are sold by weight. Higher moisture content equates to greater weight. If the ingredients are padded with extra moisture, they will be more expensive to purchase.

Any manufacturer of food products can benefit from understanding the moisture content of their product. Moisture content affects the product’s texture, shelf life, ease of processing, and cost to produce. Measuring the total moisture in their product gives manufacturers a simple tool for monitoring these four important aspects.

If you’re interested in adding moisture measurement to your testing process, take a look at the different moisture

**Question two**

**Discuss methods of food spoilage**

Food spoilage may be defined as any change that renders food unfit for human [consumption](https://www.merriam-webster.com/dictionary/consumption). It is a metabolic process that causes foods to be undesirable or unacceptable for human consumption due to changes in sensory characteristics. Spoiled foods may be safe to eat, i.e. they may not cause illness because there are no pathogens or a toxin present, but changes in texture, smell, taste, or appearance cause them to be rejected. Some ecologists have suggested these noxious smells are produced by microbes to repulse large animals, thereby keeping the food resource for themselves ([Burkepile DE](https://www.ncbi.nlm.nih.gov/pubmed/?term=Burkepile%20DE%5BAuthor%5D&cauthor=true&cauthor_uid=17168026). et al, 2006). These changes may be caused by various factors, including contamination by microorganisms, infestation by insects, or [degradation](https://www.merriam-webster.com/dictionary/degradation) by endogenous enzymes (those present naturally in the food). In addition, physical and chemical changes, such as the tearing of plant or animal tissues or the oxidation of certain [constituents](https://www.merriam-webster.com/dictionary/constituents) of food, may promote food spoilage. Foods obtained from plant or animal sources begin to spoil soon after harvest or slaughter. The [enzymes](https://www.britannica.com/science/enzyme) contained in the cells of plant and animal tissues may be released as a result of any mechanical damage inflicted during postharvest handling. These enzymes begin to break down the cellular material. The chemical reactions catalyzed by the enzymes result in the degradation of food quality, such as the development of off-flavours, the deterioration of texture, and the loss of nutrients. The typical microorganisms that cause food spoilage are bacteria (e.g., Lactobacillus), yeasts (e.g., Saccharomyces), and molds (e.g., Rhizopus).

Most natural foods have a limited life: for example, fish, meat, milk and bread are perishable foods, which means they have a short storage life and they easily spoil. Other foods also decompose eventually, even though they keep for a considerably longer time. The main cause of food spoilage is invasion by microorganisms such as fungi and bacteria.

**Physical Spoilage**: Physical damage to the protective outer layer of food during harvesting, processing or distribution increases the chance of chemical or microbial spoilage. The damage increases the chance of chemical or microbial spoilage and contamination because the protective outer layer of the food is bruised or broken, and microorganisms can enter the foodstuff more easily. For example, you may have noticed that when an apple skin is damaged, the apple rots more quickly. Examples of physical spoilage include:

* Staling of bakery products and components
* Moisture migration between different components
* Physical separation of components or ingredients
* Moisture loss or gain

**Chemical Spoilage:** When animal or vegetable material is removed from its natural source of energy and nutrient supply, chemical changes begin to occur which lead to deterioration in its structure. The two major chemical changes which occur during the processing and storage of foods and lead to a deterioration in sensory quality are lipid oxidation (rancidity) and enzymic browning. Chemical reactions are also responsible for changes in the colour and flavour of foods during processing and storage. Foods are of best quality when they are fresh, but after fruits and vegetables are harvested, or animals are slaughtered, chemical changes begin automatically within the foods and lead to deterioration in quality. Fats break down and become rancid (smell bad), and naturally-occurring enzymes promote major chemical changes in foods as they age.

**Microbial Spoilage:** These microorganisms (moulds, yeasts and bacteria) do not cause disease but they spoil food by growing in the food and producing substances which alter colour, texture and odour of the food, making it unfit for human consumption. For example, souring of milk, growth of mould on bread and rotting of fruit and vegetables. *Fungi* has been seen as a method of food spoilage, causing only an undesirable appearance to food, however, there has been significant evidence of various fungi being a cause of death of many people spanning across hundreds of years in many places through the world. Fungi are caused by acidifying, fermenting, discoloring and disintegrating processes and can create fuzz, powder and slimes of many different colors, including black, white, red, brown and green (Pitt, John I.; Hocking, Ailsa D, 2009)

**Enzymatic.** Enzymes native to plant and animal tissues or from microorganisms are responsible for changes in the texture, color, smell and appearance of foods e.g. microbial enzymes cause hydrolytic reactions, rancidity and browning in foods, and plant enzymes may cause over ripening of fruits and vegetables rendering them unsuitable for consumption.

**Question Three**

**Describe the process of food preservation by lowering the freezing temperatures.**

The term [food preservation](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/food-preservation) refers to any one of a number of techniques used to prevent food from spoiling. It includes methods such as canning, pickling, drying and freeze-drying, irradiation, pasteurization, smoking, and the addition of chemical additives. Food preservation has become an increasingly important component of the food industry as fewer people eat foods produced on their own lands, and as consumers expect to be able to purchase and consume foods that are out of season.

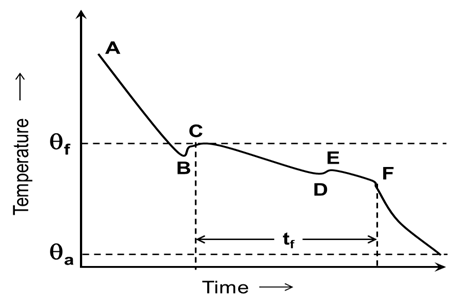
**Food preservation** involves preventing the growth of [bacteria](https://en.wikipedia.org/wiki/Bacterium), [fungi](https://en.wikipedia.org/wiki/Fungus) (such as [yeasts](https://en.wikipedia.org/wiki/Yeast)), or other [micro-organisms](https://en.wikipedia.org/wiki/Microorganism) (although some methods work by introducing benign [bacteria](https://en.wikipedia.org/wiki/Bacteria) or [fungi](https://en.wikipedia.org/wiki/Fungus) to the food), as well as retarding the [oxidation](https://en.wikipedia.org/wiki/Redox) of [fats](https://en.wikipedia.org/wiki/Fat) that cause [rancidity](https://en.wikipedia.org/wiki/Rancidification). Food preservation may also include processes that inhibit visual deterioration, such as the [enzymatic browning](https://en.wikipedia.org/wiki/Enzymatic_browning) reaction in apples after they are cut during food preparation. Food preservation of low temperature is a physical method of food preservation. Lowering the storage temperature of the food will reduce or prevent spoilage by microorganisms and/or chemical reactions.

RefrigerationTemperatures typically between 45 – 32°F (7.2 – 0°C). Preferably below 38°F.

Refrigeration or cold storage of food is a gentle method of food preservation. It has minimum adverse effects on the taste, texture, and the nutritional value of foods. It must be kept in mind, however, that refrigeration has a limited contribution towards preserving food. For most foods, we can expect refrigeration to extend the shelf-life by a few days. In many cases, refrigeration is not the sole means of preserving the food. Refrigeration temperature is a key factor in predicting the length of the storage period. For example, meat will last 6-10 days at 0° C, one day at 22° C and less than one day at 38° C. Household refrigerators are usually run at 4.7 -7°C. Commercial refrigerators are operated at a slightly lower temperature. On an average day, the room temperature is 25° C, so the longer you leave food on the kitchen counter, the sooner it will spoil. Most spoilage microorganisms prefer warmer temperatures, but there are a group of microorganisms called psychrophilicwhich will grow at refrigerated temperatures.

Refrigeration and freezing are used on almost all foods: meats, fruits, vegetables, beverages, etc. In general, refrigeration has no effect on a food’s taste or texture. Freezing has no effect on the taste or texture of most meats, has minimal effects on vegetables, but often completely changes fruits (which become mushy). Refrigeration’s minimal effects account for its wide popularity Kondratowicz. J, Matusevicius. P, 2002) Freezing preservation is one of the most beneficial preservation methods. It involves, conversion of liquid content of food into ice crystals, which lowers down water activity and microbial growth is arrested due to cold shock. Pure water is frozen at 0°C but since fruits and vegetables contain number of dissolved solids like sugars, acids, they freeze at below 0°C.

During freezing the commodity cools down below their freezing point but don’t freeze this phenomenon is called as *super cooling*. It is shown by AB phase of curve. At super cooled storage nuclei formation (*nucleation*) which is the first and most important step in ice-crystal formation in in freezing process. Here the temperature of water will be lower than 0°C but it will remain in liquid form. At this stage, further lowering of temperature result in the formation of ice crystals. The second step is called *crystal growth stage*. The release of heat of crystallization further enhances temperature (BC). Since food molecules contain substantial amount of solute hence, a progressive freezing occurs as depicted in Figure below. Various water molecules gather around nuclei and due to subsequent addition, crystal growth occurs. Nucleation may be either due to chance orientation of molecule or due to induction of nuclei from outside, but in fruits & vegetable mostly chance nucleation occur. In next step, crystal growth around these nuclei occurs and because of ice-crystal formation, heat of crystallization is generated, which cause increase in temperature of commodity. This *Tes* is shown by BC lines. So, time taken by freezing curve from initial cooling to E point of curve is known as*thermal arrest time*. It determines how quick or slow freezing process is. After this point more ice crystal formation takes place and temperature lowers down.



**Schematic diagram of freezing process**

Preservation by lowering the temperature of foods has important benefits in maintaining their sensory characteristics and nutritional value to produce high quality products.

**Question Four**

**Differentiate between Pasteurization and Sterilization.**

Foods consist of different major nutrients such as carbohydrate, protein, fat, minerals and vitamins. As a result of rich nutrient content in fresh foods, they are highly susceptible to microbial spoilage. Thus, food is often pasteurized or sterilized in order to destroy their pathogenic microbial load. Pasteurized and sterilized food can be stored for a longer period of time under refrigerated conditions or normal atmospheric conditions, respectively. **Sterilization is a temperature-based preservation technique referring to any process that removes or destroys all forms of life and other biological agents mainly in food items.**In contrast,**pasteurization is a temperature-based preservation technique referring to any process that removes or destroys all forms of pathogenic microorganisms mainly in food items.**Although this is the **main difference** between Pasteurization and Sterilization, the nutritional and organoleptic properties of these products may also differ between them. Thus, it is important to identify the difference between Pasteurization and Sterilization in order to select healthier options. In this article, let’s look at the difference between Pasteurization and Sterilization in terms of changes of nutrients and sensory parameters. (Feskanich, D., Willett, W. C., Stampfer, M. J. and Colditz, G. A. 1997), Brown, Amy Christian (2007), Montville, T. J., and Matthews, K. R. (2005) and Wilson, G. S. (1943).

**Pasteurization** is a process in which water and certain packaged and non-packaged foods (such as [milk](https://en.wikipedia.org/wiki/Milk) and fruit [juice](https://en.wikipedia.org/wiki/Juice)) are treated with mild heat, usually to less than 100 °C (212 °F), to eliminate [pathogens](https://en.wikipedia.org/wiki/Pathogen) and extend shelf life. The process is intended to destroy or deactivate organisms and [enzymes](https://en.wikipedia.org/wiki/Enzyme) that contribute to [spoilage](https://en.wikipedia.org/wiki/Food_spoilage) or risk of disease, including vegetative [bacteria](https://en.wikipedia.org/wiki/Bacteria), but not bacterial [spores](https://en.wikipedia.org/wiki/Spore) (Fellows, P. J. , 2017 & Tewari, Gaurav; Juneja, Vijay K. 2007). Since pasteurization is not sterilization, and does not kill spores, a second "double" pasteurization will extend the quality by killing spores that have germinated. Pasteurization is a process that kills the pathogenic bacteria by heating to a certain [temperature](http://www.differencebetween.net/science/difference-between-temperature-and-thermal-energy/) for a set period of time. Pasteurization only destroys the vegetative forms of the bacteria. After the pasteurization, the products have to be stored in a refrigerator to prevent the development of the survived saprophytic bacteria. However, Sterilization can be defined as any process that eliminates or destroy all forms of microorganisms and other biological agents (such as spores) present in a specified region, such as a food item, surface, a volume of fluid, packaging material, medication, instruments or in a biological culture media. Sterilization can be accomplished with one or combination of these food technologies such as heat, chemicals, [irradiation](https://pediaa.com/difference-between-radiation-and-irradiation/), high pressure, and filtration. Sterilization is different from disinfection, sanitization, and pasteurization process in that sterilization eradicates, disables, or removes all forms of life and other biological agents. Therefore, the differences between pasteurization and sterilization as summarized as below.

**Definition:** Pasteurization is the process of heating liquid to a specific temperature for a specific time period to reduce microbial growth while Sterilization is the process of eliminating all bacterial growth from various objects.

**History: Sterilization,** Food sterilization was discovered by Nicolas Appert. He discovered canning of foods which has helped to reduce foodborne illness. Pasteurization was developed by French scientist Louis Pasteur during the nineteenth century.

**Process:** Pasteurization Heats liquid to a set temperature below boiling point and then cool quickly meanwhile in sterilization, Heat or chemicals used to kill all various types of bacteria

**Different types:** Sterilization can be accomplished with one or combination of heat, chemicals, irradiation, high pressure, and filtration. Autoclave is a widely used method for heat sterilization and it generally uses the following time-temperature combination 121 °C at 100 kPa for about 3 to 15 minutes, to sterilize a product. while Pasteurization can be accomplished with heat. Milk, for example, can be pasteurized to three different stages. They are ultra-high temp (UHT), high-temperature-short-time (HTST) and low-temp long time (LTLT).

**Taste:** In Pasteurization, Taste of the food remains the same while Sterilization alters the taste of the food

**Eliminates:** Pasteurization only eliminates pathogenic microorganisms. So pasteurized products should be stored under refrigerated conditions. If the product is exposed to the microbial growth desirable environment conditions pasteurized food may be contaminated while Sterilization eliminates all various types of microbial growth including bacteria, fungi, viruses including their spores

**Application:** Sterilization is mainly applied in the food industry, medical surgery, Packaging industry, microbiology, etc. while Pasteurization is mainly applied in food industry (food preservation method)

**Question Five**

**List the qualities that a packaging material should fulfil. discuss CAP and ROP**

Food packaging is a dynamic system of the food product, packaging material, visual and structural designs, transportation and distribution. A number of packaging materials are introduced to provide desirable functions within the packaging system for numerous types of food products. In most commercial food products, paper and paperboard and plastics are primary packaging materials. Metal and glass are also widely used for various liquid and semi-solid food products. Sustainability concern in the food industry, which is a global hot topic in general, drives the more use of sustainable packaging materials such as bioplastics and bio-based materials which are either synthetized or naturally originated. The appropriate selection of packaging material is a most important factor for assurance of the safety and quality of food. Typically, the process primarily relies on the characteristics of major packaging materials (paper and paperboard, plastics, glass and metal) and their compatibility with food products. Typical properties for the food packaging system fall into the gas barrier property, mechanical, thermal, rheological, morphological, optical and physical properties. Gas barrier property is often considered as the most important factor to ensure the [shelf-life of food](https://www.sciencedirect.com/topics/food-science/shelf-life-of-foods) products (**Teck Kim, Y., Min, B., Won Kim, K, 2013).**

In selecting a packaging material, it is important to determine what the material should do for the product, how it will be transported, who will be unpacking the product and how. Wageningen Food & Bio based Research studies the properties of packaging materials to develop sustainable packaging with an optimal chain performance.

With the ease of carrying, storing and transmitting, packaging materials must be reliable, durable and trustworthy. For plastic packaging materials to be ideal there are certain properties and features that are very essential.

The key main features that packaging materials manufactured and supplied are as follows

**1. Extra Strong**

The plastic packaging materials are manufactured in high strength opaque, from 60 microns to 100 microns’ thickness options, co-extruded polyethylene film. To strengthen more and increase the security of your valuables we provide a thick seal or solid flat seal at the borders. This gives extra security and strength to the plastic packaging materials.

**2. Moisture Resistant**

The plastic packaging materials are made up of polyethylene which is moisture resistant, it doesn’t allow the outside moisture or water to enter inside thus keeping your valuables safe and secured from outside climatic conditions.

**3. Recyclable**

With increasing awareness and our concern for the environment, we manufacture plastic packaging materials with optimal thickness and quality material which are easily recycled and reused to make other different packaging or other materials.

**4. Writable Surface**

We understand your situation when you don’t understand which bag or carton contains what. Similarly, the difficulty faced in while attaching the shipment address. To help you resolve, the plastic packaging materials are made in such a way that it gives a smooth writable surface on which it is easy to write with ball point pen or permanent marker.

**5. Light Weight**

While in transit we try to reduce weight as much as possible so that it is easy to carry. We manufacture plastic envelopes and bags that has very low self-weight without compromising on the strength.

**CAP & ROP**

* **Controlled Atmosphere Packaging (CAP)**

Controlled Atmosphere Packaging (CAP)is an active system which continuously maintains the desired atmosphere within a package throughout the shelf-life of a product by the use of agents to bind or scavenge oxygen or a sachet containing compounds to emit a gas. Controlled Atmosphere Packaging (CAP) is defined as packaging of a product in a modified atmosphere followed by maintaining subsequent control of that atmosphere. It is also defined as **Steady state environment comprising of a special blend of oxygen, nitrogen, and carbon dioxide, monitored and maintained to extend the shelf life of certain products in a warehouse or storage area.**

The only types of controlled atmosphere packagings currently used with raw meats are those in which an anaerobic atmosphere is maintained indefinitely. Controlled atmosphere packagings may be used for bulk product or items of irregular shape, such as whole lamb carcasses, or as master packs for retail-ready product. Controlled atmosphere packaging is not suitable for individual trays of retail-ready product because of the undesirable colour of anoxic meat, and because packaging materials that are impermeable to gases are mostly opaque. Readily available films that are essentially gas impermeable are laminates that incorporate a layer of [aluminum foil](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/aluminum-foil), laminates with two layers of a metallised film, or laminates with unusually thick layers of plastics with high barrier properties (Kelly, 1989).

* **Reduced Oxygen Packaging (ROP)**

ROP which stands for Reduced oxygen packaging, is the process of placing food into a package, removing the oxygen from the package and sealing it, to keep food fresher for a longer time. Packaging that reduces the normal amount or proportion of oxygen (21%) found in air such that it creates anaerobic conditions that favor the growth of C. botulinum.

ROP techniques include:

* **Vacuum Packaging**. Food is placed in a bag or packaging and the oxygen (air) is removed using a special vacuum packaging machine. The package is heat sealed or crimped closed. It is sometimes defined as mechanical removal of air from packaging that prevents the transport of oxygen and sealing to prevent reentry of air.
* **Cook-Chill**. Cooked food is portioned into bags while hot. The bags are sealed or crimped closed, rapidly chilled and refrigerated. The cooking and cooling process removes oxygen from the package.
* **Sous Vide**. Raw or partially cooked food is sealed in a bag then cooked, usually at or near the desired final cooking temperature. Cooking the food in the sealed bag removes the oxygen. The cooked food can be removed from the bag and served, hot held for service or rapidly chilled and held under refrigeration until reheated for service.

ROP which provides an environment that contains little or no oxygen offers unique advantages and opportunities for the food industry but also raises many microbiological concerns. Products packaged using ROP may be produced safely if proper controls are in effect. Certain dangerous bacteria such as *Clostridium botulinum* and *Listeria monocytogenes* grow well in reduced oxygen environments. When ROP is not done correctly, these bacteria can grow in the packaged food, making people seriously ill. Proper precautions must be taken for ROP to be carried out safely.

**Benefits of ROP**

ROP can create a significantly anaerobic environment that prevents the growth of aerobic spoilage organisms, which generally are Gram negative bacteria such as Pseudomonads or aerobic yeast and molds. These organisms are responsible for off-odors, slime, and texture changes, which are signs of spoilage. ROP can be used to prevent degradation or oxidative processes in food products. Reducing the oxygen in and around a food retards the amount of oxidative rancidity in fats and oils.

ROP also prevents color deterioration in raw meats caused by oxygen. An additional effect of sealing food in ROP is the reduction of product shrinkage by preventing water loss. These benefits of ROP allow an extended shelf-life for foods in the distribution chain, providing additional time to reach new geographic markets or longer display at retail. Providing an extended shelf-life for ready-to-eat convenience foods and advertising foods as "Fresh-Never Frozen" are examples of economic and quality advantages.

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