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CAS JAMAICA

FOOD SAFETY NEWSLETTER

IN THIS ISSUE

A letter from the editor

by Andrea Goldson-Barnaby

In our last issue we spoke about the various challenges experienced during the pandemic. Are there however any new and emerging trends in the Food Industry during these unprecedented times? One emerging area that is being observed is that of an increase in food delivery services. There has been a surge in the number of food delivery options available for both processed and unprocessed foods. Food delivery and take out services have increased. In the food service industry a new and emerging trend is the operation of Cloud Kitchens also referred to as Ghost Kitchens. This concept involves the preparation of meals for delivery under a virtual brand. These brands are sold exclusively online. Orders are placed and deliveries made to the consumer reducing overhead costs associated with dine in restaurants. In Jamaica food delivery services such as QuickPlate and the 7Krave app are available. An E-commerce National Delivery Solution (ENDS) Pilot Programme was also launched which allows the delivery of essential items to consumers.

Other emerging trends in the food industry include vertical farms and sustainable packaging. In vertical farming, plants are grown vertically in a controlled environment to maximize growth. Soilless medium such as aquaponics and hydroponics is utilized to nourish the plants. Chambers Hydro Farms located in Spur Tree, Manchester utilizes hydroponics to grow fruits and vegetables. The farm specializes in the growth of grapes and strawberries.

Figure 1. Vertical Farming

In a bid to protect our environment consumers are encouraged to utilize sustainable packaging. This involves the use of biodegradable material such as paper and bamboo. Locally the government has banned the use of single use plastic bags. These plastic bags which are not biodegradable, when not properly disposed of get leached into our waterways and can harm the environment. Microplastics, which are produced, are very small pieces of plastics measuring less than 5 millimeters. These small plastic particles can harm aquatic life and infiltrate our food system. They are therefore ingested and are present in our bodies. What is unclear is the possible side effects from ingesting these small microplastics. Researchers believe that the ingestion of plastics can lead to the release of harmful chemicals, for example, phthalates and bisphenol in our bodies.

Figure 2. Bamboo cutlery

Phthalates, also known as plasticizers, are utilized to enhance plastic durability. One reported side effects from the ingestion of phthalates and bisphenol is hormonal imbalance. Ways in which we can reduce the intake of microplastics include:

1. Reducing the intake of bottled water
2. Eating more fresh foods
3. Not heating foods in plastic containers
4. Avoid the use of plastics which are known to be the cause of various health issues
5. Proper disposal of plastics
6. Recycling
7. Use of eco friendly packaging

Bamboo (*Bambusa vulgaris*), is from the grass family Poaceae and has origins in Asia. The plant is currently utilized in the manufacture of a wide array of products ranging from cutlery, plates to furniture. Advantages afforded from the use of bamboo in the manufacture of these products include its biodegradability, durability and cost effectiveness. No toxic chemicals are utilized in the manufacturing process. The plant also readily grows and regenerates. Bamboo Bioproducts Ltd, located in Westmoreland Jamaica has the capacity to produce in excess of 250,000 metric tonnes of bamboo pulp annually. This is the first bamboo mill located in the Western hemisphere.

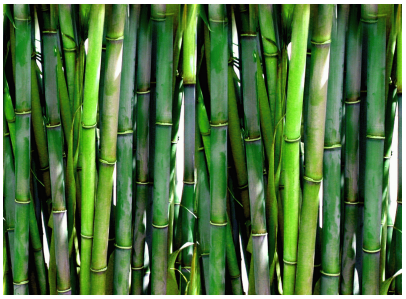

Figure 3. *Bambusa vulgaris*

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Mangroves

by Andrea Goldson-Barnaby

Mangroves are one of the most productive areas in Jamaica. There are different species of mangroves such as red, black, white and buttonwood. Red mangroves can be found growing along the coastline of Jamaica in saline or brackish water where conditions are harshest. These mangroves possess prop roots which provide stability to the plant and improve the oxygen supply of underground roots. Being salt tolerant, mangroves are also referred to as halophytes. Mangroves serve as a habitat to aquatic species such as our young fish and oysters. They also protect us from storm surges and coastal erosion. Mangroves play an important role in ecological sustainability. Recently we heard about the destruction of mangroves in Negril, Jamaica for the development of a new hotel. This summer we hosted a Mangrove Art Competition for secondary school students to bring an awareness of the importance of mangroves to the environment. Below are entries for the competition. Our winners are Grade 9 students Maria Angus, Shania Norman and Lasonya Graham from Muschett High School in Wakefield, Trelawny. The competition was sponsored by the American Chemical Society.

Mangroves, a habitat for birds and fishes

1st Maria Angus
Muschett High School,
Wakefield, Trelawny

Mangroves protecting us from storm surges

2nd Shania Norman
Muschett High School,
Wakefield, Trelawny

Mangroves with prop roots

3rd Lasonya Graham
Muschett High School,
Wakefield, Trelawny

Why Does Grandma Put Her Bread in the Freezer?

By Jacquél Johnson

When I was younger, I always wondered why my Grandmother would put bread in the freezer. Bread is not eaten frozen, was she trying to make a bread popsicle? Years later, having gained knowledge of food science, I now know that grandma's generation was using a clever technique to preserve the quality of the bread.

What causes bread quality to deteriorate?

Two major processes contribute to the deterioration of bread: Spoilage and Staling. Spoilage refers to the deterioration of food to the point where it is no longer palatable or edible (this is seen when bread goes mouldy). It is caused by small organisms that cannot be seen with the naked eye known as microorganisms. Staling is a process that happens in starchy foods, such as bread. It results in a change from the original desirable texture of the food to a hard, dry and unpalatable texture ("Staling", 2021).

Why Freezing?

Grandma would have realized that freezing it prevents both Spoilage and Staling, but how? To explain this, we must understand the science behind Spoilage and Staling.

The Science Behind Spoilage

As mentioned before, spoilage is caused by microorganisms. There are several types of microorganisms including bacteria, mould, yeast and viruses. Special microorganisms known as spoilage microorganisms specifically target the types of foods that humans consume. When this happens, the food may change in texture, odour and flavour making it unpalatable and, in some cases, completely inedible (Gram et al., 2002). Therefore, if we want to be able to store our food over time, we have to find ways to control spoilage microorganisms.

How Do We Control Spoilage Microorganisms?

To control them we must understand the factors that make them grow in the first place. In the food processing industry, we utilize the acronym FATTOM (Food, Acidity, Time, Temperature, Oxygen and Moisture) to remember this:

Food – Organisms need food to survive. Food contains nutrients that are needed for organisms to grow and thrive.

Acid - Most microorganisms do not like acidic environments, therefore the higher the acidity of a food the lower the rate of spoilage.

Time - Spoilage naturally occurs over time as microorganisms get the opportunity to grow.

Temperature – Spoilage Microorganisms thrive at room temperature (20-30 °C) but grow much more slowly at refrigerator temperatures (0-8°C) (Fellows, 2000). At freezer temperatures (≤18 °C) growth is immobilized and at high temperature (e.g. boiling at 100 °C) spoilage microorganisms are destroyed.

Oxygen – Most spoilage organisms are aerobic, which means they need oxygen in their environment to survive. If you were to completely remove all oxygen from the environment, these aerobic microorganisms would not survive.

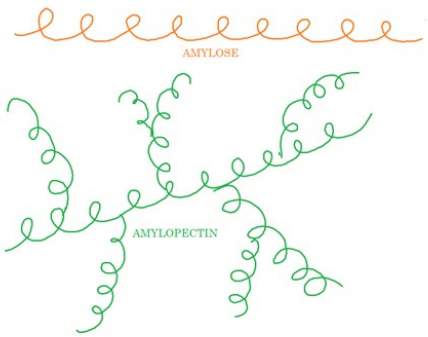
Moisture – Water is needed for all living organisms to thrive. If water is unavailable, spoilage microorganisms will not grow.

The parameters of Food, Acid and Oxygen are near impossible to control at home. Bread is rich in nutrients and is a low-acid food and so will always be susceptible to spoilage.

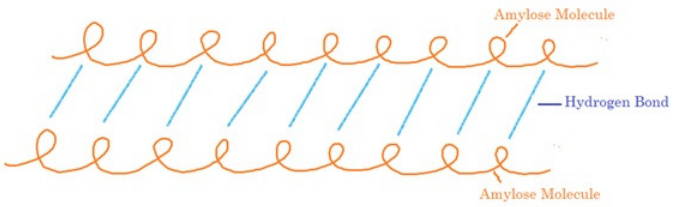
Oxygen is present throughout the home environment; it can penetrate storage containers and bread bags as they do not provide a vacuum seal. Special technology known as Modified Atmosphere Packaging (MAP) would have to be used to eliminate oxygen from your bread storage container. As we are looking for ways to store bread, consuming it in a short time (before microorganisms like mould can take it over) is not an option either. Therefore, Moisture and Temperature are the parameters of focus. Moisture can largely be avoided by storing in a dry environment. High temperatures such as boiling would degrade the texture and palatability of the bread and so low temperatures would be more suitable. Therefore, you may think to store your bread in the refrigerator. While refrigerating bread does effectively delay spoilage, you may notice that your bread becomes hard and dry very quickly. That is because as storage temperature decreases, staling occurs more rapidly (Gray & Bemiller, 2003). However, once you reach freezing temperatures, staling stops. Why is this? To understand this, we must delve into the science of staling.

The Science Behind Staling

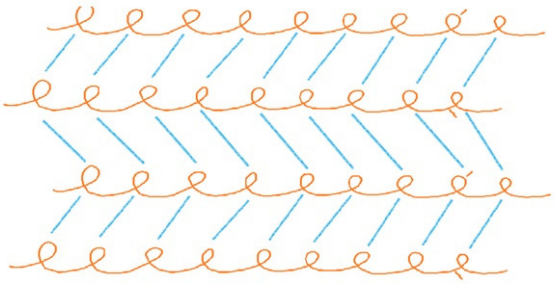
Staling is a process that is unique to starch-rich foods such as bread (Bread is about 70% starch). Therefore, to understand staling we have to look at the chemistry of starch. Starch is a large molecule or macromolecule made up of several small chains. Starch contains two types of chains: amylose (a straight chain) and amylopectin (a branched chain).



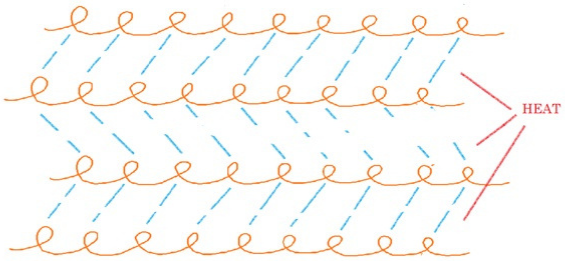
These chains form bonds together known as hydrogen bonds.



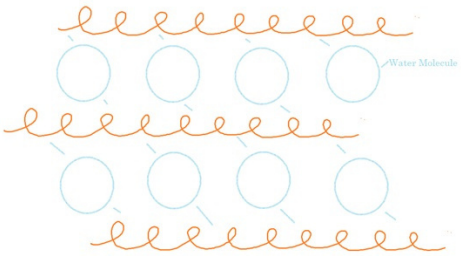
Because amylose molecules form straight chains, they are able to form many hydrogen bonds with each other and "stack" upon each other closely in an orderly fashion. This is known as crystallization.



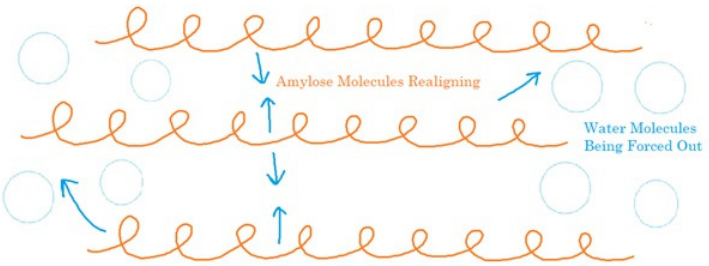
When heat is applied to starch in the presence of water (such as when flour and water are mixed to make dough and baked into bread), the hydrogen bonds that hold up the "stacked" structure of amylose begin to break.



As these bonds break, water molecules insert themselves in the spaces between the amylose chains where the hydrogen bonds were. The space between the amylose chains expands and the starch becomes swollen and hydrated via a process known as gelatinization.



This gelatinization is what gives freshly baked bread its soft, tender texture as opposed to the coarse texture of raw flour. As the bread begins to cool down however, the straight-chained molecules begin to draw closer together again. As they increase in proximity, they force out the water molecules that were absorbed between the chains and slowly return to their "stacked" or crystalline state. This process is known as Retrogradation. As water leaves the starch molecules they begin to evaporate from the surface of the bread, leaving it tough and dry or "stale" as we know it.



Cooling happens more rapidly at refrigeration temperatures, causing the amylose molecules to align themselves and push out water at a faster rate. So, while the rate of spoilage may be reduced, the rate of staling rapidly increases.

Why Grandma Was a Genius

This brings me back to my grandmothers' clever solution. If you wish to store bread for an extended period, freezing may be the better option. Freezing immobilizes the water molecules in the bread. When water molecules reach freezing temperatures, they begin to align themselves in a fixed and organized (crystalline) structure (Berk, 2009). The combination of low temperatures and immobilized water suspend the growth of spoilage microorganisms while also maintaining the water absorbed by the starch molecules in a fixed position, inhibiting retrogradation. When the bread is removed from the freezer and thawed the water molecules rehydrate the bread reinstating its soft texture. It looks like Grandma, in her own way, was a food scientist after all!

References

Berk, Z. (2009). Food Process Engineering and Technology (1st ed., pp. 391-400). Burlington, MA, USA: Elsevier.

Definition of food spoilage in Microbiology. (2020). http://kolibri.teacherinabox.org.au/modules/en-boundless/www.boundless.com/definition/food-spoilage/index.html#:~:text=Food%20Spoilage%20by%20Microbes&text=edibility%20becomes%20reduced.-,Food%20spoilage%20is%20the%20process%20in%20which%20food%20deteriorates%20to,quality%20of%20edibility%20becomes%20reduced%20.

Fellows, P. (2000). Food Processing Technology - Principles and Practice (2nd ed., pp. 387-389). Abington Hall, Abington Cambridge CB1 6AH, England: Woodhead Publishing Limited.

Gram, L., Ravn, L., Rasch, M., Bruhn, J., Christensen, A., & Givskov, M. (2002). Food spoilage—interactions between food spoilage bacteria. International Journal Of Food Microbiology, 78(1-2), 79-97. doi: 10.1016/s0168-1605(02)00233-7

Gray, J., & Bemiller, J. (2003). Bread Staling: Molecular Basis and Control. Comprehensive Reviews In Food Science And Food Safety, 2(1), 1-21. doi: 10.1111/j.1541-4337.2003.tb00011.x

Staling. (2021). https://en.wikipedia.org/wiki/Staling

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Phosphates in meats

by Kimberley Cole

The quantity of phosphate in meat is important to manufacturers because of the health concerns associated with its inclusion in meat products such as poultry. High intake of phosphate leads to the accumulation of phosphate in the blood which can lead to illnesses such as cardiovascular diseases, hyperphosphatemia, calcification of blood vessels, and bone disease. Phosphate levels are not included on labels and as such consumers are not aware of the quantity they consume on a daily basis. This could be detrimental especially for patients with chronic kidney disease. There is therefore a need for closer monitoring of the phosphate levels in processed foods.

Meats have been marinated historically, to improve flavour, tenderness, shelf life, stability and the safety of meat. Marination also enhances meat yield and water binding capacity. Food processors use different phosphates to retain marinade in meats as the phosphate blend is specific to its application. Phosphates occur naturally as organic esters in different types of foods. They are bound organically and are partially absorbed in the gastrointestinal tract. They are important for human development because they facilitate growth, maintenance and repair of tissues and cells in living organisms.

Pyrophosphate and tripolyphosphate are the most frequently used types of phosphate to increase water binding and meat capacity. Since phosphates offer a wide range of functional properties to processed meat, they are the preferred choice for meat processors. Approximately 80% of the phosphate used in further processed products made from meats is sodium tripolyphosphate. The synergistic effect between phosphates and sodium chloride is very strong in marinades and hence they are combined to improve texture and muscle yield (Mudalal et al., 2014; Glorieux et al., 2017).

Consumers and producers both benefit from the actuality that marinade increases meat yield. Marinade is beneficial for meat texture as it makes it juicier and reduces water loss during cooking. The water binding capacity of phosphates reduces drip loss, cooking loss, thaw loss and solubilize actomyosin (Alvarado & McKee, 2007). Marinades utilized commercially in poultry processing mainly contain the polyphosphates, pyrophosphate and tripolyphosphate (Xiong and Kupski, 1999). Studies have shown that polyphosphates are multifunctional when used in chicken products as they not only enhance water-holding capacity, but decreases cooking loss and improves texture scores. Previous studies have demonstrated that increased moisture retention induced by phosphates is achieved by muscle fiber expansion.

The growing availability of processed food and the increased use of additives containing phosphorous by food manufacturers has aroused health concerns. The excessive intake of phosphorous in the diet especially from processed meats contributes to the accumulation of phosphorous in the blood. This accumulation leads to phosphate toxicity and a wide range of cellular and tissue injuries.

Diseases such as hyperphosphatemia, secondary hyperparathyroidism and chronic kidney disease may also develop as a result of excess phosphorous intake. Excessive retention of phosphate in the body of patients with chronic kidney disease can encounter a higher occurrence of vascular calcification (Razzaque, 2011). Phosphate toxicity can accelerate the mammalian aging process by causing tissue damage and reducing survival. According to Uribarri and Calvo, (2003) the average daily dietary intake of phosphorous is approximately 1550 mg for males and 1000 mg for females.

These figures are changing as phosphates are now added to many processed foods such as meats, cheeses, dressings, beverages and bakery products. As a result, additives may increase one's phosphorous intake to 1 g/day depending on the food choices. The quantity of phosphate additives utilized in food products therefore needs to be regulated. Consumers also need to be aware of the levels of phosphates that they are consuming on a daily basis as this can have a negative impact on ones health.

References

Alvarado, C., & McKee, S. (2007). Marination to improve functional properties and safety of poultry meat. Journal of Applied Poultry Research, 16(1), 113-120.

Glorieux, S., Goemaere, O., Steen, L., & Fraeye, I. (2017). Phosphate reduction in emulsified meat products: Impact of phosphate type and dosage on quality characteristics. Food Technol. Biotechnol. 55(3), 390–397.

Mudalal, S., Petracci, M., Tappi, S., Rocculi, P., & Cavani, C. (2014). Comparison between the quality traits of phosphate and bicarbonate-marinated chicken breast fillets cooked under different heat treatments. Food and Nutrition Sciences, 5, 35-44.

Razzaque, S. (2011). Phosphate toxicity: new insights into an old problem. Clin, Sci. 120(3):91-7.

Uribarri, J., & Calvo, M. S. (2003). Hidden sources of phosphorus in the typical American diet: does it matter in nephrology? Semin. Dial. 16(3), 186-188.

Xiong, Y.L., & Kupski, D.R. (1999). Time-dependent marinade absorption and retention, cooking yield, and palatability of chicken filets marinated in various phosphate solutions. Poultry Science, 78(7), 1053-1059.

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Fermented foods

by Akenio Patterson

Fermentation is a metabolic process that has been used for thousands of years to preserve food. Today it is used as a method of preparing several types of food, including alcoholic beverages, yogurt, and other milk products. Fermentation gives a distinctive nutritional profile in foods and enhances their organoleptic properties. One of the many ways of classifying fermented foods is by their chemistry; that is: lactic acid, alcohol, acetic acid, and butyric acid fermentation. Fermented foods have several health benefits, most commonly antioxidant, antihypertensive, and anticancer properties. There can, however, be disadvantages, such as the production of unsafe compounds. Food safety concerns of fermented foods include food-borne infections, contamination, and intoxication.

Fermentation is an anaerobic metabolic process where microorganisms convert starch (sugar) to alcohol or an acid. It may also refer to proliferation of microorganisms on a growth medium, and is usually intended to produce a specific chemical product like enzymes, vaccines, antibiotics, and food product/additive. Thousands of years ago it was utilized to preserve food, reduce poisonous effects, and improve flavour (Bell et al., 2017). Fermented food products include products from milk (cheese, yogurt, kefir); from vegetables (pickles, soy sauce); from fruits (wine, vinegar); and from meat (salami). Fermented industrial chemicals include acetone, ethanol, amino acids, and enzymes (Chojnacka, 2010). Fermented speciality chemicals include vitamins and pharmaceuticals.

The general methods of fermentation are wild fermentation/spontaneous fermentation and culture dependent fermentation (Dimidi et al., 2019). The former involves microorganisms naturally present in food undergoing fermentation, for example sauerkraut (fermented cabbage) (Dimidi et al., 2019); the latter involves starter cultures of microorganisms undergoing fermentation, for example yogurt (Dimidi et al., 2019). Advantages of fermentation include shelf life extension, improved organoleptic properties, and increase of vitamins and digestibility. Lactobacillus spp. and Bifidobacterium spp. are often used to ferment dairy products, where they may synthesize several B vitamins (for example, riboflavin [B2], folate [B9], and cobalamin [B12]) (LeBlanc et al., 2011; Capozzi et al., 2012). When Streptococcus spp. are used, they produce compounds with anti-depressant effects (Wu and Shah, 2016), as well as effects on GABA, the main inhibitory neurotransmitter (Dhakal et al., 2012). Health benefits include anticholesterolemic, anticancer, antidiabetic and antihypertensive properties (Tamang and Kailasapathy, 2010).

Risk factors also need to be considered. Food-borne infection has been reported in fermented foods such as fresh cheese, and fermented meat and cereals (Nout, 1994). Other risks involve microbial contamination and intoxication (Nout, 1994).

Safety Concerns

Nout (1994) evaluated the risks of fermented foods, including food-borne infection, contamination, and intoxication. Food-borne infections and intoxications make up about 80% of food-related illnesses (Waites and Arbuthnott 1990). Raw materials may be contaminated by naturally toxic substances (such as cyanogenic glycosides or mycotoxins) or environmentally toxic substances (such as pesticides and herbicides). Additionally, toxic substances are produced as a by-product of fermentation (Nout, 1994).

Ethyl carbamate, for example, is a carcinogenic and mutagenic compound formed from the esterification of ethanol with carbamic acid (Canas et al., 1989). Biogenic amines (such as ethylamine), are formed from the decarboxylation of amino acids (Nout, 1994).

Contaminants like mycotoxins may lead to intoxication (Nout, 1994). Nout (1994) explained that although at pH <4, aflatoxin is reduced to a less toxic form, there is not a complete detoxification unless the lactone ring is broken. In addition to contaminated raw materials, other risk factors include lack of pasteurization, and poorly controlled natural fermentation processes (Nout, 1994). If there is no pasteurization of milk after fermentation, pathogens like Listeria will proliferate (McLauchlin et al., 1990). If natural fermentation of sausage is done incorrectly, pathogens like Salmonella spp. will proliferate (Ratnam and March, 1986).

References

Bell, V., Ferrão, J., Fernandes, T. (2017). Nutritional guidelines and fermented food frameworks. Foods, 6(8), 65.

Cañas, B.J., Diachenko, G.W. & Nyman, P.J. (1997) Ethyl carbamate levels resulting from azodicarbonamide use in bread. Food Additives & Contaminants, 14(1), 89-94. doi: 10.1080/02652039709374501

Capozzi, V., Russo, P., Dueñas, M.T., López, P., Spano, G. (2012). Lactic acid bacteria producing B-group vitamins: A great potential for functional cereals products. Appl Microbiol Biotechnol. 96(6), 1383-94. doi: 10.1007/s00253-012-4440-2.

Dhakal, R., Bajpai, V.K., Baek, K.H. (2012). Production of gaba (γ - Aminobutyric acid) by microorganisms: a review. Braz. J. Microbiol. 43(4),1230-41. doi: 10.1590/S1517-83822012000400001.

Dimidi, E,. Cox, S.R., Rossi, M., & Whelan, K. (2019). Fermented foods: Definitions and characteristics, impact on the gut microbiota and effects on gastrointestinal health and disease. Nutrients 11(8), 1806.

LeBlanc, J.G., Laiño, J.E., del Valle, M.J., Vannini, V., van Sinderen, D., Taranto, M.P., de Valdez, G.F., de Giori, G.S., Sesma, F. (2011). B-group vitamin production by lactic acid bacteria-Current knowledge and potential applications. J. Appl. Microbiol. 111(6), 1297-309.

McLauchlin, J. (1990). Distribution of serovars of *Listeria monocytogenes* isolated from different categories of patients with listeriosis. Eur. J. Clin. Microbiol. Infect. Dis. 9, 210–213.

Nout, M.J.R. (1994). Fermented foods and food safety. Food Research International, 27(3), 291-298.

Ratnam, S., & March, S.B. (1986). Laboratory studies on salmonella-contaminated cheese involved in a major outbreak of gastroenteritis. Journal of Applied Bacteriology, 61(1), 51-56.

Tamang, J.P., & Kailasapathy, K. (2010). Fermented foods and beverages of the world. U.S.A.: CRC Press.

Waites, W.M. & Arbuthnott, J.P. (1990). Foodborne illness: An overview, The Lancet, 336(8717), 722-725.

Wu, Q., Tun, H. M., Leung, F. C., and Shah, N. P. (2014). Genomic insights into high exopolysaccharide-producing dairy starter bacterium *Streptococcus thermophilus* ASCC 1275. Sci. Rep. 4:4974. doi: 10.1038/srep04974

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Iodine value Coconut & Corn oil

by Samonette Morgan

The iodine value is defined as the amount of iodine, in grams, absorbed by 100g of a sample. It is an indicator of the extent of unsaturation within fatty acids in oils. The amount of iodine absorbed is directly proportional to the extent of unsaturation within the fatty acids. This is significant as the degree of unsaturation determines the ease of rancidity that a fatty acid may undergo, either by oxidation, hydrolysis or microorganisms. This will render the oil unusable due to the off-odours and flavours that are produced as a result of the oxidation of the fatty acids. The iodine value can be used to estimate the shelf life of food products containing saturated or unsaturated fats. Saturated fats tend to have a longer shelf-life than unsaturated fats as they are more stable. Similarly, the iodine value determines the suitability of oils in the soap making process, as saturated fats are solid at room temperature and have found widespread use in soap making.

Coconut oil consists primarily of saturated fatty acids. The iodine value ranges between 7.7-10.5g iodine/100g oil (Encyclopedia of Food Sciences and Nutrition, 2003). This value can be attributed to the high degree of saturated fatty acids present in coconut oil. Coconut oil also contains unsaturated fatty acids, such as linoleic acid, which contributes to some absorption of the iodine (Boateng et.al., 2016).

Contrastingly, corn oil contains a high number of unsaturated fatty acids. The most common fatty acid in fresh corn oil is linoleic acid, occurring in the oil at 58-62% (Encyclopedia of Food Grains, 2016). Corn oil has a theoretical iodine value of 103-128g iodine/100g oil (Encyclopedia of Food Sciences and Nutrition, 2003).

References

1. Boateng, L.; Ansong, R.; Owusu, W.; Steiner-Asiedu, M. (2016). Coconut oil and palm oil's role in nutrition, health and national development: A Review. 189-196.
2. Encyclopedia of Food Sciences and Nutrition. 2nd Ed. [Online]; Academic Press,2003.

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Word Search

FOOD COLORANTS

Annatto	Anthocyanins	Astaxanthin
Azodyes	Betalains	Carmel
Carmine	Chlorophyll	Cochineal
Conjugation	Curcumin	Riboflavin
Safrole	Tartrazine	Turmeric