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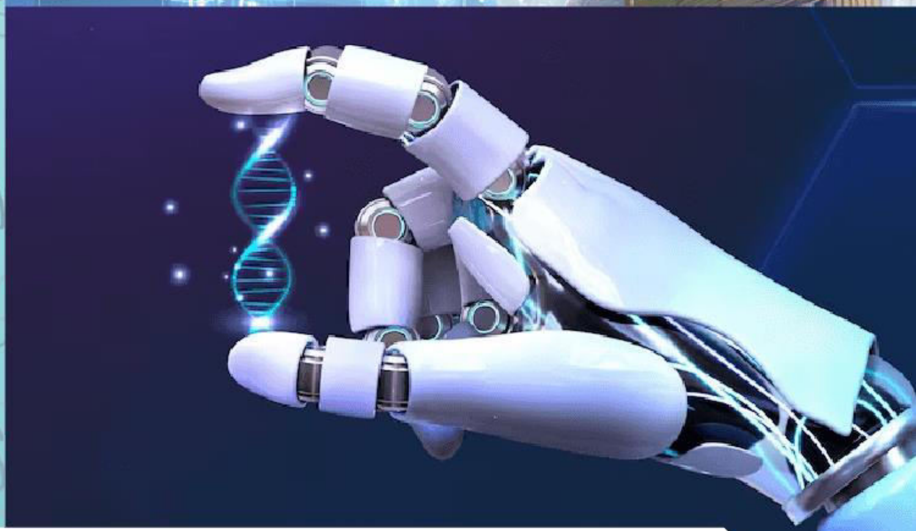

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FOOD CANNING AND THEIR IMPACT ON HEALTH

DR. ANJALI SHARMA

ASSISTANT PROFESSOR, GOVT. MS COLLEGE FOR WOMEN, BIKANER, RAJASTHAN, INDIA

ABSTRACT: Canning is a method of food preservation in which food is processed and sealed in an airtight container (jars like Mason jars, and steel and tin cans). Canning provides a shelf life that typically ranges from one to five years,[a] although under specific circumstances, it can be much longer.[2] A freeze-dried canned product, such as canned dried lentils, could last as long as 30 years in an edible state.

In 1974, samples of canned food from the wreck of the Bertrand, a steamboat that sank in the Missouri River in 1865, were tested by the National Food Processors Association. Although appearance, smell, and vitamin content had deteriorated, there was no trace of microbial growth and the 109-year-old food was determined to be still safe to eat

KEYWORDS-canned, foods, impact, health, diet

I. INTRODUCTION

Shortly before the Napoleonic Wars, the French government offered a hefty cash award of 12,000 francs to any inventor who could devise a cheap and effective method of preserving large amounts of food to create well-preserved military rations for the Grande Armée. The larger armies of the period required increased and regular supplies of quality food. Limited food availability was among the factors limiting military campaigns to the summer and autumn months. In 1809, Nicolas Appert, a French confectioner and brewer, observed that food cooked inside a jar did not spoil unless the seals leaked, and developed a method of sealing food in glass jars.[4] Appert was awarded the prize in 1810 by Count Montelivert, a French minister of the interior.[5] The reason for lack of spoilage was unknown at the time, since it would be another 50 years before Louis Pasteur demonstrated the role of microbes in food spoilage and developed pasteurization.

The Grande Armée began experimenting with issuing canned foods to its soldiers, but the slow process of canning and the even slower development and transport stages prevented the army from shipping large amounts across the French Empire, and the wars ended before the process was perfected.

Following the end of the Napoleonic Wars, the canning process was gradually employed in other European countries and the United States.

In the United Kingdom

Based on Appert's methods of food preservation, the tin can process was allegedly developed by Frenchman Philippe de Girard, who came to London and used British merchant Peter Durand as an agent to patent his own idea in 1810.[6] Durand did not pursue food canning himself, selling his patent in 1811 to Bryan Donkin and John Hall, who were in business as Donkin Hall and Gamble, of Bermondsey.[7] Bryan Donkin developed the process of packaging food in sealed airtight cans, made of tinned wrought iron. Initially, the canning process was slow and labour-intensive, as each large can had to be hand-made, and took up to six hours to cook, making canned food too expensive for ordinary people.

The main market for the food at this stage was the British Army and Royal Navy. By 1817, Donkin recorded that he had sold £3000 worth of canned meat in six months. In 1824, Sir William Edward Parry took canned beef and pea soup with him on his voyage to the Arctic in HMS Fury, during his search for a northwestern passage to India. In 1829, Admiral Sir James Ross also took canned food to the Arctic, as did Sir John Franklin in 1845.[8] Some of his stores were found by the search expedition led by Captain (later Admiral Sir) Leopold McClintock in 1857. One of these cans was opened in 1939 and was edible and nutritious, though it was not analysed for contamination by the lead solder used in its manufacture.

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In Europe

During the mid-19th century, canned food became a status symbol among middle-class households in Europe, being something of a frivolous novelty. Early methods of manufacture employed poisonous lead solder for sealing the cans. Studies in the 1980s attributed the lead from the cans as a factor in the disastrous outcome of the 1845 Franklin expedition to chart and navigate the Northwest Passage.[9] However, studies in 2013 and 2016 suggested that lead poisoning was likely not a factor, and that the crew's ill health may, in fact, have been due to malnutrition—specifically zinc deficiency—possibly due to a lack of meat in their diet.[10][11]

Increasing mechanization of the canning process, coupled with a huge increase in urban populations across Europe, resulted in a rising demand for canned food. A number of inventions and improvements followed, and by the 1860s smaller machine-made steel cans were possible, and the time to cook food in sealed cans had been reduced from around six hours to thirty minutes.

In the United States

Canned food also began to spread beyond Europe—Robert Ayars established the first American canning factory in New York City in 1812, using improved tin-plated wrought-iron cans for preserving oysters, meats, fruits, and vegetables. Demand for canned food greatly increased during wars. Large-scale wars in the nineteenth century, such as the Crimean War, American Civil War, and Franco-Prussian War, introduced increasing numbers of working-class men to canned food, and allowed canning companies to expand their businesses to meet military demands for non-perishable food, enabling companies to manufacture in bulk and sell to wider civilian markets after wars ended. Urban populations in Victorian Britain demanded ever-increasing quantities of cheap, varied, quality food that they could keep at home without having to go shopping daily. In response, companies such as Underwood, Nestlé, Heinz, and others provided quality canned food for sale to working class city-dwellers. The late 19th century saw the range of canned food available to urban populations greatly increase, as canners competed with each other using novel foodstuffs, highly decorated printed labels, and lower prices.

World War I

Demand for canned food skyrocketed during World War I, as military commanders sought vast quantities of cheap, high-calorie food to feed their millions of soldiers, which could be transported safely, survive trench conditions, and not spoil in transport. Throughout the war, British soldiers generally subsisted on low-quality canned food, such as the British bully beef, pork and beans, canned sausages, and Maconochie's stew, but by 1916, widespread dissatisfaction and increasing complaints about the poor quality canned food among soldiers resulted in militaries seeking better-quality food to improve morale, and complete meals-in-a-can began to appear. In 1917, the French Army began issuing canned French cuisine such as coq au vin, beef bourguignon, french onion soup, and Vichyssoise, while the Italian Army experimented with canned ravioli, spaghetti bolognese, minestrone, and pasta e fagioli. After the war, companies that had supplied military canned food began to improve the quality of their goods for civilian sale.

Methods

The original fragile and heavy glass containers presented challenges for transportation, and glass jars were largely replaced in commercial canneries with cylindrical tin can or wrought-iron canisters (later shortened to "cans") following the work of Peter Durand (1810). Cans are cheaper and quicker to make, and much less fragile than glass jars.

Can openers were not invented for another thirty years. At first, soldiers would cut the cans open with bayonets or smash them open with rocks. Today, tin-coated steel is the material most commonly used. Aseptically processed retort pouches are also used for canning.

Glass jars have remained popular for some high-value products and in home canning.

Microbial control

To prevent the food from being spoiled before and during containment, a number of methods are used: pasteurisation, boiling (and other applications of high temperature over a period of time), refrigeration, freezing, drying, vacuum treatment, antimicrobial agents that are natural to the recipe of the foods being preserved, a sufficient dose of ionizing radiation, submersion in a strong saline solution, acid, base, osmotically extreme (for example very sugary) or other microbially-challenging environments.[1]

Other than sterilization, no method is perfectly dependable as a preservative. Sterilization is done after the can is sealed, so that both the container and the food are secured.

The spores of the microorganism Clostridium botulinum (which causes botulism) can be eliminated only at temperatures above the boiling point of water. As a result, from a public safety point of view, foods with low acidity (a pH more than 4.6) need sterilization under high temperature (116–130 °C). To achieve temperatures above the boiling point requires the use of a pressure canner. Foods that must be pressure canned include most vegetables, meat, seafood, poultry, and dairy products. The only foods that may be safely canned in an ordinary boiling water bath are highly acidic ones with a pH below 4.6, such as fruits, pickled vegetables, or other foods to which acidic additives have been added. Although an ordinary boiling temperature does not kill botulism spores, the acidity is enough to stop them from growing.[12]

Sealing: double seams

Invented in 1888 by Max Ams,[13] modern double seams provide an airtight seal to a can. This airtight nature is crucial to keeping micro-organisms out of the can and keeping the can's contents sealed inside. Thus, double seamed cans are also known as Sanitary Cans. Developed in 1900 in Europe, this sort of can was made of the traditional cylindrical body made with tin plate. The two ends (lids) were attached using what is now called a double seam. A can thus sealed is impervious to contamination by creating two tight continuous folds between the can's cylindrical body and the lids. This eliminated the need for solder and allowed improvements in manufacturing speed, reducing cost.

Double seaming uses rollers to shape the can, lid and the final double seam. To make a sanitary can and lid suitable for double seaming, manufacture begins with a sheet of coated tin plate. To create the can body, rectangles are cut and curled around a die, and welded together creating a cylinder with a side seam.

Rollers are then used to flare out one or both ends of the cylinder to create a quarter circle flange around the circumference. Precision is required to ensure that the welded sides are perfectly aligned, as any misalignment will cause inconsistent flange shape, compromising its integrity.

A circle is then cut from the sheet using a die cutter. The circle is shaped in a stamping press to create a downward countersink to fit snugly into the can body. The result can be compared to an upside down and very flat top hat. The outer edge is then curled down and around about 140 degrees using rollers to create the end curl.

The result is a steel tube with a flanged edge, and a countersunk steel disc with a curled edge. A rubber compound is put inside the curl.[2]

Seaming

The body and end are brought together in a seamer and held in place by the base plate and chuck, respectively. The base plate provides a sure footing for the can body during the seaming operation and the chuck fits snugly into the end (lid). The result is the countersink of the end sits inside the top of the can body just below the flange. The end curl protrudes slightly beyond the flange.

II. DISCUSSION

First operation

Once brought together in the seamer, the seaming head presses a first operation roller against the end curl. The end curl is pressed against the flange curling it in toward the body and under the flange. The flange is also bent downward, and the end and body are now loosely joined together. The first operation roller is then retracted. At this point five thicknesses of steel exist in the seam. From the outside in they are:

- End
- Body Hook
- Cover Hook
- Body
- Countersink

Second operation

The seaming head then engages the second operation roller against the partly formed seam. The second operation presses all five steel components together tightly to form the final seal. The five layers in the final seam are then called; a) End, b) Body Hook, c) Cover Hook, d) Body, e) Countersink. All sanitary cans require a filling medium within the seam because otherwise the metal-to-metal contact will not maintain a hermetic seal. In most cases, a rubberized compound is placed inside the end curl radius, forming the critical seal between the end and the body.

Probably the most important innovation since the introduction of double seams is the welded side seam. Prior to the welded side seam, the can body was folded and/or soldered together, leaving a relatively thick side seam. The thick side seam required that the side seam end juncture at the end curl to have more metal to curl around before closing in behind the Body Hook or flange, with a greater opportunity for error.[3]

Seamer setup and quality assurance

Many different parts during the seaming process are critical in ensuring that a can is airtight and vacuum sealed. The dangers of a can that is not hermetically sealed are contamination by foreign objects (bacteria or fungicide sprays), or that the can could leak or spoil.

One important part is the seamer setup. This process is usually performed by an experienced technician. among the parts that need setup are seamer rolls and chucks which have to be set in their exact position (using a feeler gauge or a clearance gauge). The lifter pressure and position, roll and chuck designs, tooling wear, and bearing wear all contribute to a good double seam.

Incorrect setups can be non-intuitive. For example, due to the springback effect, a seam can appear loose, when in reality it was closed too tight and has opened up like a spring. For this reason, experienced operators and good seamer setup are critical to ensure that double seams are properly closed.

Quality control usually involves taking full cans from the line – one per seamer head, at least once or twice per shift, and performing a teardown operation (wrinkle/tightness), mechanical tests (external thickness, seamer length/height and countersink) as well as cutting the seam open with a twin blade saw and measuring with a double seam inspection system. The combination of these measurements will determine the seam's quality.

Use of a statistical process control (SPC) software in conjunction with a manual double-seam monitor, computerized double seam scanner, or even a fully automatic double seam inspection system makes the laborious process of double seam inspection faster and much more accurate. Statistically tracking the performance of each head or seaming station of the can seamer allows for better prediction of can seamer issues, and may be used to plan maintenance when convenient, rather than to simply react after bad or unsafe cans have been produced.[14]

Nutritional value[4]

Canning is a way of processing food to extend its shelf life. The idea is to make food available and edible long after the processing time. A 1997 study found that canned fruits and vegetables are as rich with dietary fiber and vitamins as the same corresponding fresh or frozen foods, and in some cases the canned products are richer than their fresh or frozen counterparts.[15] The heating process during canning appears to make dietary fiber more soluble, and therefore more readily fermented in the colon into gases and physiologically active byproducts. Canned tomatoes have a higher available lycopene content. Consequently, canned meat and vegetables are often among the list of food items that are stocked during emergencies.[16]

Potential hazards

In the beginning of the 19th century the process of canning foods was mainly done by small canneries. These canneries were full of overlooked sanitation problems, such as poor hygiene and unsanitary work environments. Since the refrigerator did not exist and industrial canning standards were not set in place it was very common for contaminated cans to slip onto the grocery store shelves.[17]

According to The Fruits of Empire: Art, Food and the Politics of Race in the Age of American Expansion by Shana Klein, "Workers also suffered injuries, specifically bruised knuckles and open sores, from trimming and packaging pineapples. Gloves were one preventative measure to protect a canner's hands from the acidity of the pineapple, but gloves did not always help."[18]

Migration of can components

In canning toxicology, migration is the movement of substances from the can itself into the contents.[19] Potential toxic substances that can migrate are lead, causing lead poisoning, or bisphenol A (BPA), a potential endocrine disruptor that is an ingredient in the epoxy commonly used to coat the inner surface of cans. Some cans are manufactured with a BPA-free enamel lining produced from plant oils and resins.[20] In February 2018, the Can Manufacturers Institute, a trade association in the United States, surveyed the industry and reported that at least 90% of food cans no longer contained BPA.[21]

Salt content

Salt (sodium chloride), dissolved in water, is used in the canning process.[22][As a result, canned food can be a major source of dietary salt.[23] Too much salt increases the risk of health problems, including high blood pressure. Therefore, health authorities have recommended limitations of dietary sodium.[24][25][26][27][28] Many canned products are available in low-salt and no-salt alternatives.[8]

Rinsing thoroughly after opening may reduce the amount of salt in canned vegetables, since much of the salt content is thought to be in the liquid, rather than the food itself.[29]

Botulism

Foodborne botulism results from contaminated foodstuffs in which C. botulinum spores have been allowed to germinate and produce botulism toxin,[30] and this typically occurs in canned non-acidic food substances that have not received a strong enough thermal heat treatment. C. botulinum prefers low oxygen environments and is a poor competitor to other bacteria, but its spores are resistant to thermal treatments. When a canned food is sterilized insufficiently, most other bacteria besides the C. botulinum spores are killed, and the spores can germinate and produce botulism toxin.[30] Botulism is a rare but serious paralytic illness, leading to paralysis that typically starts with the muscles of the face and then spreads towards the limbs.[31] The botulinum toxin is extremely dangerous because it cannot be detected by sight or smell, and ingestion of even a small amount of the toxin can be deadly.[32] In severe forms, it leads to paralysis of the breathing muscles and causes respiratory failure. In view of this life-threatening complication, all suspected cases of botulism are treated as medical emergencies, and public health officials are usually involved to prevent further cases from the same source.[31]

Canning and economic recession

Canned goods and canning supplies sell particularly well in times of recession due to the tendency of financially stressed individuals to engage in cocooning, a term used by retail analysts to describe the phenomenon in which people choose to stay at home instead of adding expenditures to their budget by dining out and socializing outside the home. Also, some people may become preppers and proceed to stockpile canned food.[33] A doomer would also be interested in stockpiling canned food upon learning about a recession.[11]

In February 2009 during a recession, the United States saw an 11.5% rise in sales of canning-related items.[34]

Some communities in the US have county canning centers which are available for teaching canning, or shared community kitchens which can be rented for canning one's own foods.[35]

III. RESULTS

Canned water is drinking water, including spring water, artesian spring water, purified water, carbonated water and mineral water, packaged in beverage cans made of aluminium or tin-plated steel.[1]

Individual serving aluminium cans and bottles are less common alternatives to bottled water. Canned water is often used where storage or distribution systems are set up for cans. Some companies have launched water in cans, offering a more environmentally sustainable alternative to plastic bottles.

Cans of various sizes are also used for storage of potable water for emergency preparedness. Water is an important part of individual or government stockpiles. Water was stored in steel cans, lined with plastic bags, under the United States Civil Defense program. Approximately twelve million 17.5-US-gallon (66 L) cans were deployed, and could hold water for more than ten years.[2]

Later, some manufacturers started to use a nitrogen flush to remove air and bacteria from their cans to prolong shelf life to 30 years or longer, making the water suitable for long-term storage.

Plastic bottled water is known to have negative environmental consequences.[3] It is estimated that only about 9% of all plastic is recycled. About 79% of this plastic waste is disposed of in landfills, incinerated and littered, which results in some plastic entering waterways.[4] In contrast, up to 65% of all aluminium cans are recycled, making aluminium cans the most recycled beverage container on the planet.[5] Due to the detrimental impact of plastic on the environment, many manufacturers are turning towards aluminium cans and glass bottles as a more sustainable solution to packaged drinking water.[14]

A drink can (or beverage can) is a metal container designed to hold a fixed portion of liquid such as carbonated soft drinks, alcoholic drinks, fruit juices, teas, herbal teas, energy drinks, etc. Drink cans are made of aluminum (75% of worldwide production)[1] or tin-plated steel (25% worldwide production). Worldwide production for all drink cans is approximately 370 billion cans per year.[1]

The first commercial beer available in cans began in 1935 in Richmond, Virginia.[2] Not long after that, sodas, with their higher acidity and somewhat higher pressures, were available in cans. The key development for storing drinks in cans was the interior liner, typically plastic or sometimes a waxy substance, that helped to keep the product's flavor from being ruined by a chemical reaction with the metal. Another major factor for the timing was the repeal of Prohibition in the United States at the end of 1933.

In 1935,[3] the Felinfoel Brewery at Felinfoel in Wales was the first brewery outside the US to commercially can beer. Prior to this time, beer had been available only in barrels or in glass bottles. From this time, lightweight tin cans could be used. Felinfoel was a major supplier to British armed forces abroad in the Second World War. Cans saved a great deal of space and weight for wartime exports compared to glass bottles and did not have to be returned for refilling. These early cans did not have a pull tab, being equipped instead with a crown cork (beer bottle top). From the 18th century until the early 20th century Wales dominated world tinplate production, peaking in the early 1890s when 80% of the world's tinplate was produced in south Wales.[4]

Canned drinks were factory-sealed and required a special opener tool in order to consume the contents. Cans were typically formed as cylinders, having a flat top and bottom. They required a can piercer, colloquially known as a "church key", that latched onto the top rim for leverage; lifting the handle would force the sharp tip through the top of the can, cutting a triangular hole. A smaller second hole was usually punched at the opposite side of the top to admit air while pouring, allowing the liquid to flow freely.[15]

In the mid-1930s, some cans were developed with caps so that they could be opened and poured more like a bottle. These were called "cone tops", as their tops had a conical taper up to the smaller diameter of the cap. Cone top cans were sealed by the same crimped caps that were put on bottles, and could be opened with the same bottle-opener tool. There were three types of conetops: high profile, low profile, and j-spout. The low profile and j-spout were the earliest, dating from about 1935. The "crowntainer" was a different type of can that was drawn steel with a bottom cap. These were developed by Crown Cork & Seal (now known as Crown Holdings, Inc.), a leading drink packaging and drink can producer. The popularity of canned drinks was slow to catch on, as the metallic taste was difficult to overcome with the interior liner not perfected, especially with more acidic sodas. Cans had two advantages over glass bottles. First for the distributors, flat-top cans were more compact for transportation and storage and weighed less than bottles. Second for consumers, they did not require the deposit typically paid for bottles, as they were discarded after use. Glass-bottle deposits were reimbursed when consumers took the empties back to the store.[16]

Standard sizes

Comparison chart of various standards		
ml	imp fl oz	US fl oz
1,000	35.2	33.8
568	20.0[nb 1]	19.2
500	17.6	16.9
473	16.6	16.0[nb 2]
440	15.49	14.88
375	13.2	12.7
355	12.5	12.0
350	12.3	11.8
341	12.0	11.5
330	11.6	11.2
320	11.3	10.8
250	8.8	8.5
237	8.3	8.0[nb 3]
222	7.8	7.5
200	7.0	6.8
150	5.3	5.1
^ one imperial pint ^ one US pint ^ half a US pint		

Capacity in countries

Various standard capacities are used throughout the world.

Australia

In Australia the standard can size for alcoholic and soft drinks is 375 ml. Energy drinks are commonly served in 250 ml and 500 ml sizes.[17]

Brazil

In Brazil the standard can size is 350 ml.

China

In China the most common size is 330 ml.

Can dimensions may be cited in metric or imperial units; imperial dimensions for can making are written as inches+sixteenths of an inch (e.g. "202" = 2 inches + 2 sixteenths).[6]

Europe

In Europe the standard can is 330 ml, but since the 1990s 250 ml has slowly become common for energy drinks (e.g. redbull), along with 500 ml, often used for beers and sometimes for soft drinks too (particularly in wholesale supply).

In the UK, 440 ml is commonly used for lager and cider.

In Ireland, 330ml and 440ml fat cans are used for soft drinks.

In Austria, energy drinks are usually sold in sizes of 200 to 330 ml.

Hong Kong

In Hong Kong most cans are 330 ml – in the past they were usually 355 or 350 ml. 200 ml has also become available. Some beers and coffees are, respectively, sold with 500-ml and 250-ml cans.[18]

India

In India standard cans are 250 ml.

Indonesia

Indonesia introduced 320 ml cans for domestically produced beer in 2018. Carbonated soft drink cans are typically 330 ml.

Japan

In Japan the most common sizes are 350 ml and 500 ml, while larger and smaller cans are also sold.

South Korea

250 ml cans are the most common for soft drinks, but when accompanying take-out food (such as pizza or chicken), a short 245-ml can is standard. Recently, some 355-ml cans which are similar to North American cans are increasingly available, but are limited mostly to Coca-Cola and Dr Pepper, and beer cans are available in 500 ml.[19]

Malaysia and Singapore

In Malaysia, beer cans are 320 ml. For soft drinks in both Malaysia and Singapore, the most commonly found cans are 300 ml for non-carbonated drinks and 325 ml for carbonated drinks. Larger 330 ml/350 ml cans are limited to imported drinks which usually cost a lot more than local ones.

The Middle East

In the Middle East standard cans are 330 ml.

New Zealand

In New Zealand the standard can size is 355 ml, although Coca-Cola Amatil changed some of its canned drinks to 330 ml in 2017.[7]

North America

In North America, the standard can size is 12 US fl oz or 355 ml. The US standard can is 4.83 in or 12.3 cm high, 2.13 in or 5.41 cm in diameter at the lid, and 2.6 in or 6.60 cm in diameter at the widest point of the body. Also available are 16 US fl oz or 473 ml cans (known as tallboys or, referring to the weight, "pounders"), and 18 US fl oz or 532 ml.

In Mexico, the standard size is 355 ml, although smaller 235 ml cans have gained popularity in the late 2010s and early 2020s.

In Canada, the standard size was previously 12 Imperial fluid ounces (341 ml), later redefined and labelled as 341 ml in 1980. This size was commonly used with steel drink cans in the 1970s and early 1980s. However, the US standard 355 ml can size was standardized in the 1980s and 1990s upon the conversion from steel to aluminum. Some drinks, such as Nestea, are sold in 341 ml cans.

In Quebec, a new standard for carbonated drinks has been added, as some grocery stores now only sell cans of all major carbonated drinks in six-packs of 222 ml cans. Many convenience stores also began selling "slim cans" with a 310ml capacity in 2015.[20]

Pakistan

In Pakistan the most common sizes are 250 ml and 330 ml, and 200 ml cans are also sold.

South Africa

South African standard cans are 330 ml (reduced in the early 2000s from the up-until-then ubiquitous 340 ml) and the promotional size is 440 ml. There is also the 500 ml can. A smaller 200 ml can is used for "mixers" such as tonic or soda water. It has a smaller diameter than the other cans. In September 2018, a 300 ml can was introduced as an alternative to the 330 ml can in a continued effort to reduce the amount of sugar consumed in soft drinks.

Thailand

Singha beer uses 320 ml cans for domestic sales and 330 ml cans for exports.[8]

Composition

Most metal drink cans manufactured in the United States are made of aluminum,[9] whereas in some parts of Europe and Asia approximately 55 percent are made of steel and 45 percent are aluminum alloy. Steel cans often have a top made of aluminum. Beverage containers are made of two different aluminum alloys. The body is made of the 3004 alloy that can be drawn easily and the top is made of the harder 5182 alloy.[10]

An empty aluminum can weighs approximately one-half ounce (14 g). There are 34 empty aluminum cans to a pound or 70 to a kilogram.[11]

In many parts of the world a deposit can be recovered by turning in empty plastic, glass, and aluminum containers. Scrap metal dealers often purchase aluminum cans in bulk, even when deposits are not offered. Aluminum is one of the most cost-effective materials to recycle. When recycled without other metals being mixed in, the can–lid combination is perfect for producing new stock for the main part of the can—the loss of magnesium during melting is made up for by the high magnesium content of the lid. Also, reducing ores such as bauxite into aluminum requires large amounts of electricity, making recycling cheaper than producing new metal.[21]

Aluminum cans are coated internally to protect the aluminum from oxidizing. Despite this coating, trace amounts of aluminum can be degraded into the liquid, the amount depending on factors such as storage temperature and liquid composition.[12][13] Chemical compounds used in the internal coating of the can include types of epoxy resin.[14]

Fabrication process

Modern cans are generally produced through a mechanical cold forming process that starts with punching a flat blank from very stiff cold-rolled sheet. This sheet is typically alloy 3104-H19 or 3004-H19, which is aluminum with about 1% manganese and 1% magnesium to give it strength and formability. The flat blank is first formed into a cup about three inches in diameter. This cup is then pushed through a different forming process called "ironing" which forms the can. The bottom of the can is also shaped at this time. The malleable metal deforms into the shape of an open-top can. With the sophisticated technology of the dies and the forming machines, the side of the can is thinner than either the top and bottom areas, where stiffness is required.

Plain lids (known as shells) are stamped from a coil of aluminum, typically alloy 5182-H48, and transferred to another press that converts them to easy-open ends. This press is known as a conversion press which forms an integral rivet button in the lid and scores the opening, while concurrently forming the tabs in another die from a separate strip of aluminum.[22]

Filling cans

Cans are filled before the top is crimped on by seamers. To speed up the production process filling and sealing operations need to be extremely precise. The filling head centers the can using gas pressure, purges the air, and lets the drink flow down the sides of the can. The lid is placed on the can, and then crimped in two operations. A seaming head engages the lid from above while a seaming roller to the side curls the edge of the lid around the edge of the can body. The head and roller spin the can in a complete circle to seal all the way around. Then a pressure roller with a different profile drives the two edges together under pressure to make a gas-tight seal. Filled cans usually have pressurized gas inside, which makes them stiff enough for easy handling. Without the riveted tab the scored section of the can's end would be impossible to lift from the can.

Can filling lines come in different line speeds from 15,000 cans per hour (cph) up to 120,000 cph or more, all with different levels of automation. For example, lid feeding alone starts with manual debagging onto a simple v-chute connected to the seamer up to fully automated processes with automatic debagging and lid feeding of lids combined with automatic roll depalletizers for filling debaggers by robots.

Opening mechanisms

Early metal drink cans had no tabs; they were opened by a can-piercer or churchkey, a device resembling a bottle opener with a sharp point. The can was opened by punching two triangular holes in the lid—a large one for drinking, and a second smaller one to admit air.

As early as 1922, inventors were applying for patents on cans with tab tops, but the technology of the time made these inventions impractical.[15] Later advancements saw the ends of the can made out of aluminum instead of steel.[23]

In 1959, Ermal Fraze devised a can-opening method that would come to dominate the canned drink market. His invention was the "pull-tab". This eliminated the need for a separate opener tool by attaching an aluminum pull-ring lever with a rivet to a pre-scored wedge-shaped tab section of the can top. The ring was riveted to the center of the top, which created an elongated opening large enough that one hole simultaneously served to let the drink flow out while air flowed in. Previously, while on a family picnic, Mr. Fraze had forgotten to bring a can opener and was forced to use a car bumper to open a can of beer. Thinking there must be an easier way, he stayed up all night until he came up with the pull tab.[16] Pull-tab cans, or the discarded tabs from them, were colloquially called "pop-tops".[17]

Into the 1970s the pull-tab was widely popular, but its popularity came with the problem of people frequently simply discarding the pull-tabs on the ground, creating a potential injury risk especially to the feet or fingers. In the 1960s, at least one inventor attempted to solve the litter problem, by having the tab be retained by a stationary key that would wrap the tab around itself, which was unsuccessful commercially.[18]

The problem of the discarded tops was initially solved by the invention of the push-tab. Used primarily on Coors Beer cans in the mid-1970s, the push-tab was a raised circular scored area used in place of the pull-tab.[19] It needed no ring to pull up; instead, the raised aluminum blister was pushed down into the can using one finger. A small unscored section of the tab prevented it from detaching and falling into the can after being pushed in. Push-tabs never gained wide popularity because while they had solved the litter problem of the pull-tab, they created a safety hazard where the person's finger upon pushing the tab into the can was immediately exposed to the sharp edges of the opening. A feature of the push-tab Coors Beer cans was that they had a second, smaller, push-tab at the top as an airflow vent. "Push-tabs" were introduced into Australia from around 1977 and were locally known as "pop-tops", before being replaced later by the Stay-on-tab.[20] The safety and litter problems were eventually solved later in the 1970s with Daniel F. Cudzik's invention of the non-removing "Stay-Tab".

Cans are usually in sealed paperboard cartons, corrugated fiberboard boxes, or trays covered with plastic film. The entire distribution system and packaging need to be controlled to ensure freshness.[21]

Pop-tab

Mikolaj Kondakow and James Wong of Thunder Bay, Ontario, Canada invented the pull tab version for bottles in or before 1951 (Canadian patent 476789).[22] In 1962, Ermal Cleon Fraze of Dayton, Ohio, United States, invented the similar integral rivet and pull-tab version (also known as ring pull in British English), which had a ring attached at the rivet for pulling, and which would come off completely to be discarded. He received US Patent No. 3,349,949 for his pull-top can design in 1963 and licensed his invention to Alcoa and Pittsburgh Brewing Company, the latter of which first introduced the design on Iron City Beer cans. The first soft drinks to be sold in all-aluminum cans were R.C. Cola and Diet-Rite Cola, both made by the Royal Crown Cola company, in 1964.[24]

The early pull-tabs detached easily. In 1976, the Journal of the American Medical Association noted cases of children ingesting pull-tabs that had broken off and dropped into the can.[23]

Full-top pull-tabs were also used in some oil cans and are currently used in some soup, pet food, tennis ball, nuts, and other cans.

Stay-on-tab

In 1958, American inventor Anthony Bajada was awarded the patent for a "Lid closure for can containers".[24] Bajada's invention was the first design to keep the opening tab connected to the lid of the can, preventing it from falling into the contents of the can. His patent expired in 1975 and has been directly cited in the mechanisms used by companies such as Crown Cork & Seal Co.,[25] Broken Hill Proprietary Co.,[26][27] and United States Steel Corporation.[28] Approximately one month after Bajada's patent expired, Daniel F. Cudzik, an engineer with Reynolds Metals, filed a design patent application for an "End closure for a container".[29] This later became known as a "Sta-Tab". When the Sta-Tab launched in 1975, on Falls City beer and, quickly, other drinks, there was an initial period of consumer testing and education. Cudzik later received patents for this "Easy Open Wall" (US 3967752, issued 1976-07-06 US 3967753, issued 1976-07-06). The validity of these patents was upheld in subsequent litigation.[30]

The similarly designed "Easy-open ecology end" was invented by Ermal Fraze and Omar Brown. Its patent application was also filed in 1975, less than two months after the expiration of Bajada's patent.[31] This design, like Cudzik's, uses a separate tab attached to the upper surface as a lever to depress a scored part of the lid, which folds underneath the top of the can and out of the way of the resulting opening, thus reducing injuries and roadside litter caused by removable tabs.[32]

Such "retained ring-pull" cans supplanted pull-off tabs in the United Kingdom in 1989 for soft drinks and 1990 for alcoholic drinks.[33]

Wide mouth

One of the more recent modifications to can design was the introduction of the "wide mouth" can in the late 1990s.[34] The American Can Company, now a part of Rexam,[35] and Coors Brewing Company have owned wide mouth design patent (number D385,192)[36] since 1997. Other companies have similar designs for the wide mouth. Ball Corporation's from 2008 has a vent tube to allow direct airflow into the can reducing the number of gulps during the pour.[37]

Press button can

One variation was the press button can,[38] which featured two pre-cut buttons—one small and one large—in the top of the can sealed with a plastic membrane. These buttons were held closed by the outward pressure of the carbonated drink. The consumer would open the can by depressing both buttons, which would result in two holes. The small hole would act as a vent to relieve internal pressure so the larger button could then be pressed down to create the hole used for consuming the drink. Consumers could also easily cut themselves on the edges of the holes or get their fingers stuck.[25]

Press button cans were used by Pepsi in Canada from the 1970s to 1980s and Coors in the 1970s. They have since been replaced with pull tabs. Used in Australia, locally known as "pop-tops", for soft drinks from 1977 to the early 1980s. However, Heineken Brewery did bring back press- or push button cans on the market in Europe as a short-lived marketing strategy in the 1990s.

Full aperture end[26]

Another variation on the drink can is the "full aperture end", where the entire lid can be removed – turning an aluminum can into a cup. Crown Holdings first designed the "360 End"[39] for use by SABMiller at the 2010 FIFA World Cup in South Africa.[40] It has been used by Anheuser-Busch InBev in China[41] and Brazil[42] and by the Sly Fox Brewing Company[43] in the United States.

Resealable lid

Another variation on the drink can is to have a resealable lid. A version patented by Cogito Can[44] in France has been used by Groupe Casino, the French grocery chain for its private label energy drink.

Recycling

The beverage can be recycled, and clean aluminum has residual market value, but recycled cans still need to be diluted by up to 50% virgin aluminum because the sides and tops of the can are of different alloys. The acronym UBC, for used beverage container, is employed by such companies as Apple, Inc for reference to the material of its portable laptop cases.[45]

Design

Most large companies serve their beverages in printed cans, where designs are printed on the aluminum and then crafted into a can. Alternatively, cans can be wrapped with a plastic design,[46] mimicking the printed can but allowing for more flexibility than printed cans.[47] A modern-day trend in craft alcohol is to design stickers to put on cans, allowing for smaller batches and quick changes for new flavors.[48]

Collecting

Beer can collecting was a minor fad in the late 1970s and 1990s. However, the hobby waned rapidly in popularity. The Beer Can Collectors of America (BCCA), founded in 1970, was an organization supporting the hobby, but has now renamed itself Brewery Collectibles Club of America to be more modern.[49]

As of late 2009, membership in the Brewery Collectibles Club of America was 3,570, down from a peak of 11,954 in 1978. Just 19 of the members were under the age of 30, and the members' average age had increased to 59.[50]

IV. CONCLUSION

Canned or tinned fish are food fish which have been processed, sealed in an airtight container such as a sealed tin can, and subjected to heat. Canning is a method of preserving food, and provides a typical shelf life ranging from one to five years. They are usually opened via a can opener, but sometimes have a pull-tab so that they can be opened by hand. In the past it was common for many cans to have a key that would be turned to peel the lid of the tin off; most predominately sardines, among others.

Fish have low acidity levels at which microbes can flourish. From a public safety point of view, foods with low acidity (pH greater than 4.6) need sterilization at high temperatures of 116–130 °C (241–266 °F). Achieving temperatures above the boiling point requires pressurized cooking.[1] After sterilization, the containing can prevents microorganisms from entering and proliferating inside. Other than sterilization, no method is dependable as a preservative. For example, the microorganism Clostridium botulinum (which causes botulism) can only be eliminated at temperatures above the boiling point.

Preservation techniques are needed to prevent spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes leading to a loss of quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish[27]

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www.ijarety.in editor.ijarety@gmail.com