CHAPTER 3

Nutrition and health, traditional foods and practices on the Island of Ireland

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Introduction

This chapter will highlight the major Irish food and beverage products, which have a place in both the domestic and international consciousness as well as identifying consumer trends and how their presence and formulation may be changing or adapting with our nutrition and food quality focused times (Byrne et al., 2013).

The definition of traditional foods and beverages in Ireland appears to be more fluid than in other countries with consumers, in general, open to reformulation of traditional recipes if it results in a healthier product (Byrne et al., 2013). For example,

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Fellendorf et al. (2017b) undertook a survey of Irish consumers ($n = 1045$) which investigated if they have assimilated the message of consuming healthier foods, including salt and fat reduced foods, into their diet. Thus, it seems that campaigns regarding the importance of a balanced diet have generally been adopted by respondents, as only a minority of the participants did not take care of their diet, independent of age, gender and level of education. More than half of the participants carefully maintained a balanced diet. Furthermore, an increase in purchasing salt reduced food was observed, although fat reduced food products were already better accepted.

Additionally, there was no conflict observed for traditional foods reduced in salt and fat content when their intrinsic sensory character is maintained. Many traditional food manufacturers are working on recipes low in fat and salt, while in parallel public health campaigns are promoting the consumption of healthier foods (Fellendorf et al., 2017b). Many countries have begun with campaigns to reduce the dietary salt and fat consumption in their population. The demand for healthier traditional foods has concurrently increased. Hence, consumers demand for healthier and more natural food is confronted with the need also for convenience foods (de Barcellos et al., 2011).

Irelands traditional food production geography

Ireland is a country with a temperate climate with enough rain and sunshine to allow grass, which covers 81% of agricultural land (hay and grass silage (3.6 million hectares)), to grow optimally. Irish farmers capitalize on this with the production of high quality meat and dairy production. An additional 11% of agricultural land is dedicated to rough grazing (0.5 million hectares) and 8% to crops, fruit and horticulture production (0.36 million hectares) (Bord Bia, 2017a). This very natural pastoral production system has its origins in traditional farming practices that have evolved to capitalize on the benefits associated with fertile land, optimal rainfall and sufficient sunshine levels that allows grass to grow abundantly. The southern part of Ireland in the province of Munster, is particularly noted for exceptional beef and dairy production with many of the large processors maintaining large butter, cheese, milk powder and meat (fresh and processed) processing facilities in the counties of Cork, Waterford and slightly further east in Kilkenny (Leinster). Hilly and mountainous regions, as found in the west of Ireland (Kerry, West Cork, Clare, Galway, Sligo, Mayo) lend themselves to lamb and mutton production with sheep grazing freely on small-holdings or common pasture land. The coastal ports of Cork, Kerry, Kilkenny, Galway and Donegal harvest Pelagic (Herring, mackerel, sprat, salmon, tuna), Demersal (Cod, plaice, ling, hake, sole) and Crustacean (Crab, lobster, mussels, clams, oysters) species from traditional fishing grounds.

History, eating cultures and traditions

Ireland is an old and ancient land inhabited by the ancestors of the Celts with a long, diverse and evolving culture of traditional food production and consumption. There

are many references to food and drink in early Irish culture. Honey was widely consumed and used to make the alcoholic beverage "mead." Ancient archaeological sites have unearthed "fulacht fia" or cooking troughs, which were filled with water and hot stones to cook meats such as venison. The Vikings and Normans invasions resulted in the intermingling of the Celtic bloodline, but also influenced agricultural and food production practices. Excavations of Viking settlements, such as those found at Wood Quay in Dublin, show dietary evidence of meat consumption such as sheep and beef, but predominantly pork. Poultry and wild geese were eaten along with a diverse variety of shellfish and fish. Seeds such as knotgrass and goosefoot are thought to have been used to make porridge and consumed along with foraged berries and hazelnuts. In modern times the subconscious constructs of Irish culture are also often linked to Irish traditional foods and beverages. Kerrygold butter, Guinness stout beer, the humble potato or Irish whiskey have come to symbolize Irish culture due to the widespread distribution of her diaspora and their influence on their subsequent communities and through media dissemination. More recently, pasture fed Irish beef and Baileys cream liqueur have joined this extensive list of Irish traditional products.

Typical Irish foods and food products, their composition benefits and adverse properties

Pasture fed Irish cows (beef/dairy)

In 2017, the United States Department of Agriculture's (USDA) approved Bord Bia's (Irish Food Board) proposals to advertise Irish beef, as pasture fed and promote the unique quality of Irish beef to US consumer. Production of dairy and beef cattle in Ireland has the unique advantage of a production system that is perfect for growing grass with animals grazing for up to 10 months of the year (300 days) (Bord Bia, 2017a). For the rest of the year when the animals are store fed they still feed on grass-based forages predominantly silage. This sets Irish beef apart from other countries where animals are store fed in intensive feedlots for the majority of their lives absent of the opportunity to express any kind of natural browsing behavior or feeding regime. This pasture based livestock production system can minimize Green House Gas (GHG) emissions compared to non-pasture systems. Thus Ireland's sustainable, ethical production scheme is advantageous to the environment, animal, the consumer as well as the quality and sensory properties of the finished product both dairy and meat based. Meat from pasture-based productions systems is often leaner (Scerra et al., 2014) with a more nutritionally beneficial fatty acid composition containing higher levels of $n-3$ polyunsaturated fatty acids (PUFA) and conjugated linoleic acids (CLAs) (Aldai et al., 2011). Fresh grass feeding regimens also produce a milk fat with higher proportions of unsaturated FA compared to those derived from total mixed ration (TMR) indoor grass/maize/grain silage and concentrate feeding systems (Couvreur et al., 2006), extensively practiced in the United States, Asia and parts of Europe. Additionally, there is evidence that pasture feeding also produces a superior

dairy products from a hedonic sensory perspective (O'Callaghan et al., 2016). Also pasture-derived feeding systems were shown to produce Cheddar cheeses yellower in color than that of TMR, which was positively correlated with increased cheese β-carotene content. The nutritional composition of Cheddar cheese was also improved through pasture-based feeding systems (O'Callaghan et al., 2017). The nutritional value of butters can also be improved by pasture feeding, with such butter having significantly higher concentrations of conjugated linoleic acid (cis-9,trans-11) and trans-β-carotene and scoring higher for hedonic appearance, flavor, and color compared to butter from concentrate fed animals (O'Callaghan et al., 2016).

Lamb

Connemara hill lamb achieved PGI (Protected Geographical Indication) status from the EU in 2007 and is produced from a sheep breed, the Connemara black-faced sheep indigenous to the Connemara hill region since the 1800s. The black face sheep is slow maturing which allows it to produce lean succulent rose red meat, with low fat cover, flavored by the foraged herbs, heathers and grasses giving the meat a unique flavor, which is particularly linked to the Connemara region. The main forage constituents are the grasses Agrostis, Festuca and Molinia and the sedges Carex, Scirpus, Eriophorum and Trichophorum as well as the heathers *Calluna vulgaris*, *Erica tetralix* and *Erica cinerea* and the plants *Narthecium ossifragum* and *Potentilla erecta* (Connemara, 2017).

Clare Island Salmon

Clare Island Salmon produced in near Clare Island in Clew bay, Co. Mayo is an organically farmed Atlantic salmon which was awarded PGI status in 1999. Fed on a GMO free organically produced diet derived from fish trimmings of fish caught for human consumption these salmon are also reared in larger pens that normally farmed salmon. This lower stocking density allows the fish to improve muscle quality while minimizing parasitic infections as they grow in these clean unpolluted waters. The flesh of Clare Island Salmon is thus low in fat and firm and thought to be more similar to wild salmon than the standard farmed variety.

Processed meats

Sausages

Many countries have their own traditional sausage recipes, which vary depending on region, county or even city of production. Ireland is no different with sausage products diverse in flavor and texture due to their constituent composition. In ancient times sausages or puddings were a favorite dish, made similarly to the present day, by filling the intestines of a pig, cow, or sheep with minced-meat and blood. They were known by the

terms *indrechtan* and *maróc*. Puddings and sausages were boiled to half cooked and then when brought to table they were fried and served hot as at the present day (Joyce, 1906).

In Ireland and the United Kingdom, breakfast sausages are virtually identical and manufactured from pork or beef along with herbs or spices, cereals or rusk. They form part of the "Irish Breakfast" which is a legacy from the English occupation of Ireland, up to 1921, and the adoption of the English breakfast in to the culinary cannon. Traditionally, the main ingredients in the "Irish Breakfast" include bacon rashers, pork sausages, fried eggs, white pudding, black pudding, toast and also optionally a fried tomato, button mushrooms, baked beans, hash browns, and brown soda bread. Irish/English breakfast sausages are stuffed into casings such as collagen, or natural casings derived from pig, sheep or cattle intestine, linked and sold fresh, after which they are fried or grilled by the consumer. Other popular varieties include the Cumberland and Lincolnshire sausage, with their own unique flavors as derived from their respective traditional spice mixes. Similar varieties also exist in the United States as well as in northern Europe (O'Sullivan and Kerry, 2011).

Black pudding

Black pudding or blood sausage is a type of sausage produced from the blood of cattle, pigs, sheep or goats and regional varieties exist across the globe, from Europe, to the United States, to Asia (O'Sullivan and Kerry, 2011). In 800 BC black pudding appeared in literature for the first time since black pudding was mentioned in Homer's classic saga "The Odyssey": "As when a man besides a great fire has filled a sausage with fat and blood and turns it this way and that and is very eager to get it quickly roasted." In the past black pudding was not just food for the poor, it was also included in a nobility breakfast for example held by King Henry VIII (King of England from 1509 to 1547). In the 17th century, the consumption of black pudding was a theological debate. Many Christian scholars believed that nobody should eat it at all. Different national varieties of black pudding also exist.

Traditional blood sausages are also popular in Ireland and England, where they are consumed typically sliced and fried as a special feature of the traditional Irish and English breakfast. This is a substantial meal consisting of bacon, a slice black and white pudding, pork breakfast sausages, beans, tomatoes, eggs and toast (The English Breakfast Society, 2014a). Black pudding, typical of those consumed in Ireland and the United Kingdom, contains lean pork meat, pork fat, pork blood powder, grains, onions, salt and seasonings. In contrast, white pudding is manufactured without blood and contains generally a higher amount of cereal grains and spices. All ingredients are chopped and cooked in casings. Consumers usually fry the pudding slices in a pan and served as part of the Irish breakfast or just with bread. Famous Irish versions of this product type include Clonakilty black pudding and Timoleague black pudding (O'Sullivan and Kerry, 2011). Both of these particularly famous black pudding products, unlike many of the other Irish varieties, are in fact brown in color and not black but both are produced in the area of "West Cork"

in southern Ireland. Clonakilty black pudding, made in the town of Clonakilty, is made from an original recipe dating from the 1880s. Timoleague black pudding is made from fresh pigs' blood, pork trimming, cereal, fresh onions, seasonings, spices and natural casings. This pudding has a Protected Geographical Indication (PGI) which stipulates is must be made from locally sourced meat ingredients and within a six-mile radius of the factory in Timoleague. The non-meat ingredients for this product must be sourced in Southern Ireland and within a 100 miles radius of the Timoleague plant.

Drisheen is another famous blood pudding speciality predominantly from Cork, Ireland, but includes sheep, cows/pig blood in the recipe. It has been mentioned in both ancient and modern Irish literature from the writings of James Joyce to the 11th century "Aislinge meic Conglinne" (The Vision of Mac Conglinne). This traditional dish from Cork city is in decline due to the predominance of the non-sheep blood black pudding varieties and the loss of the small local butcher's shop.

White pudding

White pudding meat products are also popular in Ireland and in the United Kingdom and contribute a special feature of the traditional Irish and British breakfast (Ayto, 1990). Also called Oatmeal pudding (white pudding), popular in Europe and America, is a processed meat product containing generally pork meat, fat, seasonings, bread, oatmeal and other cereal grains. These puddings can be filled into large sausage casings, formed into a semi-solid congealed loaf or encased in an animals' stomach and cooked whole, cut into slices, fried or grilled. Recipes and servings differ dramatically from country to country (Fellendorf et al., 2015, 2016). In general, it is manufactured from lean pork meat, pork fat, grains, onions, salt and seasonings, and is similar in nature to black pudding products, but lacks the blood component present in the latter form. The fat content of commercial available white puddings range from 6.0% to 22.4% though the majority of the products contain between 12% and 18% fat (unpublished data, 2013; Fellendorf et al., 2015, 2016). White pudding is generally served accompanying black pudding with an Irish breakfast. Some innovative processed meat producers (Rudd's, Birr, Ireland) have even combined the two by producing a black pudding with a white pudding core.

Bacon and ham

Cooked cuts of salted/cured pork in Ireland is called it bacon. Before the industrial revolution (1760–1840), bacon was traditionally produced on local farms. It was common to produce it at home as a large percentage of the population kept pigs. Therefore, each family had their own secret recipe. Up until the 19th century, almost all bacon was dry-cured. Today it is less common and more expensive than commercially produced bacon. Bacon is purchased uncooked and then cooked at home. The Irish national dish Bacon and cabbage is traditionally by boiling a cut of bacon in a large pot after which cabbage is added and when both are ready served with potatoes which have boiled in

their skins. The potatoes are then peeled at table and served with full-fat Irish butter. The term Bacon also refers to bacon slices called rashers, which a very traditionally Irish meat product is made from the loin in the middle of the back of the pig and belongs to the traditional Irish breakfast. The Irish bacon tends to have a layer of fat (pork belly) around the meat cut, unlike Canadian bacon, and is either; wet- or dry-cured and unsmoked. In comparison, traditional Irish bacon is much leaner and cooked until it is done, but not crisped like American style smoked side bacon made only from the pork belly (The English Breakfast Society, 2014b).

Bacon and bacon rashers may also be smoked which traditionally increased the preservation characteristics but also imparts great flavor. The primary purpose of smoking meats is to enhance and create unique product flavors and produce distinctive color attributes in cured meat products, all of which is dependent on the wood source used (wood type), the substrate from which the smoke is derived (wood, chip, sawdust, liquid sources, etc.) and the technology (hot or cold) used to produce the smoke (kilns, friction smokers, atomizers, etc.) (O'Sullivan and Kerry, 2011). Smoking considerably reduces the microbial populations on meat surfaces due to the antibacterial properties of some smoke constituents and through the dehydration of the muscle foods, thereby resulting in lower levels of moisture available to support microbial growth. Smoke components, such as; acetic acid, formaldehyde, phenols and creosote prevent microbial growth at the surface, but also, as far as the smoke penetrates into the muscle, which will be limited (O'Sullivan and Kerry, 2011).

Ham is similarly prepared to bacon but is purchased cooked and can also be smoked. A whole ham is produced from a cured pork hind leg, which is predominantly rump. After injection of the salt and nitrite containing curing brine the whole muscle (deboned) is usually tumbled in a meat tumbler for up 2 h which helps extract the proteins (actin and myosin) which will assist in binding the meat together during cooking. Once tumbled the meat pieces can be bound with netting or in steel compression molds before cooking. At Christmas time many Irish families will buy a whole or half ham which is served sliced with the traditional turkey dinner. In this case the muscle is purchased uncooked and then cooked at home, but is still referred to as ham. Cooked sliced ham is the typical traditional delicatessen Ham used in sandwiches and salads. It can be sliced in shop or bought pre-sliced in modified gas atmosphere (N_2/CO_2) flushed convenience packs. Typically this type of ham, or crumbled ham, has been rolled in crumb (cooked wheat flour with spices, paprika) prior to slicing.

Corned beef

Corned beef is a traditional cured meat product common to in Ireland but also popular in Western Europe, America and the United Kingdom. The term "corned" comes from the usage of large grained rock salt, as it looks like a wheat kernel known as a corn of salt (Oxford English Dictionary, 2010). In the 12th century, corned beef was a delicacy given

to the Irish king. Corned beef is first mentioned in the old Irish Gaelic poem Aeslinge Meic Conglinne "The Vision of MacConglinne" in the 12th century, which describes corned beef as a delicacy given to a king. In the 19th century corned beef was a festive dish in Ireland, served with cabbage and potatoes at Christmas, Halloween, weddings, wakes and on St. Patrick's Day. This tradition was transferred all over the world, especially to North America, by the emigrants of the 18th/19th centuries (Mahon, 1998). Irish produced corned beef was a stable of the British navy where it was produced from the 17th to the 19th centuries and was shipped to the colonies. There is evidence of a strong trade in Irish corned beef as a staple for African slaves in the French West Indies and in other French colonies (Mac Con Iomaire and Óg Gallagher, 2011). Later on, in the 19th century, corned beef was a festive dish for everyone in Ireland. It was served traditionally with cabbage and potatoes on special occasions, like; Christmas, Halloween, weddings, wakes and on St. Patrick's Day. In the 18th/19th centuries, Irish emigrants carried the tradition of corned beef manufacture all over the world, especially to North America (Mahon, 1998). In modern times, corned beef is widely available either as a full piece of beef or canned, though the recipes, and consequently the flavor differs (Mac Con Iomaire and Óg Gallagher, 2011). Besides a beef content of 50–95%, corned beef further contains sodium chloride and nitrite. Depending on the type of corned beef being produced, it can also contain additional ingredients, such as; starches, flours (thickeners); phosphate derivate (stabilizers), ascorbate derivate (antioxidants), glutamate derivate (flavor enhancers), dextrose and spices (unpublished data, 2014). Corned beef in its canned form was an important food source during World War II. The sodium content of the available corned beef in Ireland ranges from 0.7 g/100 g to 1.0 g/100 g (unpublished data, 2014). This tradition of production has continued to this day and it is produced and sold in "The English Market" in cork city from lean silverside beef or lass lean brisket by the O'Coughlan family butchers (Mac Con Iomaire and Óg Gallagher, 2011). Spiced beef is another famous Cork variant of corned beef which is produced similarly but with the inclusion of spices such as pimento, cinnamon, ground cloves, ginger and black pepper in the curing brine. Beef eye of the round or brisket is allowed to soak in this spiced brine for a month or 2. It is a very popular traditional product served again during the Christmas period. Durcan's butcher, again located in "The English Market" in cork city is a famous producer of this traditional Cork beef product.

Dairy and dairy products

Milk

Milk, principally cows, is produced and consumed today in Ireland as a traditional beverage very much in the same fashion as in ancient times although sheep and goat milk were also consumed then as now. Milk is defined as the secretion of the mammary glands of mammals, its primary natural function being nutrition of the young. Milk of some animals, especially cows, buffaloes, goats and sheep, is also used for human consumption, either as such or in the form of a range of dairy products (Walstra et al., 2006a). Called

"Bainne," the Irish Gaelic for milk, the main difference is that modern milk is pasteurized (72 °C, 15 s). In 2016, €521 million worth of drinking milk was produced in Ireland. Milk production has been growing in Ireland following the removal of EU milk quotas in 2015. 6.65 billion liters were produced in 2016 by a national herd of 1.4 million animals farmed by 80,000 dairy farmers (IFA, 2017). Good quality milk has a bland but characteristic flavor with a pleasant mouth-feel, determined by its physical nature, i.e., an emulsion of fat globules in a colloidal aqueous solution, and a slightly salty and sweet taste, due to the presence of salts and lactose (Thomas, 1981). When good quality raw milk is pasteurized under minimal conditions, e.g., 72 °C for 15 s, the flavor is barely affected. As more stringent conditions are used, the more the flavor gradually moves toward that of UHT milk (Nursten, 1997). Virtually no UHT milk is consumed in Ireland with virtually all being pasteurized. More intense heat treatment, e.g., 80–100 °C for 20 s, results in a "cooked" flavor, caused mainly by H_2S (Walstra et al., 2006b). This defect thus is not found in Irish liquid milk. Milk is composed of sugars, proteins and fat. Lactose, which imparts the taste sweetness to milk is a the reducing sugar, also known as milk sugar, is the distinctive carbohydrate of milk and is a disaccharide composed of glucose and galactose. Milk fat consists of triglycerides (~98%), the vast majority of which are even-numbered saturated fatty acids esterified on glycerol (Kilcawley and O'Sullivan, 2017). Milk also contains numerous minor proteins, including many enzymes as well as the minerals K, Na, Ca, Mg, Cl, and phosphate (Walstra et al., 2006a). Calcium phosphate in milk and dairy products is absorbed by humans and is important for bone growth and development (O'Sullivan, 2017b). Irish milk composition is subject to seasonal changes with increasing protein levels from Spring to Winter and slightly reducing lactose levels. Milk is not just a beverage but a raw ingredient for other dairy products such as butter, yoghurt and cheese as well as whole milk, skim and whey derived powders.

Butter

Butter is a traditional Irish food, which is widely consumed domestically but also very well known all over the world. Kerrygold Irish butter is today the most well know branded butter product in the United States and Germany. Kerrygold was first launched in 1962 by the dairy farmers and producers' co-operative "An Bord Bainne" (The Irish Dairy Board), now known as "Ornua." This co-operative sells and markets dairy products internationally on behalf of members and in 2016 sold 320 million retails packs across 90 countries globally making it one of Ireland must successful commercial dairy products and traditional foods. Irish butter is a food in its own right, which is traditionally, spread on bread, toast, or on boiled potatoes served at the dinner table. It is also an ingredient in processed foods such as pastries and convenience dishes. Butter consumption is again increasing in Ireland as more consumers move away from using vegetable oil based spreads as consumers see butter as a more natural, healthy and tasty product based on recent reports that the saturated fats in butter have many natural health benefits (Bord Bia, 2017b).

Butter is a water-in-oil (W/O) emulsions in which water forms the dispersed phase and oil forms the continuous phase. Butter is mostly made today by a continuous churn process as opposed to the batch approach. Different types of butter are available on the market such as sweet cream (salted or unsalted), cultured, and whipped butter, but in Ireland is sold domestically and internationally in the salted format. The natural conditions of the production area directly affect the quality of the dairy products (O'Sullivan, 2017b). Thus, the aroma and flavor of butter can vary depending on the season of production as well as the feed the animals are consuming (Gori et al., 2012). For example a higher amount of fresh grass in the animal diet is reported to significantly increase the relative amount of α-linolenic acid (Dhiman et al., 1999) and CLA (Conjugated Linoleic Acid) (O'Callaghan et al., 2016) in milk. Fresh grass feeding regimens, widely practiced in Ireland and New Zealand, produce a milk fat with higher proportions of unsaturated FA compared to those derived from total mixed ration (TMR) indoor grass/maize/grain silage and concentrate feeding systems (Couvreur et al., 2006), extensively practiced in the United States, Asia and parts of Europe. Additionally there is evidence that pasture feeding of Irish cows also produces a superior dairy product from a hedonic sensory perspective (O'Callaghan et al., 2016). Dairy manufacturers produce large amounts of butter in the winter months. It is often necessary to store this butter for extended periods until there is a demand for it. Freshly churned salted butter is characterized by an intense cooked/nutty flavor which likely comes from the high heat treatment that the cream receives prior to churning. This flavor is known to rapidly dissipate in butter (Bodyfelt et al., 1988). In general, cooked/nutty flavor decreased more rapidly in butters across storage compared to milk fat flavor while salty taste stays unchanged with storage time and off-flavors described as refrigerator/stale flavors increase to a greater extent in chilled stored as opposed to frozen stored butter (Lozano et al., 2007). Its nutritional value, due to a high content of fats, vitamins and minerals, and its unique and pleasant flavor make butter particularly appreciated by consumers (Mallia et al., 2008).

Cheese

The flavor of cheese governed by three main biochemical pathways; glycolysis, lipolysis and proteolysis. In general terms, the extent of each of these processes is characteristic of the individual cheese variety (Kilcawley and O'Sullivan, 2017). In Ireland cheese can be made from cows, sheep, goats milk. The milk is acidified typically through the action of an added starter culture of bacteria (lactic acid bacteria) which convert lactose in to lactic acid. Rennet is then added which is a complex mixture of enzymes containing, chymosin being the main protease, extracted from the stomach of calves which curdles the casein in milk. The curds and whey are then separated with the curds typically formed in to molds and ripened to make cheese (O'Sullivan, 2017b). Cheese sensory properties can be categorized as taste, texture and aroma/flavor properties, but color is also important for some varieties. With regard to taste, salt (NaCl) is of particular importance as it directly impacts

on taste and acts as a flavor enhancer and influences structure and rheological properties of cheese. The extent of the impact of salt in cheese flavor depends upon its concentration, cheese composition and the age of the cheese. The biochemical reactions in cheese are primarily initiated by the addition of microbial populations and/or exogenous enzymes during production. Cheese is a dynamic product, with many varieties having up to 100 billion bacteria per gram, all of which metabolize carbohydrates, lipids and/or proteins to create a myriad of aromatic and sapid compounds that contribute to cheese flavor. These biochemical reactions are in turn influenced by the milk (type, quality and treatment), production equipment/processes, indigenous/exogenous microbial populations (selection and concentration), indigenous/exogenous enzymes (selection and concentration), salting (dry and brine), production processes and ripening regimes (time, temperature and humidity), all of help contribute to the wide variety of cheeses available (Kilcawley and O'Sullivan, 2017; O'Sullivan, 2017b).

Cheddar cheese is by far the most commonly consumed cheese product by Irish consumers, but also by far the most produced cheese by processors in Ireland with most made for export. In 2016 the United Kingdom imported 78,000 tonnes of Irish Cheddar, which accounted for 82% of all the cheddar they imported. Cheddar is a typical English hard cheese, which originates from Somerset in the village of Cheddar in the United Kingdom, but is so well established in Ireland it is considered a traditional product. It has been commercially manufactured in Ireland since 1900, again predominantly for export to the United Kingdom. For cheddar cheese production, with potential maturation times of up to 2 years, the cheddar cheese grader plays a vital role in monitoring on-going quality development (Kilcawley, 2016). This specially trained grader decides which cheese meets the quality grade or criteria is held for maturation while inferior graded cheese may be sent to processing early as the experienced grader will determine that it cannot obtain the desired quality if held for longer. In many cases they will try to identify a specific time that the cheese should be retailed at, or if it should be re-evaluated in the future to ensure that it is following a predicted quality route (Kilcawley, 2016; Kilcawley and O'Sullivan, 2017). Cheddar cheese has a mild to strong flavor with textures ranging from pasty to crumbly depending on the length of ripening. Imokilly regato is a cows milk cheese made in Mogeely in East Cork, Ireland. This cheese has a PDO (Protected Designation of Origin) since 1999 and is similar to hard Italian Regato type cheeses, with a mild but slightly piquant flavor and yellow color.

Since the 1970s Irish farmhouse cheeses have achieved widespread success and these artisan high quality products have found their own modern niche and are now considered traditional cheeses. Ardrahan, is a pungent semi-soft cheese described as having buttery textured honey-colored center with a complex flavor. Originally produced during the mid-1800s its production fell in to decline only to be rediscovered in the 1980s (Cowan and Sexton, 1997). Gubbeen (Schull, west Cork) is a semi-soft washed-rind cheese made from pasteurized cow's milk with a smokey buttery flavor (Bord Bia, 2010).

Beverages

Baileys cream liqueur

Cream liqueurs typically contain 10–20% sucrose, thus a high osmotic potential, and between 10% and 15% alcohol by volume (ABV) ethanol content. Irish cream liqueurs are typically composed of cream, sodium caseinate, sugar, alcohol, flavors, colors and low-molecular- weight surfactants (Banks and Muir, 1988; Lynch and Mulvihill, 1997; O'Sullivan, 2011). Corn syrups, molasses, maltose, ribose, galactose, honey, lactose, sucrose, dextrin, modified starch and glucose have been proposed for use as the carbohydrate source in cream/alcohol containing beverages (Rule, 1983). Typical manufacture of a Irish cream liqueur involves the preparation of a caseinate trisodium-citrate blend at 55–85 °C, followed by addition of cream and molten glycerol monostearate (GMS) with continuous high speed mixing to give the cream base. An aqueous-ethanol-sucrose solution is then added to the cream base and mixed thoroughly (Muir and Banks, 1985, 1986; Dickinson et al., 1989; Lynch and Mulvihill, 1997; O'Sullivan, 2011). Various food grade thickeners may be added to contribute to the mouthfeel of cream liqueurs (Banks et al., 1981). The flavor of Irish cream profile liqueurs involves a complex interaction of volatile and non-volatile flavor compounds which originate from cream, cocoa, vanilla, top notes and whiskey. High quality Cream Liqueur can have shelf lives of 2 years when stored in ambient conditions and can maintain their sensory quality even further when stored under refrigeration conditions. One of the limiting factors to the sensory quality of cream liqueurs is the formation of ethyl esters which increase in concentration over time. These compounds are formed from the reaction of fatty acids and alcohol and manifest as fruity notes in the cream liqueur (O'Sullivan, 2011). Line extensions which include flavor variants of the original formulation are available and have included; chocolate luxe, chocolate cherry, vanilla cinnamon, salted caramel, expresso crème, pumpkin spice, almond milk, orange truffle, hint of mint chocolate, hint of Coffee Flavor, biscotti, crème caramel, etc.

Beer, lager, ales, stout and cider

Beers such as lager, stout, boch or wheat beer have their own unique characteristic sensory profiles and sensory attributes which define quality, freshness or the degree to which they have aged (O'Sullivan, 2011). Pale lager is the most widely consumed and commercially available style of beer in the world and the most popular type of beer consumed in Ireland. The flavor of these products is usually mild and the producers often recommend that the beers are served refrigerated. In general, lagers display less fruitiness and spiciness than ales, simply because the lower fermentation temperatures associated with lager brewing causes the yeast to produce fewer of the esters and phenols associated with those flavors. Beer typically has a shelf life of between 6 months and 1 year depending on the type and whether it is canned, bottled or kegged. The production of flavor-active

compounds like carbonyls are associated with extended storage (Hempel et al., 2013). Also, an initial acceleration of sweet aroma development, the formation of caramel, burnt sugar and toffee-like aromas (also called leathery) coincides with the sweet taste increase (Vanderhaegen et al., 2006). Although the most consumed lagers in Ireland are the prominent Dutch brand the main indigenous Irish lager is Harp, produced by Diageo Guinness PLC Ltd., but which is mainly consumed in northern Ireland. Craft beer production has experienced dramatic growth in the last 10 years but it is too early to say whether this is just a trend or these beers will truly establish themselves as traditional brands.

Ales have had a long tradition of consumption in Ireland. Smithwicks draught aleis a red ale (4% ABV), very popular throughout Ireland (Cowan and Sexton, 1997). The Smithwicks Brewery in Kilkenny has been in operation since 1710 in one form or another and is currently owned by Diageo Guinness Ltd.

Guinness a dry Irish black stout has been produced in Dublin at the St. James's Gate brewery (now Diageo owned) since 1725. It is a creamy thick beer with roasted malted barley notes carbonated with nitrogen and carbon dioxide. Regional variants of stout exist and are popular in the south (Cork) of Ireland including Murphy's and Beamish stouts. These are also roast malted stout beers with typically creamy heads. Beamish is described as having a bitter taste, but with sweet notes.

Bulmer's cider (4.5% ABV) is a conventional cider beverage produced by Cantrell and Cochrane (C&C) Ltd. with production started in 1935 by Bulmer-Magner Ltd. It is typically drunk in summertime, especially on hot days served in pint glasses with ice.

Gin

Cork Dry Gin (37.5% ABV) is the oldest and most prominent of the gins produced in Ireland. It is made from triple distilled corn spirit blended with botanicals including berries fruit and flavors. The Cork Distillers company (CDC), founded in 1793 first made this product which is now owned by Pernod Ricard and produced in Middleton East Cork. In recent times Gin production has undertaken a resurgence with many small distilleries producing their own distinctive and unique products.

Whiskey

For whiskey, Lee et al. (2000) reviewed the origins of the flavors in whiskies and developed a revised flavor wheel for Scotch whiskey. In whiskey, spicy, smooth, vanilla, woody and sweet aroma notes increase with time (Piggott et al., 1993), which is caused primarily by materials such as vanillin, aromatic aldehydes and other materials extracted from the wood (Conner et al., 1999). The taste and odor of freshly distilled spirits, particularly whiskey, is rather raw and unpleasant; desired flavor components develop during years of aging in wood (Freitas and Costa, 2006). Irish whiskey (*uiske beatha in gaelic, meaning water of life*), spelled with an "e" is considered smoother than scotch as peat is not generally used. Famous Irish brands include Jameson, Powers and Bushmills. Whiskey

production has resurged in recent years with many new distilleries in operation, but only the main brands offer products with any real vintage. Irish whiskey is aged in oak casks for a minimum of 3 years where evaporation, called the angels share, results in flavor concentration while additional flavors seep from the wood of the cask in to the liquor, resulting in more complex flavor generation as they age (O'Sullivan, 2017d).

Mead

Bee keeping for the purpose of harvesting honey has been practiced in Ireland pre-dating the arrival of Christianity, where the ancient Irish "Brehan Laws" (early medieval Irish law) outlined good practices and rules. Honey was used as sweetener of foods and beverages (milk) but also fermented in to the aristocratic alcoholic beverage "mead" (Cowan and Sexton, 1997). The "honeymoon" has its roots in the Irish tradition of newlyweds drinking honey wine (mead) everyday for one full moon (a month) after their wedding.

Tea

Ireland is Europe's leading nation of teas drinkers. As such, there are a couple of national tea blends with a very staunchly loyal followership by their respective consumers. Barry's tea is a tea blend, predominantly African but also Indian, produced in Cork since 1901. Lyons and Bewleys tea, packed in Dublin, are also popular household brands. Sold as loose teas leaves and teabags with the latter accounting for over 75% of sales of Irish tea. Tea is consumed all year round as a beverage alone and is also consumed with meals, including breakfast, lunch and dinner.

Bread, soda bread, boxty and Blaa

For breads, leavening is usually achieved biologically by the use of baker's yeast during proofing (fermentation). Soda bread is very popular bread type of Ireland, originated in the mid 1800s, and leavened chemically with baking soda (sodium bicarbonate) which reacts with acids in the dough (e.g. buttermilk) to produce gas. In both cases of leavening, either biological or chemical, this gas, carbon dioxide (CO_2), is essential for the formation of the breads light cellular foam like network which forms a sponge structure on baking (O'Sullivan, 2017d). Known also as soda farl or cake (Northern Ireland) it is commonly eaten, smeared with butter, at breakfast or lunch and sometimes as sandwiches. Boxty is a potato (raw and boiled) based bread popular in the north and west of Ireland and consumed similarly to standard bread. The Waterford Blaa, is a famous local bread from the south east of Ireland similar to a bap or bread roll, but more square and proud in shape. The dough is composed of white flour, yeast, water and salt dough with portions dusted with flour before baking. It originated in this region from French Huguenots settlers in Waterford city circa the 1690s. In 2013, the Waterford Blaa was awarded PGI (Protected Geographic Indication) status by the European Union.

Irish potatoes

Ireland is famed for its potato consumption which is linked to the dark and tragic history of the "Great Hunger, an Gorta Mór" potato famine of 1845–52. Potato blight, a disease of the oomcyte (non-fungus) *Phytophthora infestans* devastated the potato crop during those bleak years resulting in 1.5 million deaths and initiating a concatenation of emigration which lasted more than 100 years. The famine potato, the Lumper, was used during the pre-famine era because it was high yielding and grew well in nutrient poor soil. It is described as waxy more than floury, but is now no longer consumed. The main varieties consumed today include Rooster, White, Queen and Kerr's pink and are available all year round. All are quite floury and are consumed boiled whole and peeled or mashed. Kerr's pink are more suited to steaming because they absorb too much water when boiled but produce a very flavorsome floury potato when prepared in this fashion.

Food preservation, shelf life and environment (preservation options)

Consumer desire and demand for a wide range of fresh and minimally processed foods inspire food researchers to improve food quality, freshness and increase the shelf life of such products through packaging innovations. There are four categories of preservative packaging that can be used with raw muscle foods or cheese. These are high oxygen modified atmosphere packs (high 02 MAP), low oxygen modified atmosphere packs (low 02 MAP), controlled atmosphere packs (CAP) (Gill and Gill, 2005) and vacuum packs (VP). Modern meat packaging methods maintain a low microbial load while optimizing the sensory quality of a product. However, in Ireland high MAP (70% O_2) is the only MAP technique utilized by the industry. MAP is recognized as one of the most effective methods for shelf life extension of fresh meat and is widely used by the industry to reduce spoilage of minced meat (Koutsoumanis et al., 2008). Packaging beef in MA packs and storing at low temperatures extends the product shelf life considerably (Young et al., 1983).

Low 02 MAP are generally packed with CO_2, the antimicrobial and also N_2 as the pack shape stabilizer (Sørheim et al., 1997). The absence of 02 in an 02-free MAP or controlled atmosphere packaging (CAP) system results in a significant shelf life extension. Cooked meat products are usually MA packed using a combination of 70–80% nitrogen and 20–30% CO_2. This packaging format is popular in the Irish retail sector for packaging cooked chicken, turkey, ham and even beef (O'Sullivan, 2017e,f).

MAP is also used in Ireland to pack cheddar cheese slices where the gas is usually 100% CO_2 or CO_2/N_2 combinations which prevent mold growth on the surface. Grated cheese can also be packed in similar gas mixtures but due to the increased surface area of the product it is much more susceptible to lipid oxidation and thus a light absorbing layer must be incorporated by using a printable and transparent UV-protected and light resistant film (O'Sullivan, 2017d,e).

Vacuum packaging involves the evacuation of air from the packs prior to sealing and is used extensively in the meat poultry and cheese packing industries (O'Sullivan, 2017f).

Present nutritional conditions (statistics, trends, epidemiology) with respect to deficiencies, remedies and safety aspects (chemical and microbiological)

Salt reduced varieties of processed meat sausage (breakfast sausage, black and white pudding, cured meats)

Many studies have looked at sensory focused salt and fat reduction, without utilizing replacement ingredients, in processed meats including beef patties (Tobinal., 2012a), breakfast sausage (Tobin et al., 2014), frankfurters (Tobin et al., 2012b) white pudding (Fellendorf et al., 2015) and black pudding (Fellendorf et al., 2017a) to mention but a few. These studies essentially sequentially reduced salt and fat, without using alternative ingredients, in order to determine sensory optima but maintaining safety, functionality and adequate shelf life. Reductions in salt content could also be optimized by using packaging technologies to compensate for loss of safety or shelf life (Fellendorf et al., 2018b; O'Sullivan, 2017a).

Salt and fat replacers can offer even further possibilities with respect to reduction of salt and fat in processed meats. The use of ingredient replacers such as hydrocolloids have been used in processed meat products for many years to improve properties such as water binding and texture due to their ability to thicken, gel, bind, stabilize emulsions and pH (Fellendorf et al., 2015, 2016). Hydrocolloids, based on animal proteins, include; casein, whey, gelatin and blood-derived protein. Additionally, an enormous range of polysaccharides are available on the market, such as; starches (corn, wheat, maize, potato, tapioca, pea), celluloses (carboxymethylcellulose), gums (guar, alginate, pectin, locust bean), fibers (β-glucan), chitin/chitosan and xanthan derived from microorganisms (Cutter, 2006). Recently, published studies have also presented the use of different types of edible seaweed (Sea Spaghetti, Wakame and Nori) in meat products (Cofrades et al., 2008; Jiménez-Colmenero et al., 2010; Fellendorf et al., 2015).

Due to their high contribution of the daily salt intake in the Irish population the salt level of cured meat products, such as corned beef, has to be reduced (Irish Universities Nutrition Alliance, 2011). Additionally, any optimized products must fulfill the sensory expectations of consumers. Fellendorf et al. (2018a) employed an affective (hedonic) and descriptive sensory-driven sodium reduction strategy for corned beef. They investigated firstly sodium reduction and then used the same sensory methodology to further reduce salt, using salt replacers. Physicochemical and microbiological properties were also investigated to ensure that variants were still viable from a shelf life perspective. A sodium reduction of 60% in corned beef was achieved with products formulated with potassium lactate and glycine (KLG). This sensory-driven approach allowed the development of a healthier, reduced sodium, and consumer acceptable product while maintaining the traditional sensory characteristics, although the product was described as less-salty than the standard variety (Fellendorf et al., 2018a).

Future outlook

European consumers demand safe and tasteful traditional food products but also for a higher variety, more convenient, more nutritive and healthier options that fit better with the present needs in modern societies (see e.g. Grunert et al., 2008, Guerrero et al., 2009, Favalli et al., 2013a,b, Stolzenbach et al., 2011, 2013a,b; Byrne et al., 2013). According to Guerrero et al. (2009) producers of traditional food products still face the challenge to further improve the safety, healthiness, and convenience of their products by means of different innovations, which will enable them to maintain and expand their market share in a highly competitive and increasingly global food market. In the case of meat products consumers demand variations that are low in salt, fat, cholesterol, nitrites and calories in general and contain in addition health-promoting bioactive components such as for example carotenoids, unsaturated fatty acids, sterols, and fibers (Weiss et al., 2010). Convenience food versions of traditional recipes are quite common across EU countries and the demand for such products is steadily increasing; therefore, understanding convenience food consumption is an important issue toward the market development (Grunert et al., 2008; Brunner et al., 2010; Byrne et al., 2013).

Overall, what is clear is the production of traditional foods and beverages in Ireland has developed from a long tradition but is also innovative in adapting to current consumer demands as well as regulatory guidelines. Thus, the essence and provenance of these products transcend the generations and maintain their identity, while some also are in a fluid state of change and definition due to external consumer or commercial demands (Table 1).

Table 1 Overview of the traditional foods in Ireland as a quick guide and reference list

Name in English language	Name in the Irish language	Description
Bacon and cabbage	Bágún agus cabáiste	Unsliced back bacon boiled together with cabbage and potatoes.
Barmbrack	Bairín breac	A leavened bread with sultanas and raisins.
Black pudding	Putóg dhubh	Sausage made from cooked pig's blood, pork fat, pork rind, pork shoulder, pork liver, oats, onion, rusk (wheat starch, salt), water, salt, pimento and seasoning (rusk, spices). Picture shows slices of black pudding (dark) and white pudding (light).
Boxty	Bacstaí	Finely grated raw potato and mashed potato mixed together with flour, baking soda, buttermilk and occasionally egg, then cooked like a pancake on a griddle pan.

Continued

Table 1 Overview of the traditional foods in Ireland as a quick guide and reference list—cont'd

Name in English language	Name in the Irish language	Description
Champ, also known as "Poundies"	Brúitín	Mashed potatoes and chopped scallions (spring onions) with butter and milk.
Coddle	Cadal	Layers of roughly sliced pork sausages bacon, usually thinly sliced, somewhat fatty back bacon, with sliced potatoes, and onions.
Colcannon	Cál ceannann	Mashed potatoes with kale or cabbage.
Cottage pie	Pióg an aoire	Cottage pie is a beef and vegetable mixture with gravy topped with mashed potato.
Crubeens	Crúibín	Boiled pigs' feet.
Drisheen	Drisín	A type of black pudding. It is distinguished from other forms of Irish black pudding by having a gelatinous consistency.
Farl	Farla	A traditional quick bread or cake, roughly triangular in shape.
Fried bread	Arán friochta	Bread fried in bacon fat.
Full breakfast, also known as "full Irish" or "Irish fry"	Bricfeasta friochta	Rashers, sausages and eggs, often served with a variety of side dishes such as fried mushrooms, soda bread and puddings.
Goody	Gudaí	A dessert dish made by boiling bread in milk with sugar and spices.
Gur cake	Cáca gur	A pastry confection associated with Dublin.
Irish stew	Stobhach/ Stobhach Gaelach	A traditional stew of lamb, or mutton, potatoes, carrots, onions, and parsley.
Limerick Ham	Liamhás Luimnigh	A particular method of preparing a joint of bacon within the cuisine of Ireland. The method was originally developed in County Limerick, Ireland.
Irish Seafood Chowder	Seabhdar	A particular method of preparing a seafood soup, often served with milk or creal.

Table 1 Overview of the traditional foods in Ireland as a quick guide and reference list—cont'd

Name in English language	Name in the Irish language	Description
Mashed potato	Brúitín	Prepared by mashing freshly boiled potatoes with a potato masher, fork, ricer, or food mill, or whipping them with a hand beater. Butter and milk are sometimes added.
Pastie	"Pastie"	A round, battered pie of minced pork, onion, potato and seasoning.
Scone	Scóna	A scone is a single-serving quick bread/cake, usually made of wheat, barley or oatmeal with baking powder as a leavening agent and baked on sheet pans. A scone is often lightly sweetened and occasionally glazed with egg wash.
Potato bread	Arán prátaí	A flat bread made from potato and flour, dry-fried. A key component of the Ulster Fry.
Skirts and kidneys—Stew	Duáin Stobhach	A stew made from pork meat, including the kidneys, bladder, and liver.
Soda bread	Arán sóide	A variety of quick bread traditionally made in a variety of cuisines in which sodium bicarbonate (otherwise known as baking soda) is used as a leavening agent instead of the more common yeast. The ingredients of traditional soda bread are flour, bread soda, salt, and buttermilk. Sometimes raisins are added to make it sweeter.
Spiced beef	Mairteoil spíosraithe	A cured and salted joint of rump steak or silverside beef, which is traditionally served at Christmas or the New Year.
White pudding	Putóg bhán	Very similar to black pudding, but containing no blood. Contains pork meat and fat, suet, bread, and oatmeal formed into a large sausage shape. Picture shows slices of white pudding (light) and black pudding (dark).

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