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Sauces, spices, and condiments: definitions, potential benefits, consumption patterns, and global markets

Maria Nieves García-Casal,[1] Juan Pablo Peña-Rosas,[1] and Heber Gómez-Malavé[2]

[1]Evidence and Programme Guidance, Department of Nutrition for Health and Development, World Health Organization, Geneva, Switzerland. [2]Department of Sociology, University of Geneva, Geneva, Switzerland

Address for correspondence: Maria Nieves García-Casal, Ph.D., Evidence and Programme Guidance, Department of Nutrition for Health and Development, World Health Organization, Avenue Appia 20, Geneva, GE 1211, Switzerland. mngarciacasal@gmail.com

Spices and condiments are an important part of human history and nutrition, and have played an important role in the development of most cultures around the world. According to the Codex Alimentarius, the category of salts, spices, soups, sauces, salads, and protein products includes substances added to foods to enhance aroma and taste. Spices have been reported to have health benefits as antioxidant, antibiotic, antiviral, anticoagulant, anticarcinogenic, and anti-inflammatory agents. Health claims about the benefits of condiments for disease prevention or health improvement need to be science based and extensively supported by evidence; data on their preventive or protective potential in humans are currently limited. The condiments market has been growing continuously over the last few years, with the quantity of products sold under the category of sauces, dressings, and condiments during the period 2008–2013 increasing from 31,749,000 to 35,795,000 metric tons. About 50 of the 86 spices produced in the world are grown in India. From 2008 to 2013, the United States was the largest importer of spices, followed by Australia, the United Kingdom, Canada, and Russia. The main buyers of fish sauce are Vietnam and Thailand, with purchases of 333,000 and 284,000 metric tons in 2013, respectively. The sauces and condiments category is dynamic, with large differences in consumption in habits and practices among countries. This paper aims to establish definitions and discuss potential health benefits, consumption patterns, and global markets for sauces, spices, and condiments.

Keywords: sauces; spices; condiments; consumption; global markets

Introduction

Spices and condiments are an important part of human history and nutrition and played an important role in the development of most cultures around the world. The use of curry was documented in 2000 B.C.E. in India, and Egyptians used garlic, cumin, coriander, and other species at least since 1500 B.C. The use of spices was also common in ancient Greece and Rome. The travels of Giovanni da Pian del Carpini, William Rubruck, and Marco Polo in the 13th century opened European trade with Central Asia and China, and the travels and cultural contacts of other Western visitors inspired by Marco Polo, as well as the European colonization of America, Africa, and Asia during the 15th–17th centuries, spread and diversified the use of spices and condiments around the world. Christopher Columbus was a spice seeker, as were Vasco de Gama and his Portuguese mariners who were inspired by pepper to find a route to India.

Condiments and spices are terms that need examples included as part of their definition. According to *Collins English Dictionary*, a spice is defined as any of a variety of aromatic vegetable substances, such as ginger, cinnamon, nutmeg, used as flavorings.[1] In *Webster's New World College Dictionary*, a spice is defined as a pungent or aromatic vegetable substance, such as pepper or cinnamon, used to season food,[2] and *The American Heritage Dictionary of the English Language* defines a spice as any of various pungent, aromatic plant substances, such as cinnamon or nutmeg, used to flavor foods or beverages.[3] The definitions of condiments in these three dictionaries are, respectively, any spice or sauce, such as

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salt, pepper, or mustard;[1] something used to flavor food, such as mustard, ketchup, salt, or spices;[2] and a substance, such as relish, vinegar, or spice, used to flavor or complement.[3]

Other definitions of spices differentiate between culinary herbs and spices. The leaves of a plant used in cooking are denominated as culinary herbs, while any other part of the plant is known as a spice. Spices can be leaves (e.g., bay leaf), buds (e.g., clove), barks (e.g., cinnamon), roots (e.g., ginger), berries (e.g., grains of pepper), seeds (e.g., cumin), or even the stigma of flowers (e.g., saffron).[4] The concept of condiments is wider, since it includes spices (as herbs or spices) but also salt, bouillon cubes, soy sauce, fish sauce, or ketchup used for the purpose of adding flavor to foods.

Codex Alimentarius

According to the Codex Alimentarius, the category of salts, spices, soups, sauces, salads, and protein products includes substances added to food to enhance aroma and taste.[5] They are categorized as salt and salt substitutes (12.1); herbs, spices, seasonings, and condiments (12.2); vinegars (12.3); mustards (12.4); soups and broths (12.5); sauces and like products (12.6); salads (e.g., macaroni salad, potato salad) and sandwich spreads (12.7); yeast and like products (12.8); soybean-based seasonings and condiments (12.9); and protein products from sources other than soybeans (12.10). Each of these categories includes a variety of substances, as further discussed below.

Salt and salt substitutes

The salt and salt substitutes category includes, as salt, primarily food-grade sodium chloride, plus table salt, iodized and fluoridated iodized salt, and dendritic salt; and includes, as salt substitutes, seasonings with reduced sodium content intended to be used on food in place of salt.

Herbs, spices, seasonings, and condiments

Herbs, spices, seasonings, and condiments include items whose use is intended to enhance the aroma and taste of food and that are usually derived from botanical sources, and may be dehydrated and either ground or whole. Examples of herbs are basil, oregano, and thyme, and examples of spices are cumin and caraway seeds. Spices may also be found as blends in powder or paste form, for example, chili seasoning, chili paste, curry paste, curry roux, and dry cures or rubs that are applied to external surfaces of meat or fish. Seasonings and condiments include seasonings, such as meat tenderizers, onion salt, garlic salt, Asian seasoning mix (dashi), a topping to sprinkle on rice (furikake containing e.g., dried seaweed flakes, sesame seeds, and seasoning), and seasoning for noodles. The term "condiments" as used in the Food Category System in the Codex Alimentarius does not include condiment sauces (e.g., ketchup, mayonnaise, mustard) or relishes.

Vinegars

Vinegars are the liquids produced from fermentation of ethanol from a suitable source, such as wine or cider. Examples include cider vinegar, wine vinegar, malt vinegar, spirit vinegar, grain vinegar, raisin vinegar, and fruit (wine) vinegar.

Mustard

Mustard is a condiment sauce prepared from ground, often defatted, mustard seed that is mixed into a slurry with water, vinegar, salt, oil, and other spices, and refined. Examples include Dijon mustard and hot mustard (prepared from seeds with hulls).

Soups and broths

With respect to soups and broths, the finished products may be water (e.g., consommé) or milk based (e.g., chowder): (1) ready-to-eat soups and broths, including canned, bottled, and frozen, are water- or milk-based products consisting of vegetable, meat, or fish broth with or without other ingredients (e.g., vegetables, meat, noodles). Examples include bouillon, broths, consommés, water- and cream-based soups, chowders, and bisques; and (2) mixes for soups and broths: concentrated soup to be reconstituted with water and/or milk, with or without addition of other optional ingredients (e.g., vegetables, meat, noodles). Examples include bouillon powders and cubes, powdered and condensed soups (e.g., mentsuyu), and stock cubes and powders.

Sauces and like products

Sauces and like products include ready-to-eat sauces, gravies, and dressings, and mixes to be reconstituted before consumption. The ready-to-eat products are divided into subcategories for emulsified and nonemulsified products, whereas the mixes are divided into subcategories that encompass both emulsified and nonemulsified sauce mixes: (1) emulsified sauces and dips (e.g., mayonnaise,

salad dressing, onion dips), such as sauces, gravies, dressing-based sauces and dips, at least in part, in a fat- or oil-in-water emulsion—examples include salad dressing (e.g., French, Italian, Greek, ranch style), fat-based sandwich spreads (e.g., mayonnaise with mustard), salad cream, and fatty sauces and snack dips (e.g., bacon and cheddar dip, onion dip); (2) nonemulsified sauces (e.g., ketchup, cheese sauce, cream sauce, brown gravy) include water, coconut milk, and milk-based sauces, gravies, and dressings, such as barbecue (BBQ) sauce, tomato ketchup, cheese sauce, Worcestershire sauce, Asian thick Worcestershire sauce (tonkatsu sauce), chili sauce, sweet and sour sauce, and white sauce (milk-based sauce, with little added fat and flour); (3) mixes for sauces and gravies are concentrated products, usually in powdered form, to be mixed with water, milk, oil, or other liquid to prepare a finished sauce or gravy, including mixes for cheese sauce, hollandaise sauce, and salad dressing (e.g., Italian or ranch dressing); and (4) clear sauces (e.g., fish sauce) include thin, nonemulsified clear sauces that may be water based and used as condiments or ingredients rather than as finished gravy. Examples include oyster sauce and Thai fish sauce (nam pla).

Salads and sandwich spreads

Salads (e.g., macaroni salad, potato salad) and sandwich spreads, excluding cocoa- and nut-based spreads of food categories, include prepared salads, milk-based sandwich spreads, nonstandardized mayonnaise-like sandwich spreads, and dressing for coleslaw (cabbage salad).

Yeast and like products

Yeast and like products include baker's yeast and leaven used in the manufacture of baked goods and the Asian product koji (rice or wheat malted with *Aspergillus oryzae*) used in the production of alcoholic beverages.

Soybean-based seasonings and condiments

Soybean-based seasonings and condiments include products that are derived from soybeans and other ingredients intended for use as seasonings and condiments, such as fermented soybean paste and soybean sauces. Fermented soybean paste (e.g., miso) is made from soybeans, salt, water, and other ingredients using the process of fermentation and includes dou jiang (China), doenjang (Republic of Korea), or miso (Japan), which may be used in the preparation of soups or dressings or as a seasoning. Soybean sauce is a liquid seasoning obtained by fermentation of soybeans, nonfermentation (e.g., hydrolysis) of soybeans, or by hydrolysis of vegetable protein. Soybean sauces include (1) fermented soybean sauce, which is a clear, nonemulsified sauce made of soybeans, cereal, salt, and water by the fermentation process; (2) nonfermented soybean sauce, also known as non-brewed soybean sauce, which may be produced from vegetable proteins, such as defatted soybeans that are acid hydrolyzed, neutralized, and filtered; and (3) other soybean sauce—a nonemulsified sauce made from fermented and/or nonfermented soybean sauce, with or without sugar, and with or without the caramelization process.

Protein products from sources other than soybeans

Some protein products are derived from sources other than soybeans, such as milk protein, cereal protein, and vegetable protein analogues or substitutes for standard products, like meat, fish, or milk. Examples include vegetable protein analogues, fu (a mixture of gluten and flour that is sold baked or raw and is used as an ingredient in miso soup and other dishes), and proteinaceous meat and fish substitutes.

Food additives

A food additive refers to any substance not normally consumed as a food by itself or used as a typical ingredient of the food, whether or not it has nutritive value, that is intentionally added to food for a technological purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport, or holding of food, resulting in the additive becoming a component of such foods. The use of food additives is justified only when it is advantageous, does not present an appreciable health risk or mislead the consumer, and serves one or more of the following technological functions: (1) to preserve the nutritional quality of the food; (2) to provide necessary ingredients or constituents for foods manufactured for groups of consumers with special dietary needs; (3) to enhance the keeping quality or stability of a food or to improve its organoleptic properties, provided that this does not change the nature, substance, or quality of the food so as to deceive the consumer; and (4) to aid in the manufacture, processing, preparation, treatment,

packing, transport, or storage of food, provided that the additive is not used to disguise the effects of the use of faulty raw materials or of undesirable (including unhygienic) practices or techniques during the course of any of these activities. In the Codex General Standard for Food Additives, there is a list of additives approved for use in sauces and condiments.[6]

Codex Committee on Spices and Culinary Herbs

The 36th Session of the Codex Alimentarius Commission in 2013 agreed to establish a Codex Committee on Spices and Culinary Herbs (CCSCH), of which the first meeting was held in February 2014, in India. The Committee has to formulate standards on various spices and culinary herbs, prioritizing the work that takes into consideration the following factors: (1) volume of production and trade, (2) consumer protection, (3) intended use of the commodity, (4) existing standards that are already in place, (5) international or regional market potential of the commodity, and (6) need for scientific advice.[7] Some of the activities of international organizations relevant to the work of CCSCH are related to safety and quality of food in international trade in order to protect consumer health.

Some commonly used spices, condiments, and sauces

Barbecue sauce

BBQ is a flavoring sauce or condiment ranging in consistency from watery to very thick, with the most common ingredients being ketchup, vinegar, sugar, garlic, onion, and mustard. BBQ sauce is thought to have been invented in the United States around the 1600s to mask harsh flavors new to the colonial settlers. Other accounts trace the origins of BBQ sauce to the end of the 15th century, when Christopher Columbus brought with him a sauce from Spain.[8]

Bouillons and consommés

Bouillons and consommés are thin, clear liquids obtained either (1) by cooking of suitable protein-rich substances or their extracts and/or hydrolysates with water, with or without the addition of seasonings and/or flavoring substances, edible fats, sodium chloride (salt), spices and their natural extracts or distillates or other foodstuffs to improve their taste, or (2) by reconstitution of an equivalent mixture of dehydrated ingredients according to the directions for use. The forms of presentation may be as ready-to-use bouillons and consommés to be consumed with or without heating; condensed and concentrated bouillons or consommés presented as liquid, semiliquid, or paste-like products, which, after the addition of water according to the directions for use, yield regular bouillons or consommés; and dehydrated bouillons and consommés, which are dry products that, after reconstitution with water according to the directions for use with or without heating yield the regular hydrated product.[9]

Chili sauce

Chili sauce is a product intended for use as a seasoning and condiment, prepared from the edible portion of sound and clean fresh chili (*Capsicum* spp.) or processed chili, such as chili that has been powder roasted, ground, or preserved in vinegar or brine. It also may contain mango, papaya, tamarind, tomato, garlic, onion, carrot, sweet potato, other spices and herbs, and other edible ingredients.[10]

Cumin

Cumin is the seed of a small umbelliferous plant from the Apiaceae family, commonly known as the parsley family, composed of aromatic plants with hollow stems. Cumin grows in India, North Africa, China, and the Americas and is consumed dried or ground to a brownish-green powder. Cumin it is not a traditional European spice.[11,12]

Curry paste

Curry paste is a combination of spices and herbs, and its composition varies between regions and sometimes depends on the protein dish that is going to be prepared (e.g., goat, beef, chicken, sheep). For example, in Thailand, the hot and spicy curry paste khua-kling used by Thai Buddhists does not contain strongly flavored spices, such as cumin, cinnamon, nutmeg, and star anise, but that used by Thai Muslims does contain these spices.[13] In India, curry is freshly ground each day and comes in standard and Madras (hot) versions.

Fenugreek

Fenugreek (*Trigonella foenum-graecum*) grows similarly to peas, with a thick stem, yellow sweet-pea–like flowers, and long horn-shaped seed pods that contain square yellow seeds. The seeds must be ground to release their maple–curry–nutty flavor. Fenugreek sprouts and leaves have a similar but sweeter flavor than the seeds and are eaten as a

vegetable and mixed into dough, beans, and stews. The leaves, seeds, and flowers are used dried, and the herb is used extensively in alpine cheeses and breads.[11]

Fish sauce

Fish sauce is a translucent, not turbid, liquid product with a salty taste and fish flavor obtained from fermentation of a mixture of fish and salt. The product is prepared by mixing fish (sound and wholesome fish or parts of fish in a condition fit to be sold fresh for human consumption) with salt and is fermented in covered containers or tanks. Generally, the fermentation process takes not less than 6 months. Subsequent extractions may follow by adding brine to further the fermentation process, in order to extract the remaining protein, fish flavor, and odor. Other ingredients may also be added to assist the fermentation process.[14]

Garlic

Garlic (*Allium sativum*) is a member of the family Liliaceae. *Allium* is the Latin name for garlic, derived from the Celtic word *al*, meaning pungent or burning,[15] and has been used as a condiment and medicament for more than 4000 years. Probably originating in Central Asia, it was used by Sumerians, Egyptians, Greeks, and Romans, reaching modern Europe and the United States, and is widely used today.[16] Besides its taste and aroma, garlic is also associated with inhibition of lipid peroxidation and improvements in the functioning of the cardiovascular system, and is thought to have antiviral, antifungal, antimicrobial, and antitumorigenic properties. These effects seem to be mediated through sulfur-containing compounds.[15]

Ginger

Ginger (*Zingiber officinale*), originally from Southeast Asia, has been introduced to many parts of the world and is one of the most used spices, including for medicinal purposes.[17] The dietary habits of people living in China, India, and Southeast Asia are very diverse with respect to traditions, food patterns, and culture, but in all of these cultures, ginger is widely used. Ginger use has been widespread around the world since the Medieval period,[18] and ginger is regularly consumed in other tropical countries, such as Nigeria, Sierra Leone, Indonesia, Bangladesh, Australia, Fiji, Jamaica, Nepal, Haiti, Mexico, and Hawaii.[19,20] Ginger rhizome is typically consumed as a fresh paste, dried powder, slices preserved in syrup, candy (crystallized ginger), or as tea flavoring.[21]

Pimento

Jamaican pimento derives from the pimento tree (*Pimenta dioica)*, which was found growing in Jamaica by early Spanish explorers who were impressed by the taste and aroma of the berries and leaves. The name pimento originated from the Spanish word *pimienta*. To most English-speaking people, the tree is referred to as pimento and the berries referred to as allspice. Pimento trees were later discovered in Cuba and were presumed to have been taken there by migratory birds that had eaten the berries. They have also been found in Mexico, but it is in Jamaica where they have had the longest history, having been in continuous production since the tree was identified in approximately 1509.[22] In 1601, the use of pimento was reported in London. Berries from the pimento tree are called allspice berries, since they combine the taste and aroma of many other spices, such as pepper, cloves, nutmeg, ginger, and cinnamon.[23]

Ketchup

The use of ketchup began as a Chinese fish sauce called ke-tsiap and was originally tomato free. The name was gradually changed to ketchup, and in Britain other ingredients instead of fish were added. The sauce was more similar to soy sauce or Worcester sauce than to the tomato ketchup. During the 19th century, ketchup was prepared from oysters, mussels, mushrooms, walnuts, lemons, celery, and even fruits, such as plums and peaches. Usually, components were either boiled down into a syrup-like consistency or left to sit in salt for extended periods of time. Both of these processes led to a highly concentrated end product: a salty, spicy flavor bomb. Tomatoes were included in ketchup around 1700, and modern ketchup contains tomatoes, onions, vinegar, sugar, and spices.[24,25]

Mayonnaise

Mayonnaise is a thick, creamy sauce or dressing that is made of oil, egg yolks, lemon juice or vinegar, and seasonings. It is an emulsion made by slowly adding one ingredient to another that normally cannot be combined, by fast and uniform mixing. In this way, droplets of one liquid are suspended within the other. There are reports on the origins of

mayonnaise in 1756, during the French naval assault on Minorca, a Mediterranean island with a port named Mahon. Some historical accounts indicate that mayonnaise was invented by Duke de Richelieu's chef to celebrate the victory, while others indicate that part of the assault was planned to steal the sauce.[26] In 1905, the first ready-made mayonnaise was sold at Richard Hellman's New York deli. In 1912, mayonnaise was mass marketed and called Hellman's Blue Ribbon Mayonnaise.[27,28]

Mustard

Mustard is a member of the *Brassica* genus of plants, which bears tiny, round, edible seeds, as well as tasty leaves. During the Roman Empire, mustard was actively used and Romans spread its use in their colonies. Mustard was reported as being popular in the Middle Ages in Europe. There are three major types of mustard seeds: white, brown, and black, with the brown variety most commonly used in ballpark mustard and in pickling. White and brown seeds are blended to make English mustard, and powdered mustard is simply finely ground mustard seed. Originally, mustard was called *sinapis*. It has been claimed that, during the Roman Empire, the word *sinapis* started to be replaced by words such as *mustum*, *mustarum*, and *mustardum* as new wine, or "must," was mixed with mustard seeds to make a paste.[29] Other accounts claim that its English name, mustard, is derived from a contraction of the Latin *mustum ardens*, meaning burning must.[30] More recently, it has been proposed that the Duke of Burgundy gave the town of Dijon a coat of arms in 1382 with the motto *moult me tarde*, which was adopted by the town's mustard makers, who eventually shortened it to moul-tarde (to burn much).[29]

Pepper

Pepper, one of the world's most popular spices, is a member of the botanical family Piperaceae. The pepper vine (*Piper nigrum*) grows in tropical regions, close to the equator. It is a climbing vine native to India and Indonesia and, in its natural jungle habitat, climbs up trees 20 ft high. It has thick, broad, dark green leaves and small white flowers that grow in clumps and mature into berries that ripen from green to orange to red. In the case of pepper, the spice is the fruit, called peppercorns. Black pepper is the dried, unripe berry. White pepper initially develops the same as black pepper, but is allowed to ripen more fully on the vine. The outer shell is then removed by soaking the berries in water until the shell falls off, or they are held under flowing spring water, yielding a whiter, cleaner pepper. Green peppercorns are from the same fruit as black and white peppercorns, but are harvested before they mature. Instead of being dried in the sun, they are quickly dehydrated so that they retain their bright green color and mildly spicy flavor. Pink pepper, which is not a vinous pepper, comes from the French island Réunion. Pink peppercorns have a brittle, papery pink skin enclosing a hard, irregular seed, much smaller than the whole fruit.[11]

Salt

Since the beginning of civilization, condiments have been used to enhance the flavor of food. The first condiment was salt, and the history of humanity begins with salt. The history of the world in relation to salt is simple: animals wore paths to salt licks that humans followed. Trails became roads, and settlements grew beside them, because water was also present there. When the human menu evolved to cultivars of vegetables and cereals, more salt was needed to supplement the diet. But the underground deposits were beyond reach, and the salt sprinkled over the surface was insufficient. Scarcity kept the mineral precious, and salt became one of the world's principal trading commodities.[31] Salt has been used as a preservative and to enhance the flavor of food, but also has had many uses and connotations during history: it was used as an antiseptic, as trading currency, for paying taxes, for sorcery, and even to determine the social rank of people in a power group.

Soy sauce

Soy sauce was invented in China and reached Europe in the 17th century, and by the mid-18th century, it was popular in Britain. Since 1998, there has been a lot of controversy about the definition of soy sauce and whether to include fermented soy sauce. The International Association of Consumer Food Organizations stated that "if a product purporting to be soy sauce is not produced using the traditional method, that product should not be labeled simply as 'soy sauce.' Doing so would mislead consumers."[32] A draft from a joint group from Codex Alimentarius tried to include all variants of soy sauce, but in 2005 the joint work ended for some of the participants, for example, in Japan. According to the proposed draft Codex Standard

for Soy Sauce,[33] soy sauce is a liquid seasoning obtained by fermentation of soybeans and/or soybeans and cereal grains. Brewed soybean sauce is the product obtained by the culture of *A. oryzae* and/or *Aspergillus sojae*, as a starter, in either soy beans or soybeans and cereal grains; or by the culture of bacteria and/or molds and/or yeasts in either soybeans or soybeans and cereal grains; or by the mixing of food-grade enzymes with either soybeans or soybeans and cereal grains. This product could also be aged with brine and/or combined with other ingredients.

The addition of enzymes should be allowed for brewed soy sauce. In traditional soy sauce manufacturing, microorganisms are added for the sole purpose of producing enzymes that hydrolyze soy proteins for the development of the characteristic taste attributes of soy sauce. Whether produced traditionally or added directly, enzymes carry out the same function. In addition, mixed soy sauce is the product obtained by brewed soy sauce and hydrolyzed vegetable protein. The proportion added by brewed soy sauce should not be less than 50%.

Turmeric

Turmeric is an ancient spice and a native rhizome of Southeast Asia, used since antiquity as a dye and a condiment. It is cultivated primarily in Bengal, China, Taiwan, Sri Lanka, Java, Peru, Australia, and the West Indies, and its use dates back nearly 4000 years to the Vedic culture in India, where it was used as a culinary spice and had some religious significance. The name derives from the Latin *terra merita*, meaning "meritorious earth," and in many languages turmeric is simply named "yellow root." It is usually available in a ground form, as a bright yellow, fine powder. Turmeric is one of the least expensive spices.[11]

Various sauces

In the 16th, 17th, and 18th centuries, various sauces and condiments were invented. For example, pesto sauce was invented in 16th century Italy; béchamel, chasseur, and chutney were first used in the 17th century; and the use of hollandaise sauce was first recorded in the mid-18th century. Sauces similar to tartar sauce were made in the Middle Ages, but modern tartar sauce was first made in the 1800s. In the 19th century, with the Industrial Revolution, condiments began to be mass produced in factories.[34] Of the sweet spices, cinnamon, anise, cardamom, cloves, nutmeg, and mint are in common use around the world. Honey and sugar, although not condiments but foodstuffs, have been considered as fortification vehicles because of their widespread consumption.

Vinegar

Another ancient condiment is vinegar. There is evidence for the use of vinegar by Babylonians 5000 years ago. Its name is probably derived from the French words *vin aiger*, meaning sour wine.[35] It was only in 1865 that Pasteur solved the mystery surrounding vinegar through his research on fermentation and the role of microscopic organisms, uncovering the process of acetification. Diluted vinegar has been used as a strengthening and energizing tonic by the military throughout time. Roman soldiers called this refreshing drink "posca" and used it regularly, as did the Japanese samurai.[36] Although, initially, vinegar was made from wine, it can be made from any plant material, fruits, cereals, sugar cane, and rose petals.

Worcester sauce

Worcester sauce—a traditional English condiment with an intense flavor and composed of a mixture of ingredients, including soy sauce, garlic, onion, molasses, and anchovies—was invented in Worcester in 1835 by John Lea and William Perrins. According to Bottone, in 1835 Lord Marcus Sandys, an ex-governor of Bengal, approached Worcester chemists/grocers John Lea and William Perrins to replicate his favorite sauce. They made the sauce, but Sandys hated it, and the excess sauce was stored in a basement. After a year, the sauce, when tasted, had mellowed and hate became love and big business.[37]

Za'atar

Za'atar refers to a blend of herbs and spices, such as thyme, oregano, savory, and often sumac and sesame. It is often mixed with olive oil and spread on bread, but it is also used as seasoning for vegetables, salads, meatballs, or kebabs. The word za'atar has been used to mean a spice blend from Jordan, Syria, or Lebanon, a variety of thyme plant in Egypt (then called saem). Another variety of za'atar includes *Majorana syriaca* as the main ingredient.[38]

Potential beneficial effects of spices and condiments

There are numerous reports on the beneficial effects of spices on health, including as antioxidants, antibiotics, antivirals, anticoagulants, anticarcinogenics, and anti-inflammatory agents, having potential effects on infection, cancer, diabetes, hypertension, coronary diseases, cataract, neurodegenerative disease, digestive problems, and ulcerative lesions. While data in cultured cells and animal models confer enthusiasm about these phytochemicals, clinical or epidemiological data supporting their chemopreventive potential in human populations are limited.[4,39]

Claims about the health benefits of condiments for disease prevention or health improvement need to be based in science, extensively supported by evidence, and standardized. In many cases, purification procedures vary, identification and nomenclature of active ingredients are not completely standardized, and results on bioactive compounds and chemical composition are not always comparable.[40] *In vitro* and animal models are very valuable but have limitations when extrapolating to humans. The specifications for spice-related health claims are unclear for some compounds, in spite of a large body of work. The use of *in vitro* models allows for the use of concentrations, purified products, and conditions that do not necessarily resemble the real use of compounds on a routine basis for human consumption. Especially in the case of spices, human studies are needed, but should not only focus on their use as medicines, in which case clinical trials and studies designed as drug trials are needed but should also focus on conducting randomized controlled trials studying the effects on health of spices in the amounts and conditions as when used as condiments. Even if a nutrient or chemical compound has particular health benefits, it does not necessarily mean that the condiment containing the nutrient or chemical compound will have such properties.

One of the most studied effects of spices that is used to explain their health benefits is their antioxidant capacity. This effect could be exerted by chelating metallic ions (especially iron and copper), hydrogen donation, scavenging of free radicals, and by associating with, or acting as, a substrate for radicals (hydroxyl or superoxide). Their ability to act as such is related to the structure of the bioactive compound in the spices, especially related to size, number of charges, and the degree of hydroxylation and methylation.[41–44] Some active ingredients from the most widely used spices are discussed below.

Gingerol

The rhizomes of ginger contain [6]-gingerol (1-[40-hydroxy-30-methoxyphenyl]-5-hydroxy-3-decanone) and its homologs as pungent ingredients that have a wide array of pharmacological and physiological activities, including antioxidant and anticancer properties.[18,45,46]

Curcumin

Curcumin ((1E,6E)-1,7-bis (4-hydroxy-3-methoxyphenyl) -1,6-heptadiene-3,5-dione), a yellow pigment from the roots of turmeric (*Curcuma longa Linn.*), possesses antioxidant, anti-inflammatory, and antitumorigenic properties *in vitro* and in animal studies. Curcumin, as well as other related compounds present in turmeric, have shown inhibition of lipid peroxidation, through interaction with iron, quenching of free radicals, and an increase in antioxidant enzymes.[47–51]

Capsaicin

Capsaicin (8-methyl-*N*-vanillyl-*trans*-6-nonenamide), the principal pungent and irritant constituent of hot red and chili peppers, has been reported to have antiproliferative and anti-inflammatory effects on hepatic stellate cells, responsible for early repair of hepatic cell damage.[52] It was recently observed that 6-gingerol (6-hydroxy-1-(4-hydroxy-3-methoxyphenyl)-3-decanone), the most bioactive compound described in ginger and related to capsaicin (chili pepper) and piperine (black pepper), effectively protected against DNA damage produced by hydroxyl radical generation.[53] However, there have been *in vitro* reports of capsaicin promoting or preventing carcinogenesis, depending on the experimental conditions.[46,54]

The antitumorigenic properties of curcumin, gingerol, and capsaicin have been associated with an anti-inflammatory effect, mediated by nuclear factor κB, that has been linked to proliferation and survival of certain tumor cells and regulation of the expression of various genes, including cyclooxygenase-2, responsible for inflammation and malignant transformation.[55]

Piperine

Piperine (1-[5-(1,3-benzodioxol-5-yl)-1-oxo-2,4-pentadienyl]piperidine), the active ingredient of black pepper, has been reported to act as an antioxidant by trapping free radicals and preventing lipid oxidation,[56] although some reports indicate that the use of high concentrations could promote oxidation by favoring the Fenton reaction and generating hydroxyl radicals.[57]

Alliin and allicin

At least 33 sulfur compounds have been isolated from garlic. Alliin (*S*-allyl cysteine sulfoxide), allicin (diallyl thiosulfinate), dialyl sulfides, disulfides, and trisulfides are some of them. Alliin, the odorless precursor of allicin, inhibits platelet aggregation in human blood. When garlic is chopped or crushed, alliinase acts on alliin to produce allicin, a thermally unstable antibacterial and antithrombotic agent, which possesses the characteristic smell of garlic.[15] Allicin also has important lipid-lowering properties, as well as antitumorigenic effects *in vitro*.[58–60] With respect to the antioxidant properties, components in garlic have been reported to increase the activity of antioxidant enzymes, such as superoxide dismutase, and to decrease lipid peroxidation.

Quercetin glucosides

The quercetin glucosides 4′-*O*-β-glucoside and 3,4′-*O*-β-diglucoside, present in onions, increase the activity of glutathione peroxidase and inhibit lipid peroxidation *in vitro*.[39] However, although it contains sulfur compounds similar to garlic, the health benefits of onion are less clear.[59]

Other condiments that are mixtures of spices, such as some Indian spices, have also been studied as therapeutic agents. In particular, curry and other turmeric-containing blends, because of their inclusion of turmeric and curcumin, have been reported to increase detoxifying enzymes, prevent DNA damage, improve DNA repair, decrease mutations and tumor formation, and exhibit antioxidant potential in animals.[61]

World trade of spices and condiments

The market for condiments has been growing continuously in the last few years. Condiment sales grew 9.4% from 2007 to 2009, becoming the second largest category in the specialty foods market, with the largest category being cheese. The permanent changes, the new flavors, new influences, and new products make the sauces and condiments category very dynamic. For example, more than 40 mayonnaises entered the market in 2010, and in the United States, mayonnaise is the first in the list of sauces and condiments.

Mintel values the U.S. market of spices and condiments at $5.6 billion. Driven by its core audience, 18- to 34-year-old consumers, that market will swell to $7 billion by 2015, as new whole-grain mustards, spicy ketchups, fruit-flavored salsas, blended aiolis, chutneys, and hot sauces become available at grocery stores.[62]

India contributes 25–30% of the total world trade in spices. Nine spices—pepper, ginger, clove, cinnamon, cassia, mace, nutmeg, pimento (allspice), and cardamom—constitute 90% of the total world trade, and about 50 of the 86 spices produced in the world are grown in India.[63]

Global trends in sauces, spices, and condiments

When indicated, the data presented were commissioned to Euromonitor and were based on a desk search in each country, accessing sources such as governmental offices, trade associations, industries, broker reports, and online databases. Store checks were part of the search in each country, as were trade surveys. When necessary, the company combined the information from industries with secondary sources. Data validation was reviewed at country, regional, and global levels. Comparative checks were carried out on per-capita consumption and spending levels, growth rates, patterns of category and subcategory breakdowns, and distribution of sales by channel.[64] According to these data, the use of sauces, dressings, and condiments has been steadily increasing at least for the last 5 years (Table 1). During 2013 and by World Health Organization (WHO) region, the highest use of this category was registered in the Western Pacific region, followed by the region of the Americas and the European region (Table 2).

The main consumer of spices, sauces, and condiments is China, while the United States is the largest importer of spices, followed by Australia, the United Kingdom, Canada, and Russia. The main consumed spice is black pepper and the top producer is Vietnam.[65] Furthermore, the top three buyers of fish sauces are Vietnam, Thailand, and Myanmar; for bouillon cubes, the top three buyers

are China, the United States, and Japan. In some cases, there are large differences between countries (e.g., the use of soy sauces in China, Japan, and Indonesia is 5,875,800; 856,000; and 420,000 metric tons, respectively (1 metric ton = 1000 kg = 2205 lb) (Table 3).

During 2013, China used more bouillon cubes, monosodium glutamate, oyster sauce, and soy sauce than any other country; Vietnam was the leader in purchases of fish sauce; and the United States in herbs and spices, ketchup, and BBQ sauce. The use of mayonnaise was led by Russia (Table 4).

Fortification of spices and condiments

A recent consideration about spices, but especially condiments, relates to the possibility of their use as fortification vehicles for addition of micronutrients. Micronutrient deficiencies are the main nutritional problem in the world, and fortification of foods with vitamins and minerals is one of the most cost-effective approaches to combat micronutrient deficiencies. Usually programs have been directed to fortify staple foods, but in some situations, fortification of condiments or seasonings (e.g., soy and fish sauces, curry powder, or bouillon powders or cubes) may be a useful alternative, if they are consumed consistently by most of the population, as is the case in many Asian and African countries.[66]

There is a significant number of people consuming spices and condiments worldwide. However, the consumption of spices varies widely not only between different countries but also for individuals within the same country. For example, a study of daily consumption of commonly used spices in India showed important differences in adults—consumption of turmeric varied from 0.2 to 4.8 g/day; curcumin, 4–100 mg/day; red pepper, 2.4–4.1 g/day; capsaicin, 7–120 mg/day; fenugreek,

Table 1. The top 10 countries using the category of sauces, dressings, and condiments during 2008–2013

	Sales[a]					
Year	2008	2009	2010	2011	2012	2013
Countries						
China	6823.8	7195.5	7583	7971.8	8403.9	8834.5
United States	4882.1	4939.1	4955.1	4994.9	5014.5	5033.4
Japan	3644.8	3577.5	3509.8	3404.9	3331	3321.2
Russia	1245.6	1256.8	1274.7	1290.5	1313.5	1357.5
Germany	1189.4	1209.3	1213.5	1218.3	1222.5	1226.8
Brazil	941.2	987.7	1043.6	1081.1	1129.6	1176.2
Mexico	938.4	976	1003.9	1036.5	1052.8	1100.7
Indonesia	748.3	792.6	855	924.6	996	1071.8
South Korea	931.4	936.6	947.9	952.3	962.6	972
United Kingdom	828.9	840	847.3	859.9	864.7	867.8

[a]Metric tons ×1000 (1 metric ton = 1000 kg = 2205 lb).

Table 2. Quantity of product[a] sold via retailing channels under the category of sauces, dressings, and condiments, by WHO region during 2008–2013

	2008	2009	2010	2011	2012	2013
Africa region (AFRO)	427.2	446.3	468.4	493.9	516.3	540.6
East Mediterranean region (EMRO)	1080.6	1138.3	1187.6	1189.7	1236.2	1282.2
Southeast Asia region (SEARO)	1699.7	1792.8	1912.3	2037.3	2171.5	2315.3
Europe region (EURO)	7821.3	7894.6	7979.6	8039.8	8113.8	8215.6
Americas region (AMRO)	8162.1	8372.2	8467.7	8599.9	8704.9	8845.8
West Pacific region (WPRO)	12,557.6	12,945.8	13,338.2	13,695.3	14,116.4	14,598.4
Total	**31,748.5**	**32,590**	**33,353.8**	**34,055.9**	**34,859.1**	**35,797.9**

[a]In metric tons ×1000 (1 metric ton = 1000 kg = 2205 lb).

300–600 mg/day; garlic, 0–20 g/day; and onion, 0–500 g/day.[39] In a study on dietary intake of spices and herbs in Northeast Thailand, using 24-h recall questionnaires, the herbs and spices identified as the most consumed in the region were garlic, chili pepper, tamarind, lemongrass, shallot, galangal, kaffir lime leaves, hairy basil leaves, mint, bai-ya-nang (a local vegetable herb), and fennel leaves. The quantity of spices in the four most common dishes (somtum, jaew, pon, and kang-normai) was 4.9, 26.1, 14, and 11 g, respectively, per meal.[67]

Another aspect to be considered is the fortification of condiments that would be used for the preparation of processed foods. For example, in the Philippines, the use of iodized salt for preparation of salted fish at the industrial level would provide 64–85% of the recommended nutrient intake (RNI) for iodine for women of reproductive age and 107–141% of the RNI for iodine for children aged 1–6 years.[68] However, the use of iodized salt in industrialized products needs to be controlled and regulated to avoid excess. Also, polyphenols, whose high content in spices is responsible for their reported antioxidant effects, are also potent inhibitors of iron absorption.[69] For example, in a study on the effects of six spices (chili pepper, garlic, pak kyheng (Thai leafy vegetable), shallot, tamarind, turmeric) and one mixture of spices (curry paste) on iron availability, a dose-dependent reduction in iron dialyzability was shown for all spices except for tamarind, which has polyphenol contents of 0.5–33 mg polyphenol per meal.[70]

Although salt is classified as a condiment by the Codex Alimentarius, extensive discussion on salt is beyond the scope of this paper. Salt has been used as a fortification vehicle for iodine for many years and also has been used for double or multiple micronutrients (i.e., double-fortified salt with iodine and iron). The WHO recently released a guideline on salt fortification to harmonize salt reduction policies.

Fortification of condiments and seasonings is a relatively new strategy that may have several benefits, including feasibility, cost-effectiveness, sensory acceptability, targeting of subpopulations, and frequent and consistent use by populations. People in less advantaged groups tend to have little variety in their diets, and a small number of foods accounts for most of their calories per day. In these cases, condiments, spices, and seasonings overcome monotony in the diet and become frequently used products, possibly reaching some people who cannot afford other fortified foods.

Table 3. Top 10 buyers of products included in the category of sauces, dressings, and condiments during 2013, classified by product and country

Product	Country	Metric tons (×1000)[a]
Bouillon cubes	China	322.7
	United States	189.9
	Japan	97.8
	Nigeria	74.9
	Indonesia	65.7
	Brazil	64.9
	Thailand	63.0
	South Korea	43.0
	Australia	42.3
	Mexico	41.1
Fish sauces	Vietnam	333.0
	Thailand	284.7
	Myanmar	36.7
	Philippines	8.2
	Japan	4.6
	Cambodia	4.5
	France	3.2
	Laos	2.1
	Canada	1.3
	the Netherlands	1.3
Herbs and spices	United States	136.3
	India	87.2
	Russia	33.8
	China	33.4
	Poland	25.3
	Ukraine	18.1
	Germany	16.6
	Malaysia	14.6
	Canada	14.5
	South Korea	12.6
Soy sauces	China	5875.8
	Japan	856.0
	Indonesia	419.9
	South Korea	192.1
	United States	175.6
	Philippines	107.0
	Vietnam	90.2
	Thailand	66.8
	Myanmar	60.6
	Malaysia	33.5

[a]1 metric ton = 1000 kg = 2205 lb.

Table 4. Top buyers of products included in the category of sauces, dressings, and condiments during 2013, classified by product and country

Product	Country	Metric tons (×1000)[a]
Bouillon cubes	China	322.7
Curry sauces	the Netherlands	9.2
Fish sauces	Vietnam	333.0
Herbs and spices	United States	136.3
Ketchup	United States	679.6
Mayonnaise	Russia	717.0
Monosodium glutamate	China	1185.4
Mustard	United States	118.0
Oyster sauces	China	439.6
Soy sauces	China	5875.8

[a]1 metric ton = 1000 kg = 2205 lb.

Final remarks

The category of sauces, spices, and condiments includes a broad range of substances with different characteristics and consumption patterns, which are in constant evolution, including new flavors and products. The category is very dynamic, with enormous volumes of production and with some countries supporting part of their economies with production for internal use and for trading around the world. Although spices have been reported as having health benefits with respect to disease prevention and control, health claims need to be science based for each particular spice and for a well-defined effect and concentration to avoid adjudicating antitumorigenic or antioxidant properties to all spices. Because of their widespread consumption and acceptability, some condiments (especially sauces) could be considered as suitable vehicles for fortification with micronutrients, although the heterogeneity of the category requires that each potential food item should be studied to determine if fortification of that condiment is an appropriate choice for a particular country or region.

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Conflicts of interest

The authors declare no conflicts of interest.

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