



Unit 7) Plants on the Plate

That was Then and This is Now...

THEN

"The other day Henry Hoot came and asked me to get him a sack of flour, said he was entirely out and had no money and the neighbors couldn't loan him any, for they had not enough to see them through till threshing time. The mill dam at Bull City was washed out a couple of weeks ago and so the mill was idle and flour was hard to get.

I searched all the stores in town and found that C. Herzog and Co. had practically a corner on flour that day. Their stock consisted of two 48-pound sacks, and the price was \$2.80 per sack. They were not particularly anxious to sell it either, for while they had sent August Kaser to Cawker City for a load of flour, he was caught somewhere down in that vicinity by high water and there was no telling when he would reach Osborne.

Hoot thought that by the time he had used the one sack he would be able to help himself, and he would return the flour as soon as he threshed a small field of spring wheat then ripening. So I got the flour at the price asked. Herzog Brothers did not make a big profit on the article, as flour is selling @ \$7 per cwt. at Russell, and the freighting costs 40 cents per hundred pounds." ¹

Howard Ruede, May 13, 1877

Now

"I was able to spend time at the new 'Nature's Harvest' office in Manhattan today. I'm excited at some of the new foods, snacks and beverages that are being created out of the plants that grow in Kansas!

A new kind of grass is being tested at K-State that has sugar in it. It is not quite the same as the sugar we put on our corn flakes each morning, but it tastes almost the same and has fewer calories.

The scientists there are also studying how to make chocolate using grain sorghum. Grain sorghum has special vitamins and antioxidants, and is very healthy. Who knew eating chocolate could be so good for you?

Of course, farmers will still plant wheat for use in breads, crackers, rolls, and flour. The food guide says about one out of every five foods we eat each day should be grain foods, and at least half of those should be whole grains.

Soybeans are used not only for a snack called edamame, but also the oil from soybeans is very healthy and is used in cooking.

My cousin in Sterling says his canola looks really good right now. The oil that comes from squeezing canola seeds really hard is one of the healthiest cooking oils you can buy, and I make sure to stock up when I'm at the store.

When I think about all the good things you can make from the things we grow right here in Kansas, well, it truly is 'Nature's Harvest.'"

Bill Spiegel, November 5, 2010

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FEEDING PEOPLE

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TEACHER'S RESOURCES



Kansas: The Wheat State

Credit: Kansas Wheat Commission

Kansas has rightfully earned the titles of “The Wheat State” and “The Breadbasket of the World” as the leading wheat-producing state in the United States. Kansas also ranks high on the lists for grain sorghum, sunflowers, alfalfa, corn, and soybean production, as well as many other crops that meet consumer needs and wants.

Kansas crops have a place in a well-balanced diet because they provide many essential nutrients our bodies need to grow and function properly. The journey that those crops take from the field to our plates, however, is remarkable. After harvest, Kansas crops are transported to storage facilities, flour mills, processing plants, or wholesale distributors. There, they are prepared to be sold as raw products or processed further to become ingredients in other food



Grain Products

Credit: National Cancer Institute

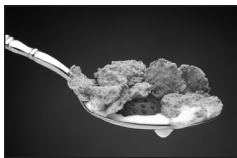
FOOD-RELATED ENERGY CONSUMPTION²



products. Finally, these crops make their way either onto grocery and convenience store shelves or into restaurants and fast food outlets where they are purchased and enjoyed by consumers. During each step, Kansas crops are transported, stored, processed, and packaged as safely as possible to ensure the highest quality products are available to all consumers.

FOOD PRODUCTS FROM KANSAS CROPS

Many products in grocery stores and restaurants can easily be traced back to the fields of Kansas. Whether the food products are cereals, baked goods, canned vegetables and fruits, or vegetable oils, Kansas crops are incorporated into products enjoyed by people all over the United States and around the world.



Cereal

Credit: Scott Bauer, USDA ARS

GRAINS

Grains are crops that produce a small hard seed, like wheat and corn. The first record of a wheat crop in Kansas occurred in 1839 at the Shawnee Methodist Mission, located in present-day Johnson County. However, corn was the principal crop of early pioneers in Kansas as the wheat varieties the pioneers carried with them to Kansas were not well suited for growing here. Over time, different wheat varieties more suitable for Kansas conditions were developed, aided by the introduction of Turkey Red hard red winter wheat by German Mennonites from the Ukraine. The first crop of this variety was planted in Marion County in 1873 and harvested in 1874. The Turkey Red wheat variety remained the most popular wheat variety in the United States until 1944.



Grain Foods

Credit: Stephen Ausmus, USDA ARS

GRAINS

Grains – crops that produce a small, hard seed, like wheat and corn.

Cereal grains – grain crops that produce seeds used as food by people, like wheat, corn, grain sorghum, oats, rice, and barley.

CORN VS. WHEAT IN KANSAS

Kansas farmers plant and harvest more acres of wheat than corn.

Kansas farmers produce more total bushels of corn than wheat.

The dollar value of the Kansas corn crop is higher than that of the Kansas wheat crop.

Kansas usually produces more wheat than any other state in the United States, accounting for 20 percent of the nation's wheat harvest.

Kansas produces less than 4 percent of the corn grown in the United States.



Field Corn

Credit: Lynn Betts, USDA NRCS



Kansas Wheat

Credit: George Sheets

Developments in harvesting machinery, hybrid corn varieties, and irrigation technologies brought corn back into prominence in Kansas agriculture. Today, wheat and corn wrestle for production honors in Kansas as Kansas farmers plant and harvest more acres of wheat than corn, but they produce more total bushels of corn than wheat. The dollar value of the corn crop is also higher than that of the wheat crop. However, Kansas usually produces more wheat than any other state in the United States, accounting for 20 percent of the nation's wheat but less than 4 percent of the corn produced in this country.

Cereal grains, crops that produce seeds used as food by people, include wheat, corn, grain sorghum, oats, rice, and barley.

Wheat

Worldwide, wheat is the most widely consumed cereal grain. In the United States, more than 36 percent of the wheat grown here is used in food products, according to Kansas Wheat. Multitudes of products available in supermarkets today, such as cereals, pastas, and baked goods, rely on wheat to contribute to their flavor and texture.

Kansas almost always produces more wheat than any other state in the United States. Kansas also ranks first in flour milling capacity but dropped to second in the amount of wheat flour milled in 2009.



Wheat Foods

Credit: Keith Weller, USDA ARS

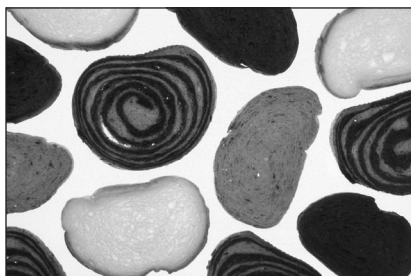
WHEAT FACTS

Worldwide, wheat is the most widely consumed cereal grain.

More than 36 percent of the wheat grown in the United States is used in domestic food products.

Nearly 75 percent of all grain food products in the United States are made with wheat flour.

Wheat is the only grain with an adequate gluten content to make a raised loaf of bread.



Wheat Breads from Different Classes of Wheat

Credit: Scott Bauer, USDA ARS

In the United States, nearly 75 percent of all grain food products are made with wheat flour. Baked goods, including breads, cakes, cookies, pies, and pastries, all contain wheat flour. Different classes of wheat and different wheat varieties within each class produce flours with diverse baking qualities.

Products often require flour with specific baking qualities so millers may blend wheats with different qualities to make the desired flour. For example, cake and pastry flours have very fine textures and are low in protein. All-purpose flour, with medium protein content, is generally used for home baking. Bread flour, used because of its strength and elasticity, has the highest protein (gluten) content of any flour. Gluten is a sticky, nutritious protein found in wheat. According to the Wheat Foods Council, gluten gives bread its elasticity, strength, and gas-holding properties. In fact, wheat is the only grain with an adequate gluten content to make a raised loaf of bread.



Whole Wheat Tortillas

Credit: Wheat Foods Council



Cracked Wheat Bread

Credit: Wheat Foods Council

In addition to baked goods, many cereals on the market today are made from wheat and some product names even include the word "wheat." Cereals make excellent food choices for consumers because they are nutritious, convenient, and tasty.

Pastas are also made from wheat. Durum wheat is used to make pasta



Spaghetti

Credit: Renee Comet, NCI

GLUTEN

When yeast cells eat and digest sugars (from the flour itself or other ingredients) in a bread dough mixture, bubbles of carbon dioxide gas are released as part of the fermentation process. Those bubbles trapped in the dough cause the bread to rise. The dough mixture may be kneaded to distribute the gas bubbles more evenly. The yeast cells die as the bread is baked.

Wheat is the only grain with an adequate gluten content to make a raised loaf of bread. Gluten, a protein that is formed when flour and water are mixed together, gives bread its elasticity, strength, and gas-holding properties.



Wheat Bread

Credit: Daniel Stone, NCI

because this wheat's qualities make the pasta firm. Semolina, which is used to make high-quality pasta products, is produced when the endosperm of durum wheat is coarsely ground. Semolina is used in spaghetti, macaroni, and specialty pasta products.

Wheat is also being used as a nontraditional ingredient in many food products. Wheat may be found in the ingredient list of milk-replacement products, egg-white substitutes, and non-dairy whipped toppings and creamers. Recently, wheat starch has been used as a replacement for fats in desserts. Research has indicated that when wheat starch replaces fat in a frozen dessert, the result is a dessert with a lower fat content and a creamier texture, which consumers perceive to taste better.

Corn

Corn is also a major component of Kansas' agricultural economy. In fact, in eight of the last 10 years, Kansas farmers produced more corn than any other crop, according to the Kansas Corn Growers Association.

Worldwide, corn is the third most consumed cereal grain. Sweet corn, corn on the cob, and creamed corn all come to mind when most people think about eating corn. However, people actually eat less than one percent of the corn grown in the United States as "corn" in those foods.³ On the other hand, the supermarket shelves are lined with products that contain corn, including breakfast cereals, snack foods, and sweetened beverages. Additionally, cornmeal, cornstarch, and corn oil are all products from corn that are used in cooking or baking.



Ear of Corn

Credit: Larry Rana, USDA



Sweet Corn

Credit: Renee Comet, NCI

CORN FACTS

Worldwide, corn is the third-most consumed cereal grain.

Less than one percent of the corn grown in the United States is eaten as sweet corn, corn on the cob, or creamed corn.

In vegetable oil production, the amount of corn oil produced in the United States ranks second behind soybean oil.



Corn Products

Credit: Keith Weller, USDA ARS

PRODUCTS FROM CORN

Cornmeal – flour ground from the whole kernel of corn.

Cornstarch – dense powder obtained from the endosperm of the corn kernel.

Corn oil – oil extracted from the germ of the corn kernel.

According to the Corn Refiner's Association, the amount of corn oil produced in the United States is second only to the amount of soybean oil produced. Corn oil may be an ingredient in salad dressings, margarine spreads, sauces, baked goods, or fried foods. It has a high polyunsaturated fatty acid content, which helps lower elevated blood pressure levels and regulate blood cholesterol concentrations.

Corn sugar, also known as high fructose corn syrup (HFCS), is corn's most valuable product. Corn sugar is considered a natural ingredient because it does not contain any artificial or synthetic ingredients. In addition, it has the same number of calories as table sugar and is equal in sweetness.⁴ Corn sugar can enhance food flavors, protect a food's texture, and stabilize a product's shelf life. It also acts as a source of sugar for yeasts to feed on during fermentation processes and helps create the desired brown color in many baked products. In addition to baked goods, corn sugar may be found in yogurt, sauces, condiments, granola or energy bars, canned and frozen fruits, frozen concentrated beverages, and sweetened beverages. As with any food, sensible portion sizes of foods that contain corn sugar are necessary in a healthy diet.

HIGH FRUCTOSE CORN SYRUP (CORN SUGAR)

High fructose corn syrup (HFCS), also called corn sugar, has the same number of calories as table sugar and is equal in sweetness. The only differences between table sugar (sucrose) and high fructose corn syrup are in the proportions of fructose and glucose and the chemical bonds between those sugars. In table sugar, there is a chemical bond between equal percentages of fructose and glucose (50 percent each). In high fructose corn syrup, there is no chemical bond between the fructose and the other sugars, primarily glucose. High fructose corn syrup usually contains either 42 percent or 55 percent fructose.

Grain Sorghum

Kansas leads the nation in the production of grain sorghum. In the United States, the primary uses of grain sorghum are for livestock feed and ethanol production. Worldwide, however, people and livestock consume nearly the same amount of sorghum. For example, sorghum is the leading cereal grain consumed in Africa.

Food sorghums (for human consumption) are specific varieties of grain sorghum that produce white berries, which are used to make flour. Grain sorghum does not contain gluten, so sorghum food products can play an important role in the diets of people who are gluten intolerant or allergic to wheat.



Grain Sorghum Products

Credit: Stephen Ausmus, USDA ARS

GRAIN SORGHUM FACTS

Kansas leads the nation in the production of grain sorghum.

Worldwide, people and livestock consume nearly the same amount of sorghum.

Sorghum is the leading cereal grain in Africa.

Grain sorghum does not contain gluten, meaning people with an allergy or intolerance for gluten can safely consume products made with sorghum flour.

Oats, Barley, and Rice

Other important cereal grains are rice, barley, and oats. Although barley and rice are not being produced for food consumption in Kansas at this time, both are leading cereal grains worldwide. Globally, rice is the second most consumed cereal grain and barley ranks fourth. However, most of the barley produced in the United States is used to make malt beverages.



Oats and Barley Food Products

Credit: Peggy Greb, USDA ARS



Barley Foods

Credit: Peggy Greb, USDA ARS

OTHER CEREAL GRAINS

Worldwide, rice is the second-most consumed cereal grain (behind wheat); corn ranks third and barley ranks fourth.

In Kansas, rice is not a traditional or historic crop. However, rice is being grown for a bioprocessing facility in Junction City. Ventria Bioscience extracts a protein from the rice grown specifically for that facility by Kansas farmers. The protein, which also occurs naturally in breast milk, is being used to improve infant health worldwide.

In the United States, the food industry consumes less than five percent of the oats produced domestically. Oats are grown in nearly every state in the United States but most of the oats grown in this country are used as livestock feed. In Kansas, more than one-half of the acres planted to oats each year are harvested as hay.



Cooked Oatmeal

Credit: Renee Comet, NCI



Oilseeds (from left): Soybeans; Sunflowers; Cottonseed; Canola

Credits (from left): Lynn Betts, USDA NRCS; National Sunflower Association; K-State Research & Extension; Copyright: Monsanto Company

OILSEEDS

Plants that produce oil-rich seeds are called oilseeds because oil is extracted primarily from the seeds, rather than from other parts of these plants. Oilseeds also include crops like cotton where the oil extracted from the seeds is a coproduct of processing the crop for other uses.

Oilseeds produce both edible and inedible oils, although almost all crude oil extracted from oilseeds must be processed in some way before it can be considered edible. Edible oils are consumed directly, used as food ingredients, and heated to cook other foods.

OILSEED

Oilseed – a plant that produces oil-rich seeds. Oil is extracted from the plant's seeds, rather than other parts of the plant.

EDIBLE OILS

Oils are fats that are in liquid form at room temperature.

Oils contain essential fatty acids.

Oils from plant sources do not contain cholesterol.

Kansas crops that produce oils used in food production and preparation include corn, soybeans, cotton, sunflowers, canola, pecans, and walnuts.

VEGETABLE OIL

Vegetable oil may be made from a single ingredient or a blend of several oils.

The oil(s) will be listed as ingredients on the product's label.

Soybean oil (soy oil) accounts for about 75 percent of the vegetable oil used in commercial and consumer cooking in the United States.

Source: United Soybean Board

In Kansas, oilseed crops became major agricultural crops much later than cereal grains and forages. For example, Kansas settlers experimented with growing cotton following the disruption of cotton production in the traditional cotton growing states during the Civil War. However, other crops like wheat and corn became more profitable and cotton production in Kansas had dropped to only three acres by 1910. Cotton began making a comeback in Kansas in the early 1980s and has continued to expand with the development of new varieties suitable for southern Kansas, as well as the building of four new cotton gins in the state since 1998.



Cotton Oil

Credit: The Cotton Foundation

Cottonseed oil actually dominated the U.S. market for vegetable oil until the 1940s, when food processors turned to soy oil as a result of domestic cottonseed oil shortages caused by World War II. Soybeans were first introduced in Kansas in 1904, but production was not tracked until the 1920s. Today, soybeans are the third largest crop in Kansas, trailing only wheat and corn in the number of acres planted and harvested, as well as dollar value.

Sunflowers are another major oilseed crop in Kansas and the United States. In fact, Kansas ranks third in sunflower production behind only North Dakota and South Dakota. However, sunflowers did not become a major crop in Kansas until the late 1970s.

Worldwide, the most important oilseeds are soybeans, rapeseed, cottonseed, peanuts, sunflower seeds, coconut, and palm kernel. Oilseed crops grown in Kansas include soybeans, sunflowers, cotton, and canola.

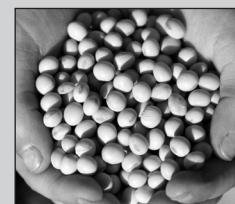
SOYBEAN FACTS

Worldwide, more soybeans are produced than any other oilseed.

Soybeans are the third largest crop in Kansas, trailing only wheat and corn in the number of acres planted and harvested as well as dollar value.

Approximately 10 percent of the soybeans produced in the United States are used for human consumption.

The United States leads the world in the production of soybean oil (soy oil).



Soybeans

Credit: Minnesota Soybean Research & Promotion Council

Soybeans

Even though the soybean plant is technically a legume, soybeans are considered oilseeds. Oil is stored in the soybean seed to serve as the food source for a developing embryo. The oil is extracted from the seed, rather than other parts of the plant. In 2010, Kansas ranked tenth in the nation in soybean production, producing more than 138.1 million bushels of soybeans according to the Kansas Agricultural Statistics Service. While that was only a little more than four percent of the national crop, production continues to increase in Kansas, contributing to the available supply of soybeans.

According to the Kansas Soybean Commission, approximately 10 percent of the soybeans produced in the United States are used for human consumption, either as food products or food ingredients. Products made from soybeans include soybean oil, tofu (soybean curd), soymilk, soynut butter, soy sauce, soy flour, and soy infant formulas. Soybean oil is a major source of soy lecithin, which is used in products like ice cream and chocolate products. Lecithin, a naturally-occurring substance found in plant and animal tissues, has properties that prevent ingredients in a mixture from separating, like the cocoa and cocoa butter combined to make the chocolate in a candy bar. Lecithin also helps maintain an even distribution of ingredients in a dough mixture and is used to prevent sticking, as in a nonstick cooking spray.

Oil constitutes 18 to 19 percent of the weight of a soybean. The United States leads the world in the production of soybean oil and soybean oil is the leading vegetable oil produced in the United States. Soy oil (soybean oil) is the principle source of omega-3 fatty acids in the U.S. diet, one of the few



Soyfoods

Credit: Soybean Checkoff



Soy Milk

Credit: Soybean Checkoff



Soy Oil

Credit: Minnesota Soybean Research & Promotion Council

EDAMAME

Known in Japan as edamame, green (immature) soybeans still in the pod are gaining popularity as a food item in the United States. Edamame soybeans are bigger and sweeter than the traditional soybeans grown by most farmers in the United States. Also known as vegetable soybeans, green vegetable soybeans, and sweet beans, they are considered an emerging specialty crop in the United States. Edamame makes a healthy snack or a tasty addition to a stir-fry. It may be found in the frozen foods section of many larger grocery stores or natural and health food stores.

Marinated Edamame Salad

Credit: James Gathany, CDC



non-fish sources of this important essential fatty acid, according to the United Soybean Board. Liquid soybean oil is used in salad dressings, some brands of margarine, and cooking oils. At the supermarket, most of the cooking oils labeled "vegetable oil" are soy oil.

Sunflowers

There are two types of sunflowers produced in Kansas: oilseed and non-oil (confection). More than 75 percent of the sunflowers produced in the United States are oilseeds. In Kansas, nearly 80 percent of the sunflowers produced in 2010 were oilseeds, according to the Kansas Agricultural Statistics Service.

An intact oilseed sunflower seed consists of more than 42 percent oil. An average crop can yield 600 pounds of oil per acre, which is significantly more oil per acre than soybeans.⁵ Sunflower oil, light gold in color, is a versatile oil used for cooking and frying.

There are three types of oilseed sunflowers: NuSun®, high oleic, and linoleic. Each type produces an oil with a different oleic (fatty acid) structure, which gives the oil unique characteristics. According to the National Sunflower Association, 70 percent of the

Sunflower Seeds

Credit: National Sunflower Association



Confection vs. Oilseeds

Credit: National Sunflower Association



Roasting Sunflower Seeds

Credit: National Sunflower Association



SUNFLOWER FACTS

Kansas ranks third in sunflower production in the United States, behind North Dakota and South Dakota.

An intact oilseed sunflower seed consists of more than 42 percent oil.

An average crop of sunflowers can yield significantly more oil per acre than soybeans.

More than 75 percent of the sunflowers produced in the United States are oilseed sunflowers, rather than non-oil (confection) sunflowers.



Sunflower

Credit: National Sunflower Association

SUNFLOWER SEEDS

Sunflower seeds are a popular American snack. These striped seeds are produced by non-oil (confection) sunflowers. While the largest seeds are sold intact, the hulls (shells) are usually removed from the medium-sized seeds, which are sold as sunflower kernels. Snack foods like granola or trail mix often contain sunflower kernels, which are also used in salads, cereals, breads, or desserts.



Sunflower Oil and Chips

Credit: National Sunflower Association



Sunflower Margarine

Credit: National Sunflower Association

oilseed sunflowers planted in the United States are NuSun® varieties. These varieties produce excellent frying oil that does not require hydrogenation, a process that can produce trans fats. Because NuSun® oil is trans fat-free, it is used commercially by major snack food manufacturers and other segments of the food industry due to its heart-healthy benefits and light taste. High oleic sunflower oil is a commercial oil used in baking, frying, and in food products such as non-dairy creamers, cereal, crackers, and dried fruit. Linoleic sunflower oil, the traditional sunflower oil, is the preferred oil for cooking in many countries. In the United States, it is also used in margarine and salad oils.

Cotton

Although cottonseed once had no value, today it accounts for about 15 percent of the value of the cotton crop. On average, one ton of cottonseed produces about 320 pounds of oil. Cottonseed oil, which is extracted from the seed kernels after the hulls and cotton linters have been removed, requires additional processing before it is used in food. Cottonseed oil is primarily used as a salad or cooking oil. It is also used in baking and frying snacks and other foods.



Salad Oil

Credit: National Cottonseed Products Association



Fried Chicken

Credit: National Cottonseed Products Association



Cotton Oil

Credit: National Cottonseed Products Association

OTHER OILSEEDS

Cottonseed oil (cotton oil) is extracted from the cottonseed kernels after the hulls and cotton linters have been removed.

One ton of cottonseed produces about 320 pounds of oil.

About 70 percent of the canola oil used in the United States is imported from Canada and Europe.

Canola and Peanut

Other edible oils include canola oil and peanut oil. Both canola and peanut oil have a high smoke point, which means that higher temperatures can be used when frying with these oils. When food is fried at a higher temperature, less oil is absorbed into the food and the food develops a thinner crust and a crispy texture.

At the present time, 70 percent of the canola oil used in the United States is imported from Canada and Europe, according to K-State Research and Extension. Although there are no canola processing facilities in Kansas, canola acreage is rising in the state.

Peanut kernels contain 48 to 56 percent oil. While peanuts are not commercially grown in Kansas, the production of peanut oil world wide is second only to soybean oil among edible vegetable oils.⁶

FRUITS

The term "fruit" is typically used to describe the fleshy seed-associated structures of certain perennial plants. Fruits can be eaten raw (without cooking) and are usually sweet. Fruit-bearing plants and trees native to Kansas include wild crabapple, red and white mulberry, black cherry, chokecherry, persimmon, pawpaw, blackberry, currant,

FRUIT

Fruit – a term typically used to describe the fleshy seed-associated structures of certain perennial plants, usually sweet-tasting. Note: scientifically, a fruit is defined as the reproductive structure of a seed plant.



Fruit

Credit: Stephen Ausmus, USDA ARS

POMOLOGY

Pomology – the science of growing fruit.

elderberry, gooseberry, black raspberry, grape, strawberry, and eight species of plum, including the popular sandhill plum. Many of the early settlers brought other well-known fruit trees and shrubs with them when they first came to Kansas. They planted trees and orchards to recreate the landscapes they had left behind and to provide food and income for their families. The first records placing a value on orchard products in Kansas date back to 1860.



Pawpaw Fruit

Credit: Scott Bauer, USDA ARS

Interested fruit growers formed the Kansas Pomological Society in 1867. (Pomology is the science of growing fruit.) The State Horticultural Society grew out of the pomological society and the Kansas State Horticultural Society was awarded a gold medal in 1869 for its display of fruits at the Pomological Congress in Philadelphia.⁷

In 1880, the Kansas State Board of Agriculture reported nearly 2.4 million apple trees, more than 5 million peach trees, and more than 900,000 cherry, pear, and plum trees in the state, as well as more than 5,500 acres of vineyards and nearly 7,000 acres of raspberries, blackberries, and strawberries.⁸ Prohibition, the national ban on the sale, manufacture, and transportation of liquor from 1920 to 1933, and a damaging freeze in 1940 contributed to substantial declines in fruit production in Kansas. Other agricultural crops became more profitable than fruit production, which is labor-intensive and requires a two to four year waiting period between planting and the first fruit crop for many fruit trees and plants.

Today, a wide variety of fruits are available from Kansas growers, including apricots, apples, blackberries, blueberries, cherries, elderberries, gooseberries, grapes, nectarines, peaches, pears, plums, raspberries, and strawberries.



Blackberries

Credit: Scott Bauer, USDA ARS



Pears

Credit: Scott Bauer, USDA ARS

Cherries

Credit: Brian Prechtel, USDA ARS

NATIVE KANSAS FRUITS

Black cherry	Gooseberry	Sandhill Plum
Black raspberry	Grape	Strawberry
Blackberry	Pawpaw	White mulberry
Chokecherry	Persimmon	Wild crabapple
Currant	Plum	
Elderberry	Red mulberry	

Apples

Most orchards in Kansas are apple orchards. According to University of Illinois Extension, there are 2,500 types of apples grown in the United States and 100 of those varieties are grown commercially. Some types are better suited for certain uses. For instance, Granny Smith apples are perfect for baking while Honeycrisp apples are best for snacking.

Many consumer food products are apple-based, like apple juice and concentrate, cider, and applesauce. Apple chips (dried apple slices) are a popular snack food while canned apples are incorporated into pies, cobblers, and other delicious desserts. Apples also make great additions to salads.

More than two-thirds of the apples produced in the United States are consumed as fresh fruit, according to the U.S. Department of Agriculture's Economic Research Service. Apples are an excellent snack option as they are high in vitamin C, antioxidants, and dietary fiber. Most of the fiber and certain antioxidants are concentrated in the skin of the apple.



Apples

Credit: U.S. Apple Association



Apple Food Products

Credit: U.S. Apple Association



Choosing Apples

Credit: Keith Weller, USDA ARS



Apple Trees

Credit: Doug Wilson, USDA

APPLE FACTS

Most orchards in Kansas are apple orchards.

More than two-thirds of the apples produced in the United States are consumed as fresh fruit.

Apples are high in vitamin C, antioxidants, and dietary fiber.

The skin of an apple contains most of the fiber and higher concentrations of certain antioxidants.

FACTS ABOUT GRAPES

Before Prohibition, Kansas was one of the top grape-producing states in the United States.

One acre of grapevines may yield from 4,000 to 6,000 pounds of grapes per year.

Grapes contain 70 to 80 percent water.

Grapes

According to the Kansas Department of Commerce, Kansas was one of the top-producing grape states before Prohibition. Even after Prohibition ended in 1933, the state of Kansas continued to enforce strict state laws concerning alcohol production and consumption, which contributed to the abandonment of many Kansas vineyards. In 1985, the state passed a new law allowing farm wineries, and the first commercial winery opened in Kansas in 1988.

Commercial grape production requires a large investment of capital because the vines do not reach full production until four or five years after planting. When properly managed, most vines will continue to produce for at least 25 years, according to K-State Research and Extension. An acre of vines may yield from 4,000 to 6,000 pounds of grapes per year.⁹



Grapes

Credit: Renee Comet, NCI



Vineyard near Lincoln, KS

Credit: Barbara Oplinger

KANSAS VINEYARD RESEARCH

K-State Research and Extension conducts vineyard research at the John C. Pair Horticulture Center in Haysville, Kansas.

GROWING GRAPES

Grapes are perennial plants, with clusters of fruit developing on vines. Grapevines are supported by trellises that hold the vines above the ground. This allows the vines to be managed and increases the amount of sunlight exposure the leaves receive, leading to additional photosynthesis and fruit production. Pruning is necessary to maintain fruit production. Grapes may be mechanically harvested or harvested by hand.

THE SCIENCE OF GRAPES

Enology – the science dealing with wine and wine making.

Viniculture – the science, production, and study of grapes used for winemaking.

Viticulture – the science, production, and study of grapes.

CULTIVARS VS. VARIETY

Cultivar – a new plant usually propagated (created) through cuttings, grafting, or tissue culture rather than grown from seed. Seeds of cultivars usually do not reproduce plants identical to the parent plant.

Variety – a plant grown from seed. The plant will have the same characteristics of the plant that produced the seed and will produce seeds with those same characteristics.

Today, Kansas vineyards produce table grapes, multi-purpose grapes (for desserts, juice, or jelly-making), and grapes for winemaking. Nutrients vary among the various types of grapes and grape cultivars. In general, grapes contain 70 to 80 percent water, are low in fat but high in carbohydrates, and are good sources of vitamins C and K.

VEGETABLES

The word "vegetable" is typically used to describe edible plants or plant parts that are salty or sharp-tasting rather than sweet like fruit. The nutritional content varies among vegetables and even between the edible parts of the plants. Generally, vegetables contain little protein or fat, are high in water content, and are low in calories.

Many vegetables are annual plants compared to fruit-bearing plants, which are usually perennials. Many plants now considered vegetables were first cultivated as medicinal plants, rather than for food consumption. Others provided livestock feed before being adapted for food uses.

Today, many people grow vegetables in home, school, and community gardens. In addition, a wide variety



Vegetables

Credit: James Gathany, CDC

Gardening

Credit: Cade Martin, CDC



DEFINING A VEGETABLE

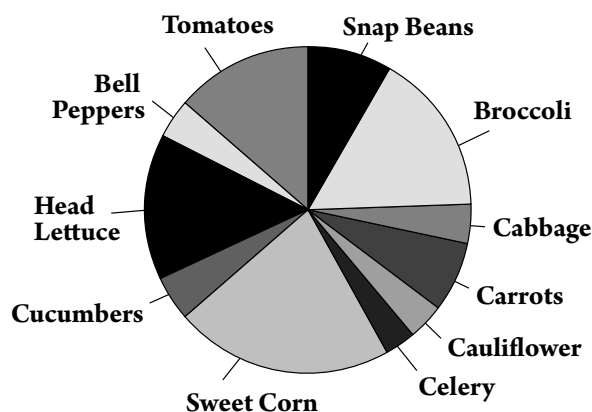
There is no scientific or botanical definition of the term "vegetable," only cultural and culinary definitions that vary from country to country. For example, the avocado is considered a fruit in Brazil, but is considered a vegetable in the United States and Mexico.

In 1893, the U.S. Supreme Court ruled that the tomato is a vegetable. At the same time, the court recognized that a tomato fits the botanical definition of a fruit. The court case (Nix v. Hedden) involved a tax issue because, at the time, imported fruits were taxed differently than imported vegetables.



Tomato

Credit: National Garden Bureau

SELECTED SPRING SEASON VEGETABLES: 2011*Total Harvested Acres (U.S.) - 193,680*Source: National Agricultural Statistics Service¹⁰

of vegetables are grown as agricultural crops. In Kansas, vegetables grown as agricultural crops include sweet corn, tomatoes, onions, asparagus, pinto beans, potatoes, and pumpkins.

Pinto Beans

Pinto beans fall into the dry edible beans category of vegetables. Navy beans, black beans, lima beans, kidney beans, and garbanzo beans (chickpeas) are also categorized as dry edible beans. Dry edible beans are distributed as whole seeds in unprocessed form or processed into canned products. Uncooked dry edible beans contain trypsin inhibitors, chemical substances that prevent protein digestion in humans and non-ruminant animals. The application of heat during processing or home cooking deactivates the trypsin inhibitors and makes the beans fully digestible. According to the U.S. Dry Bean Council, the United States leads the world in the production of dry edible beans. However, only 25 percent of the dry edible beans produced in the United States are exported; Americans consume the rest.¹¹

Nearly all the dry edible bean acreage in Kansas is planted to pinto beans. Sherman County typically accounts for nearly one-third of the state's production of dry edible beans. A pinto bean processing plant in adjoining Wallace County provides a market for pinto beans

**Pinto Beans**

Credit: Scott Bauer, USDA ARS

**Dry Edible Beans**

Credit: U.S. Dry Bean Council

FACTS ABOUT PINTO BEANS

Pinto beans fall into the dry edible beans category of vegetables.

The second-leading provider of pinto beans in the United States is located in Sharon Springs, Kansas.

Pinto beans turn pink in color when cooked.

produced in northwest Kansas. Located in Sharon Springs, Kansas, 21st Century Bean Processing is the second-leading provider of pinto beans in the United States.¹²

Pinto beans are high in protein, iron, potassium, magnesium, and fiber. They can be incorporated into salads, soups, stews, chili, and casseroles. Processed products made from pinto beans include refried beans and refried bean paste. These products reflect a distinctive characteristic of pinto beans, which turn pink in color when cooked.

**Chili**

Credit: Rene Comet, NCI

Potatoes

Potatoes are the leading vegetable crop in the United States, according to the Ag Marketing Resource Center at Iowa State University. Kansas was the third-leading state in potato production in 2008, producing more than 1.5 million pounds of potatoes valued at nearly \$26.5 million, according to the Kansas Agricultural Statistics Service.

The National Potato Council reports that nearly eight out of 10 consumers eat some form of potatoes 3.6 times every two weeks. Potatoes are all-around vegetables that can be baked, scalloped, mashed, or fried, which makes them an excellent addition to any meal. Because potatoes freeze well, frozen potatoes, in the form of fries, tater tots, and hash browns, are convenient options for consumers and widely used in the fast food and restaurant industries. Around 40 percent of the potatoes produced in the United States are consumed as frozen products.¹³ Processed potatoes include potato chips and other snack foods. Potatoes can also be dehydrated to create potato flakes or granules, which are used in instant mashed potato products or in Pringles® potato crisps.

A baked potato – by itself – is a good source of minerals and vitamins. The majority of the nutrients are found in the potato itself, not in the skin. Potatoes are high in vitamin C, vitamin B₆, dietary fiber, and potassium. In fact, a potato provides more potassium than a banana!

**Potato Products**

Credit: Scott Bauer, USDA ARS

POTATO FACTS

Potatoes are the leading vegetable crop in the United States.

Kansas ranks third in potato production among the 50 states.

Around 40 percent of the potatoes produced in the United States are consumed as frozen products.

The potato itself, not the skin, contains most of the nutrients.

One potato provides more potassium than a banana.

**Potatoes**

Credit: Peggy Bain, USDA ARS

Plants on the Plate

Pumpkins

Ninety percent of the pumpkins grown in the United States are raised within a 90-mile radius of Peoria, Illinois – near the location of a Libby's® pumpkin processing plant that cans more than 85 percent of the world's pumpkin crop each year.¹⁴ A pumpkin's outer layer (the rind) forms a hard shell around the pulp. Pumpkin pulp, the edible portion of a pumpkin, is high in fiber and rich in vitamin A and potassium.

Because pumpkins are harvested in the fall, pumpkin food products often correlate with the cooler, holiday season. However, canned pumpkin or canned pumpkin pie mix allows consumers to enjoy the savory and slightly sweet taste of pumpkin anytime during the year. Although pumpkin is incorporated into many baked goods like breads and cookies, it can also be featured in other dishes, such as soups, casseroles, and sauces. Whether sweetened with sugar or enhanced with spice, pumpkin is truly a versatile Kansas crop.

Pumpkin seeds are also edible. They can be roasted with seasonings for a tasty snack.



Pumpkins

Credit: National Garden Bureau



Pumpkin Pie

Credit: Peggy Greb, USDA ARS



Pumpkin Soup

Credit: James Gathany, CDC

PUMPKIN FACTS

Ninety percent of the pumpkins grown in the United States are raised within a 90-mile radius of Peoria, Illinois.

More than 85 percent of the world's pumpkin crop is canned at a pumpkin processing plant in Morton, Illinois.

The pumpkin pulp is the edible portion of a pumpkin.

Pumpkin seeds are edible.



Roasted Pumpkin Seeds

Credit: National Garden Bureau

OTHER FOOD CROPS

Pecans and Black Walnuts

Pecans and black walnuts are important nut crops in Kansas. Both pecan and walnut trees produce fruit with a green outer husk that turns brown at maturity. Inside the outer husk, a shell develops around an edible kernel known as the nutmeat. These nutmeats are sold to



Pecan Nuts

Credit: Peggy Greb, USDA ARS

KANSAS NUT CROPS

Pecan and black walnut trees are native to Kansas.

Kansas produces about one percent of the U.S. pecan crop each year.

In an average year, more than 37 tons of black walnuts are collected in Kansas.

PECAN RESEARCH IN KANSAS

Kansas State University's Pecan Experiment Field is a regional research and extension center serving pecan producers in Kansas and Missouri. The Pecan Experiment Field is located east of Chetopa, Kansas.

bakeries, candy makers, food stores, and used in baked goods and gourmet recipes. Nutmeats like pecans and walnuts are high-energy protein food sources packed with vitamins and minerals.

Pecans contain more than 19 vitamins and minerals and very little saturated fat. They are rich in omega-6 fatty acids and high in vitamin E and other antioxidants. Pecans have a distinctive sweet odor and a rich, buttery flavor that is compatible with most foods, allowing them to be eaten fresh or used as ingredient in many food products.

The pecan tree, which is native to Kansas, is the only tree that produces a thin-shelled oblong nut. The United States is the world's largest producer of pecans, but Kansas only contributes about one percent to the U.S. pecan production each year.¹⁵ Even so, the Kansas pecan crop was valued at \$1.9 million in 2008, according to the Kansas Agricultural Statistics Service.

Black walnut trees are also native to Kansas where, in an average year, more than 37 tons of black walnuts are collected. Many are taken to a commercial walnut shelling plant in Stockton, Missouri, which is one of only two such facilities in the United States. Black walnuts have an intense, nutty flavor and are eaten raw, as well as used in salads and baked goods. They are low in saturated fats and are a rich source of antioxidants, including vitamin B₉. Black walnuts are particularly high in manganese, a mineral needed to form bones and connective tissue.



Native Pecan Trees

Credit: Dr. William Reid

Honey

The U.S. Department of Agriculture estimates that about one-third of the food eaten by people in the United States comes from insect-pollinated plants and trees. Honeybees are responsible for 80 percent of that pollination, based on estimates by the U.S. Department of Agriculture.

Honeybees are responsible for pollinating many flowers, fruits, vegetables, and crops in Kansas. In the process, they produce honey, which is the only insect-produced food eaten by humans.



Honey

Credit: Scott Bauer, USDA ARS

**Honeybee on Apple Blossom**

Credit: Jack Dykinga, USDA ARS

**Bee Hive**

Credit: Cynthia Hart

The color and flavor of honey are influenced by the honeybees' nectar source. The honeybees from a single beehive only collect nectar from one type of flower. Each bee may visit more than 1,000 flowers in order to collect enough nectar to fill its honey sac just one time. (The honey sac is about the size of the head of a pin.) Honeybees rely on their vision to locate the correct flowers and may fly up to six miles in search of the right flowers. The flavors and colors of honey produced in Kansas may be derived from wildflowers, clover, or alfalfa.

**Honeybee**

Credit: James Gathany, CDC

Natural sugars – mostly fructose and glucose – account for approximately 80 percent of honey's carbohydrate content. Honey also contains small amounts of vitamins, minerals, and amino acids (protein).

Liquid honey is the most recognizable form of honey. However, honeycombs, whipped honey, and honey sticks are also available. Honey may also be included in sauces or marinades, sweetened beverages, and baked goods. More than 500,000 pounds of honey, valued at more than one million dollars, were produced in Kansas in 2009.¹⁶

HONEY FACTS

Honey is the only insect-produced food eaten by humans.

The color and flavor of honey are influenced by a honeybee's nectar source.

The honeybees from a single beehive only collect nectar from one type of flower.

Honeybees are not native to the Western Hemisphere.

European settlers brought the first honeybees to North America in the 1600s.

NUTRIENTS

Nutrient – a substance needed for an organism to grow and function properly.

Essential nutrient – a nutrient that must be obtained from dietary sources because the human body cannot manufacture the nutrient in needed amounts.

ESSENTIAL NUTRIENTS FOR HUMANS

Water
Proteins
Carbohydrates
Vitamins
Minerals
Fats

**Nutritious Foods**

Credit: Adam Gillum, USDA ARS

NUTRITION

Nutrition is important because it provides our bodies with the energy required to maintain good health. A nutritionally sound diet can ward off fatigue, positively affect mood, boost the immune system, and prevent serious illnesses. Plentiful in protein, carbohydrates, vitamins, minerals, and healthy fats, there is no doubt that Kansas crops have a place in a well-balanced diet.

ESSENTIAL NUTRIENTS

A nutrient is a substance needed for an organism to grow and function properly. There are six essential nutrients for people: proteins, carbohydrates, fats, minerals, vitamins, and water. These nutrients must be obtained from dietary sources because the human body cannot manufacture these nutrients in the needed amounts.

Water

The human body is made up of 60 to 75 percent water. A person cannot survive without water. Water's most important function is distributing other nutrients throughout the body. It is found in all body tissues and performs many other functions, such as maintaining body temperature, aiding in the digestion of food, and helping move waste material through the body.

WATER FACT

Water distributes other nutrients throughout the body, maintains body temperature, aids in the digestion of food, and helps move waste material through the body.

**Water**

Credit: Tim McCabe, USDA NRCS

Plants on the Plate

Water sources include fluids and beverages as well as solid foods. Many fruits and vegetables have high water content, more than 90 percent in some cases. For example, apples have a water content of 80 percent while a baked potato is about 75 percent water. Protein-rich foods such as meat, fish, or chicken may contain as much as one-half to two-thirds their weight in water. Even grain products may be up to one-third water.¹⁷



Food Sources for Water
Credit: Peggy Greb, USDA ARS



Carbohydrate Sources
Credit: NCI

PROTEINS

Proteins strengthen, maintain, and replace tissues in the body.



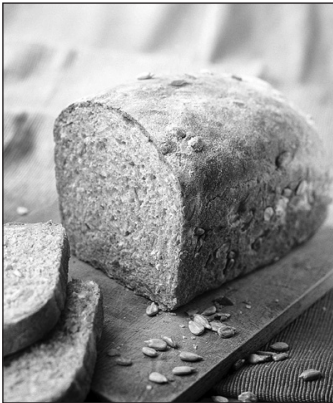
Cheeseburger
Credit: Renee Comet, NCI

Fried Eggs
Credit: Renee Comet, NCI

Proteins

Proteins are a vital part of a diet because they strengthen, maintain, and replace tissues in the body. Important sources of protein include dry beans and nuts as well as food products that utilize Kansas crops in their production, including meats like beef, pork, lamb, and poultry, as well as fish, eggs, milk, cheese, and other dairy products.

Some Kansas crops are known for their protein content. Pinto beans, for example, are high in protein. Non-oil (confection) sunflower seeds also have high protein content. According to the National Sunflower Association, one ounce of sunflower seeds contains six grams of protein, making them an ideal snack or addition to breads, salads, and desserts. Soyfoods also provide high-quality protein. According to the United Soybean Board, soyfoods can contribute significantly toward meeting protein needs, generally while staying low in saturated fat and being cholesterol free. Important sources of soy protein include tofu, soy nut butter, and soy burgers.



Sunflower Wheat Bread
Credit: National Sunflower Association

Carbohydrates

Carbohydrates are used by the body to make glucose, which is the fuel that provides energy for the body. Carbohydrates can be found in grain foods, fruits, vegetables, milk and dairy products, and foods containing added sugar, such as baked goods or beverages. Foods higher in carbohydrates are considered healthier if they include dietary fiber and whole grains without added sugars. Kansas crops like wheat, corn, pinto beans, potatoes, and many fruits and vegetables are significant sources of carbohydrates.

There are two types of carbohydrates: simple and complex. Simple carbohydrates, which usually taste sweet, are digested and converted to glucose quickly, providing a burst of energy. But, any excess glucose

CARBOHYDRATES

Carbohydrates are used by the body to make glucose, which is the fuel that provides energy for the body.

There are two types of carbohydrates: simple and complex.

There are two types of complex carbohydrates: starch and dietary fiber.

Eating Carbohydrates
Credit: Scott Bauer, USDA ARS

CARBOHYDRATE WORDS	
Carbohydrate	– an essential nutrient that is used by the body to make glucose.
Complex carbohydrate	– a carbohydrate that takes longer to break down into glucose; usually does not taste sweet.
Dietary fiber	– a complex carbohydrate; includes all parts of plant foods that the human body cannot digest or absorb.
Simple carbohydrate	– a carbohydrate that is digested and converted to glucose quickly; usually tastes sweet.
Starch	– a complex carbohydrate; plants store energy in the form of starch.

from simple carbohydrates that the body does not immediately use may be stored in the body's liver and muscle cells as glycogen. Simple carbohydrates include some of the sugars found naturally in foods like fruits, vegetables, and dairy products. Simple carbohydrates may also include sugars added during food processing.

Complex carbohydrates usually do not taste sweet. They take longer to break down into glucose, providing a steady stream of energy over a longer period of time. There are two types of complex carbohydrates – starch and dietary fiber. Plants store energy in the form of starch, which is easily digested by the human body and turned into glucose. In contrast, dietary fiber includes all parts of plant foods that the human body cannot digest or absorb, including the cellulose found in plant cells. Dietary fiber aids the movement of material through the digestive tract and helps prevent overeating by producing a feeling of fullness.



Leafy Green Vegetables

Credit: Peggy Greb, USDA ARS

Vitamins

Kansas crops are naturally rich in vitamins and minerals. Vitamins and minerals play vital roles in the body, with each vitamin and mineral serving a unique purpose. The best way to ensure that the



Choosing a Balanced Diet

Credit: Peggy Greb, USDA ARS

ENRICHED AND FORTIFIED FOODS

Some foods have been enriched or fortified, meaning nutrients (vitamins or minerals) have been added to the products.

Enriched – in the final product, nutrients lost during processing have been replaced in the same amounts; also applies to products that meet the U.S. Food and Drug Administration's definition for a type of food with a name that includes the term "enriched," like enriched flour or enriched bread.

Fortified – the final product contains nutrients that are not naturally in the product or are in amounts greater than those naturally found in that product.

body absorbs enough vitamins and minerals to grow and develop normally is to eat a balanced diet with a variety of foods. Many products available in the grocery store are enriched or fortified to include a multitude of vitamins and minerals.

Kansas crops are good sources for important vitamins, including A, B₆, B₉ (folic acid), and E. Vitamin A plays a significant role in vision, bone development, normal cell growth and development, and enhancement of white blood cell functions, like those that help prevent and fight infections. Deep yellow, orange, or dark green foods are often high in beta-carotene, which is converted to vitamin A in the human body. Pumpkins, sweet potatoes, carrots, apricots, cantaloupe, peaches, broccoli, and spinach are examples of foods that are good sources of vitamin A.

Vitamin B₆ serves the body in several ways, supporting the nervous system, processing carbohydrates, and, most importantly, assisting in the formation of new cells. Soybeans and confection sunflower seeds are nutrient dense in vitamin B₆, meaning they have high levels of this nutrient in comparison to their calorie content.

Another important B vitamin is vitamin B₉ (folate or folic acid). Dry edible beans, like pinto beans,



Vitamin A Sources

Credit: James Gathany, CDC



Dry Edible Beans

Credit: Peggy Greb, USDA ARS

FOLATE VS. FOLIC ACID

Folate – a B vitamin that occurs naturally in foods like pinto beans, sunflower seeds, peanuts, asparagus, spinach, broccoli, and citrus fruits.

Folic acid – the synthetic form of folate added to fortified foods.

ENRICHED FLOUR

In response to public health concerns in the 1930s, the federal government began requiring millers to enrich flour with three B vitamins – thiamine, niacin, and riboflavin. An additional B vitamin – folic acid – has also been required since January 1998.

Specified amounts of the vitamins are added to the flour shortly before packaging. According to U.S. regulations, one pound of enriched flour must contain 2.9 milligrams thiamine, 1.8 milligrams riboflavin, 24 milligrams niacin, 0.7 milligrams folic acid, and 20 milligrams iron. Kansas laws prohibit the sale of flour and white bread or rolls for human consumption in this state unless the products are enriched.

Enriched flour accounts for nearly 95 percent of the white flour sold in the United States.

Plants on the Plate

are natural sources of folate, as well as nuts, sunflower seeds, and certain fruits and vegetables. This vitamin helps the body produce and maintain new cells. When taken before and during pregnancy, vitamin B₉ prevents birth defects of the brain and spinal cord. By law, all enriched grain products in the United States, such as breakfast cereal, bread, flour, pasta, cornmeal, and rice, have been fortified with folic acid since January 1, 1998. The Wheat Foods Council reports that grain foods and breakfast cereals provide more than 62 percent of the folic acid consumed in American's diets.¹⁸

Vitamin E is an antioxidant that prevents the production of free radicals in the body, which are believed to contribute to the development of cardiovascular disease and cancer.¹⁹ Many Kansas crops and their products naturally contain vitamin E. These include wheat germ, confection sunflower seeds, sunflower oil, soy oil, and corn oil.

Minerals

Minerals of importance found naturally in Kansas crops include chromium, iron, magnesium, and zinc. Chromium enhances the action of insulin, which is a hormone significant in the metabolism and storage of carbohydrate, fat, and protein in the body.²⁰ Whole-grain products, like whole wheat bread, and many fruits and vegetables are good sources of chromium.

In the body, iron is found in hemoglobin – the protein in red blood cells that carries oxygen to tissues. Iron is found in Kansas crops like soybeans, wheat, and pinto beans.

Magnesium plays several roles in the body, including keeping the heart rhythm steady, strengthening bones, and maintaining nerve and muscle function. Soybeans, wheat germ and bran, pinto beans, and leafy green vegetables are all rich in magnesium.

Beans and whole grains are good sources of zinc. Zinc serves the body in several different ways, including healing wounds, maintaining a healthy immune system capable of fighting off infection or disease, and ensuring normal growth and development by regulating genetic activities that direct cell division and repair damaged DNA.



Enriched Flour

Credit: Wheat Foods Council



Wheat Foods

Credit: Scott Bauer, USDA ARS



Foods High in Magnesium

Credit: Peggy Greb, USDA ARS



Foods High in Zinc

Credit: Keith Weller, USDA ARS

VITAMINS AND MINERALS

Eating a balanced diet with a variety of foods is the key to ensuring that the body absorbs enough vitamins and minerals to grow and develop normally.

LIPIDS

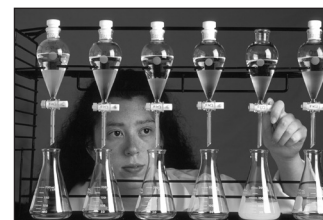
Lipid is another word for "fat." A lipid can be more formally defined as a substance like a fat, oil, or wax that dissolves in alcohol but not in water.

As sources of stored energy, lipids are an important part of living cells. Together with carbohydrates and proteins, lipids are the main components of plant and animal cells.



Saturated and Unsaturated Fats

Credit: Bill Branson, NCI



Testing for Lipids & Fatty Acids

Credit: Scott Bauer, USDA ARS

Fats (Lipids)

Fats, also known as lipids, are an important part of living cells. Along with carbohydrates and proteins, fats are the main components of plant and animal cells. There are many types of fat, including saturated, unsaturated, and trans fats. Saturated fats retain a more solid form at room temperature while unsaturated fats stay liquid at room temperature.

Dieticians recommend that most of the fat consumed should come from unsaturated fat sources like vegetable oils and nuts. Unsaturated fats include monounsaturated fats and polyunsaturated fats. Sources of monounsaturated fats from Kansas crops include confection sunflower seeds and the oils of corn, soybeans, and sunflowers.



Butter

Credit: Renee Comet, NCI

SATURATED VS. UNSATURATED FATTY ACIDS

Saturated fat – retains a more solid form at room temperature; found mainly in animal sources of food.

Unsaturated fat – stays liquid at room temperature.

UNSATURATED FATS

Monounsaturated fat – a type of unsaturated fat that starts to turn solid when chilled; found in a variety of foods and oils.

Polyunsaturated fat – a type of unsaturated fat that provides essential fatty acids that the human body cannot make; found mostly in plant-based foods and oils.

Polyunsaturated fats provide essential fatty acids the human body cannot make. There are two types of polyunsaturated fats: omega-6 and omega-3. Both omega-6 and omega-3 fatty acids are essential to normal growth and development. However, since they often function in opposite ways, it is important to balance the consumption of these fatty acids. There are fewer sources of omega-3 fatty acids, which are typically found in cold water fish, walnuts, flaxseed, and soy oil. Oils rich in omega-6 polyunsaturated fats are more numerous, including corn oil and soy oil. Oils do contain calories, so the amount of oil consumed on a daily basis needs to be limited to balance total calorie intake.

Trans Fats

Trans fats are created during food processing when liquid oils are transformed into solid fats through a process called hydrogenation. As a result, these partially-hydrogenated oils tend to lengthen the shelf-life of foods in the grocery store; however, these trans fats also increase the risk for heart disease. Trans fats are not considered part of a healthy diet, and dietary guidelines recommend consuming as little trans fats as possible. Substituting monounsaturated fats and polyunsaturated fats for trans fats and saturated fats is encouraged.

TRANS FATS

Trans fats – fats created during the process of hydrogenation.

Hydrogenation – the process of transforming liquid oils into solid fats.

DIETARY GUIDELINES

According to the Center for Nutrition Policy and Promotion, the Dietary Guidelines for Americans are issued and revised every five years by the U.S. departments of Agriculture and Health and Human Services. These guidelines provide reliable advice for persons two years and older about how good dietary habits can promote health and decrease risks for major chronic diseases.

MyPLATE

The U.S. Department of Agriculture develops nutrition education materials based upon the current dietary guidelines. The key message of the 2010 Dietary Guidelines for Americans is to eat a healthy diet and be physically active. The MyPlate icon debuted in June 2011, replacing the MyPyramid graphic and nutritional recommendations. The MyPlate icon illustrates how to build a healthy plate based on these food groups: fruits, vegetables, grains, dairy, and protein foods (meat, nuts, eggs, and beans).

Vegetables and Fruits

MyPlate recommends that fruits and vegetables make up at least one-half of each plate of food.

Any vegetable or 100 percent vegetable juice counts as a member of the vegetables food group.

The vegetables food group includes dry beans and peas, dark green vegetables, orange vegetables, starchy vegetables, and others. Vegetables may be raw or cooked, fresh, frozen, canned, or dried (dehydrated); and whole, cut-up, or mashed. Many Kansas crops fall into the vegetables food group, including pinto beans, soybeans, corn, potatoes, sweet potatoes, and pumpkins.

Any fruit or 100 percent fruit juice counts as part of the fruits food group. Fruits may be fresh, canned, frozen, or dried, and may



Fruits and Vegetables

Credit: Peggy Greb, USDA ARS



Vegetable Platter

Credit: James Gathany, CDC

MyPLATE DIETARY GUIDELINES

MyPlate Key Messages

Every meal should include portions from the five food groups: fruits, vegetables, grains, proteins, and dairy.

Fill up at least one-half of each plate of food with fruits and vegetables.

Make whole-grain foods at least one-half of the grain foods on each plate of food.

Vary protein choices, choose lean meats, and keep meat and poultry portions small.

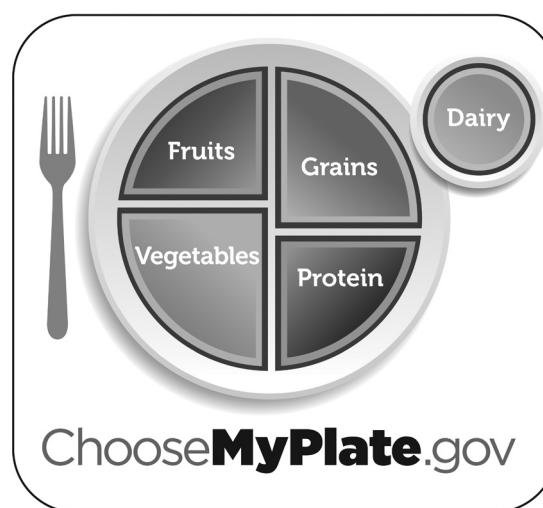
Switch to fat-free or low-fat milk and dairy products.

Avoid oversized portions.

Choose lower calorie menu options.

Eat to feel “satisfied” rather than “full.”

Be physically active.



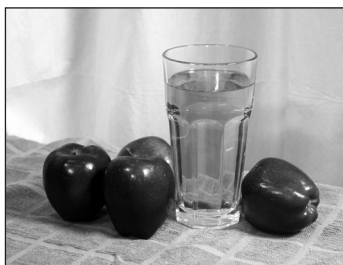
Credit: USDA Center for Nutrition Policy and Promotion

Plants on the Plate



Fruit Salad

Credit: Renee Comet, NCI



Apple Juice

Credit: Alex Lord, KFAC

be whole, cut-up, or pureed. The fruits food group includes melon, like cantaloupe and watermelon. Kansas produces many crops that fall into the fruits food group, such as apples, grapes, cherries, strawberries, peaches, plums, and apricots.

Grains

The grains food group includes any food made from a cereal grain. Cereal grains grown in Kansas include wheat, corn, grain sorghum, and oats. MyPlate recommends that at least one-half of the grains consumed daily be whole grains, which contain the entire kernel. Choose foods that name whole-grain ingredients first on the label's ingredient list, like whole wheat, whole oats, whole-grain corn, whole-grain sorghum, oatmeal, rolled oats, bulgur, brown rice, whole rye, or wild rice.



Corn Food Products

Credit: Scott Bauer, USDA ARS

GRAINS

Whole grain – nothing has been added or removed by processing. Whole grain products must retain nearly the same relative proportions of bran, germ, and endosperm as the original grain, even if the kernels have been cracked, crushed, or flaked. Food manufacturers may fortify whole-grain foods with folic acid.

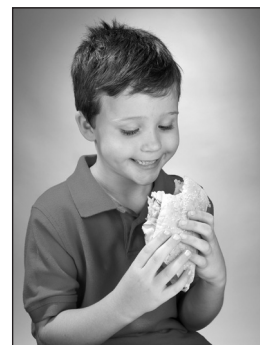
Refined grain – some of the dietary fiber and other important nutrients were removed during processing. Refined grains have been enriched with iron, riboflavin, niacin, and thiamine since 1941, leading to the eradication of pellagra and beriberi in the United States.

Enriched grains – nutrients lost during processing have been replaced in the same amounts. In the United States, enriched refined grain products are required by law to be fortified with folic acid, thiamine, riboflavin, niacin, and iron.

Fortified grain products – the final product contains nutrients that are not naturally in the product or are in amounts greater than those naturally found in that product. According to the Centers for Disease Control and Prevention, the fortification of enriched grain products with folic acid has decreased neural tube birth defects in the United States by one-third since 1998.

Protein Foods

The new dietary guidelines emphasize varying protein food choices. The protein foods group includes all foods made from meat, poultry, fish, dry beans or peas, eggs, nuts, and seeds. Dry beans and peas are part of this food group as well as the vegetables food group because they provide plant protein, particularly useful as a meat alternative. Several Kansas crops fall into the protein foods group, including pinto beans, soybeans, pecans, walnuts, and sunflower seeds. In addition, Kansas crops used as livestock feed, such as corn, grain sorghum, soybeans, and alfalfa, contribute to the availability of Kansas-produced meat products like beef, pork, and lamb that fall into this food group. MyPlate recommends keeping meat and poultry portions small and choosing lean meats.



Deli Sandwich

Credit: Stephen Ausmus, USDA ARS



Asian Stir Fry

Credit: The Beef Checkoff

Dairy

The MyPlate graphic illustrates a place setting with the dairy foods group to the side and top of a plate filled with the other food groups, similar to how a glass of milk might be placed on the table. The dairy food group includes all fluid milk products and foods like cheese and yogurt that are made from milk. The new dietary guidelines recommend switching to fat-free (skim) or low-fat (1%) milk, which provides the same amount of calcium and other nutrients as whole milk but contains less fat and fewer calories. Many Kansas crops are used to feed dairy cattle, including grains, alfalfa, and other hay products that supply the necessary nutrients for milk production.



Dairy Foods

Credit: Scott Bauer, USDA ARS

Food Choices

A certain number of calories are required each day to keep the body functioning and provide energy for physical activities. The dietary guidelines emphasize finding the personal daily calorie limit for each individual and keeping that number in mind as foods are

CALORIE (FOOD)

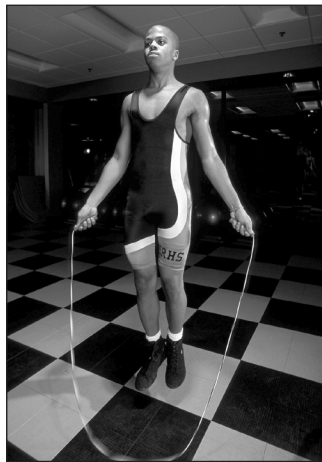
A calorie is a measurement of the potential energy stored in a food. One calorie approximates the energy (heat) needed to increase the temperature of one kilogram of water by one degree Celsius. When more calories are consumed than the body needs, the leftover calories are converted to fat.

- One gram of carbohydrates equals four calories.
- One gram of protein equals four calories.
- One gram of fat equals nine calories.



Food Choices

Credit: Len Rizzi, NCI



Exercise

Credit: Stephen Ausmus, USDA ARS

chosen for consumption. In addition to eating the amount of calories that will help an individual maintain or lose weight, the guidelines recommend avoiding oversized portions, choosing lower calorie menu options, eating to feel "satisfied" rather than "full," and being physically active. Using a smaller plate, bowl, or glass may encourage someone to eat smaller portions as well.

The dietary guidelines stress the importance of reading and understanding food labels. Food product labels not only list the number of calories in each serving but also allow people to choose foods with lower amounts of saturated fat, trans fat, sodium (salt), and sugar.



Single Serving

Credit: James Gathany, CDC

FOOD PRODUCT LABELS

Food packaging and labeling may tempt consumers to purchase certain products because the text, graphics, or design may be appealing. However, food labeling is beneficial to consumers because food companies are required by law to include specific information on their product packages. This information allows consumers to make well-informed purchases of products that fit into healthy lifestyles. Food labeling is required for most packaged foods, but nutrition labeling for raw produce (fresh fruits and vegetables) and fish is voluntary. Food product labels include the principal display panel and the information panel label, as well as the nutrition facts label.



Principal Display Panel

According to the U.S. Food and Drug Administration, the principal display panel is the portion of the product package that is most likely to be seen by the consumer at the time of purchase. The principal display

Comparing Labels

Credit: Stephen Ausmus, USDA ARS

NUTRITION LABELING

Nutrition labeling for raw produce (fresh fruits and vegetables) and fish is voluntary.

New nutritional labeling requirements for single-ingredient, raw meat and poultry products become mandatory starting January 1, 2012. However, there are exemptions for small processors and retailers, as well as some cuts of meat. The new regulations do not differentiate between meat from animals raised using different production practices.

panel must contain the name of the product and the amount of product in the package. The net quantity of the package's contents must be stated in both metric (grams, kilograms, milliliters, and liters) and U.S. Customary System terms (ounces, pounds, or fluid ounces). Other information about the product may also be included on the principal display panel, such as nutrient enrichment or fortification, health claims, or other nutrient content claims.



Principal Display Panels

Credit: Bill Branson, NCI

Many foods, like cereals, pastas, and milk, are enriched or fortified with additional nutrients, which must be reported on the principal display panel. The U.S. Food and Drug Administration has also defined the terms relating to nutrient content that can appear on a food product's principal display panel, such as "low fat," "high fiber," "reduced calories," and "cholesterol free." In addition, the U.S. Food and Drug Administration has approved 12 specific "health claims" that a food product can make, like "Diets low in sodium may reduce the risk of high blood pressure, a disease associated with many factors."

Organic labeling claims, regulated by the U.S. Department of Agriculture, refer to the production and processing methods used to produce food products. For products to be labeled as organic, they must be produced and processed in accordance with National Organic Program standards and be certified by U.S. Department of Agriculture-accredited certifying agents. In addition, labeling requirements are dependent upon the percentage of organic ingredients in the product. In order for the USDA organic seal to appear on product packages and in advertisements, products must consist of at least 95 percent organically produced ingredients.



USDA Organic Seal

Source: USDA

INFORMATION PANEL LABEL

The information panel label is located adjacent to and to the right of the principal display panel. It contains the nutrition facts label, the list of ingredients and allergens, and the name and address of the manufacturer, packer, or distributor of the product.



Information Panel Label

Credit: Alex Lord, KFAC

OTHER FOOD LABELS
Free-range – a marketing term; certification only available for poultry, which must have access to the outdoors according to U.S. Department of Agriculture (USDA) regulations.
Healthy – must meet specific criteria that limits the amounts of fat, saturated fat, cholesterol, and sodium, and requires specific minimum amounts of vitamins, minerals, or other beneficial nutrients; defined by federal law.
Hormone free – a marketing term; banned from any meat product labels by the USDA. Meat and dairy products carrying the “no hormones administered” claim imply that the animal must not have received any added hormones during the course of its lifetime. The USDA prohibits the use of hormones in the raising of poultry and hogs.
Local – a marketing term with no generally accepted definition in terms of the distance between production and consumption. Retailers set their own standards for "local" products, which may be based on where the food is grown or how many miles or hours the food is transported to where it is sold or consumed.
Natural – a marketing term. While there is no regulatory definition of the term, the U.S. Food and Drug Administration (FDA) does not object to the use of the term if the food does not contain added color, artificial flavors, or synthetic substances.
Organic – must meet USDA standards in the way it is grown or produced. In order for the USDA seal to appear on product packages and in advertisements, products must consist of at least 95 percent organically produced ingredients. However, the USDA makes no claims that organically produced food is safer or more nutritious than conventionally produced food.
Sustainable – often used as a marketing term. While the USDA has a formal definition for "sustainable agriculture," generally, any farming practice that reduces inputs while maintaining production, or that generates more production while holding inputs constant, can be considered sustainable.

Source: U.S. Food and Drug Administration

Nutrition Facts Label

The nutrition facts label is presented on the information panel label and sometimes on the principal display panel. It contains information specific to that product and package. The U.S. Food and Drug Administration specifies that the nutrition facts label must be displayed as a box. The government urges manufacturers to strive for consistency in displaying nutrition facts labels, which must include serving size, calories, and nutrient information. Generally, the only nutrients required to be displayed on the nutrition facts label are vitamins A and C, calcium, and iron.

The serving size and the number of servings in the package must be reported on the nutrition facts label. The serving size found on the nutrition facts label allows users to quantify or visualize the amount of food a package contains. The U.S. Food and Drug Administration has specific requirements for reporting serving sizes to maintain consistency between food companies and among similar products. The calorie content and nutrient information on the nutrition facts

NUTRITION FACTS LABEL			
Nutrition Facts			
Serving Size 1 cup (228g)			
Servings Per Container 2			
Amount Per Serving			
Calories 250		Calories from Fat 110	
		% Daily Value*	
Total Fat 12g		18%	
Saturated Fat 3g		15%	
Trans Fat 1.5g			
Cholesterol 30mg		10%	
Sodium 470mg		20%	
Total Carbohydrate 31g		10%	
Dietary Fiber 0g		0%	
Sugars 5g			
Protein 5g			
Vitamin A		4%	
Vitamin C		2%	
Calcium		20%	
Iron		4%	
* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:			
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Source: U.S. Food and Drug Administration

label are based on one serving, regardless of how many servings are contained in the product or package.

A nutrition facts label lists the number of calories per serving, a measurement of how much energy a consumer would get from eating one serving of food from that product. The label also lists how many calories in a single serving come from fat.

Key nutrients affecting health are also listed on the nutrition facts label. These nutrients are separated into two main groups. The nutrients listed first are the nutrients that people generally eat in adequate, or even excessive, amounts. These include total fat (with separate listings for saturated fat and trans fat), cholesterol, and sodium. The second group of nutrients listed on the nutrition facts label are ones that many people do not eat enough of in their diets: dietary fiber, vitamin A, vitamin C, calcium, and iron.

The percent daily value is included for each nutrient listed on the nutrition facts label. According to the U.S. Food and Drug Administration, the percent daily values are useful because they help consumers determine whether a food is high or low in a nutrient and compare the nutritional content of different products. In general, five percent or less daily value is considered low and 20 percent or more is considered high. The percent daily values are based on a 2,000-calorie per day diet for individuals over the age of 18.

Ingredients List

All packaged foods must list the ingredients in the product on the information panel label. Ingredients are listed by quantity, from most to least. This information may appear before or after the nutrition facts label and the name and address of the manufacturer, packer, or distributor.

SERVING SIZES

Nutrition facts label serving sizes on food products are based on – but not necessarily equal to – the amount of food customarily eaten at one time, as reported from nationwide food consumption surveys.

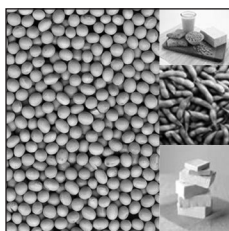
Although the MyPyramid nutrition guide offered serving sizes for the consumption of foods in the various food groups, the MyPyramid serving sizes were not the same as the serving sizes listed on the nutrition facts labels of food products. Typical portion sizes were just one factor in determining serving sizes for MyPyramid.

Source: USDA Center for Nutrition Policy and Promotion

Food Allergens

Many Americans suffer from food allergies. The Food Allergen Labeling and Consumer Protection Act of 2004 requires food labels to identify the source of all major food allergens. By law, according to the U.S. Food and Drug Administration, the eight foods that must be identified on a label are milk, eggs, fish, crustacean shellfish, tree nuts (e.g. almonds, pecans, and walnuts), peanuts, wheat, and soybeans.

Allergens may be listed one of two ways. The first way is called a “contains” statement, which follows the list of ingredients. For example, a “contains” statement for a food may be “Contains: Wheat, Milk, and Soy.” Another way to list allergens is listing the food source in parentheses following each ingredient. For example, the ingredient list may appear as “flour (wheat)” or “lecithin (soy).” Listing allergens on food labels allows consumers to avoid foods known to cause health issues in certain individuals.



Soybeans and Soyfoods

Credit: Soybean Checkoff



Milling Flour

Credit: IGP at K-State

FOOD PROCESSING

Detailed information on flour milling and vegetable oil extraction is discussed in Unit 6, Machines and Technology.

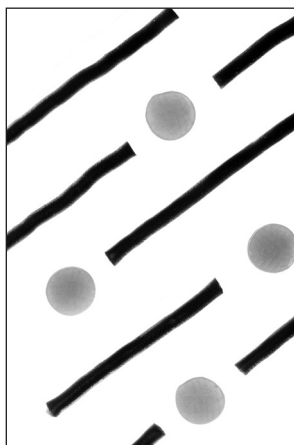


Extruding Snack Products

Credit: Paul Periot, USDA ARS

Extruded and Molded Fruit Purees

Credit: Scott Bauer, USDA ARS



FOOD PROCESSING METHODS

Canning – packing food into sealed or airtight containers and heating the containers to a specified internal temperature in the food; results in a waterproof and airtight container that may be stored at non-refrigerated temperatures.

Dehydration – removing water from food in order to prevent microorganism growth or spoilage.

Extraction – removing oil from oilseeds by mechanically squeezing the oil out of the seeds or with the use of a solvent that removes the oil from the seeds.

Fermentation – converting carbohydrates in food into acids by using microorganisms such as yeast or bacteria.

Low temperature preservation – refrigerating or freezing foods to reduce the growth rate of microorganisms and slow down any physical or enzymatic reactions.

Milling – grinding seeds and sifting the particles to produce flour.

Pasteurization – applying heat to liquids and other food products to destroy harmful bacteria.

Pickling – preserving perishable food by marinating and storing the food in an acid solution, usually vinegar.

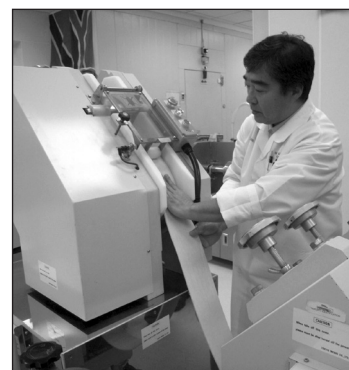
Thermal processing – using heat over a pre-determined length of time to preserve foods; includes canning and pasteurization.

FOOD PROCESSING METHODS

Kansas crops take many routes to reach consumer's tables. Kansas grains like wheat and corn are milled into flour, which is the basic ingredient for many food products like bread, cereal, pizza dough, cookies, pie, pastries, and other baked goods. Vegetable oil is extracted from oilseeds grown in Kansas, such as soybeans, sunflowers, and cotton. The oils are consumed directly, used as food ingredients, and heated to cook other foods.

Other Kansas crops like fruits and vegetables are eaten as fresh produce or processed in a variety of ways before reaching consumers.

Food processing methods help foods last longer on the grocery store and pantry shelves and can make foods more appealing and marketable. Food processing is not a new concept. People have been processing food using basic methods, like salt preservation and solar (sun) drying, since prehistoric times. Although some of those simpler processing methods are still used, food processing has improved in



Making Ramen Noodles

Credit: Julia Debes, U.S. Wheat Associates

Plants on the Plate

many ways. Today, the food processing industry uses methods that include thermal processing, dehydration, low-temperature processing, and fermentation and pickling. Food processing is highly regulated and food processors must register their formulas and procedures with the U.S. Food and Drug Administration.

Thermal Processing

Thermal processing is a type of processing that uses heat over a pre-determined length of time to preserve foods. Thermal processing methods include canning and pasteurization.

Canning

Any food sold in a hermetically sealed (waterproof and airtight) container at non-refrigerated temperatures may be defined as a canned food. Canning is a thermal processing method that has been used for years because it can easily and safely be done in the home or commercially.



Canned Foods

Credit: Alex Lord, KFAC

Most commercial canneries are located close to the source of the food, which reduces transportation time and ensures foods are processed while they are fresh and have the highest nutritional value. This is important because fresh foods typically have a high water content, which can lead to enzyme activity and the growth of unwanted microorganisms if processing is delayed.

The canning process begins with packing food into sealed or airtight containers and then heating the containers to a temperature high enough to kill certain microorganisms that cause foods to spoil, like bacteria, yeasts, and molds. The high temperatures also deactivate enzymes naturally present in plants that can cause chemical changes in the food.



Canning Tomatoes at Home

Credit: National Center for Home Food Preservation

Those chemical changes can affect the taste and appearance of the food or cause the quality of the food to deteriorate. The time required to heat the containers to achieve a specified internal temperature in the food inside the containers, called the "processing time," can vary from 20 minutes to several hours.²¹ While the container is heating, air is driven from it, and a vacuum seal forms as the container cools. This vacuum seal prevents air from getting back into the product, preventing the entry of microorganisms that would contaminate the food. To protect public health and safety, processing times and procedures must be reviewed and approved by food regulators before food products can be sold commercially.

Food products have unique qualities, so each type requires specific processing methods to ensure safety. The pH scale is used to determine which canning process is appropriate for specific foods. Low-acid foods (a pH above 4.6) like vegetables and meats must be pressure cooked at high temperatures for long periods of time to kill bacteria spores. Foods with a high acid content (a pH of 4.6 or lower) include fruits, tomatoes, pickled foods, jams and jellies. High-acid foods require less heating because bacteria spores cannot grow in a high-acid environment. Food products like salsa, which combine low-acid ingredients (peppers and onions) and higher acid ingredients (tomatoes), require processing and heating times sufficient to ensure the safety of the low-acid ingredients.

Pasteurization

Pasteurization is a thermal process that destroys most disease-producing organisms. Pasteurization also limits fermentation in liquids like milk, beer, and apple cider by partial or complete sterilization. The process of using high heat – just below boiling – and time to process liquids is named after Louis Pasteur, a French scientist who invented this practice in 1864.



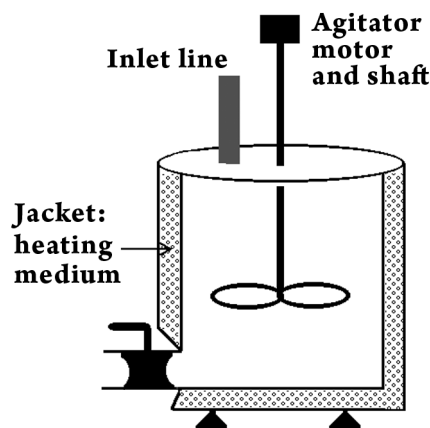
Filling Milk Jugs

Credit: Purdue Dairy Page

Pasteurization temperatures are determined by the pH level of the liquid. Liquids can be pasteurized in one of two ways, depending on the product and preferences of the processor. Batch pasteurization is used when processors pasteurize one batch of liquid at a time. Continuous pasteurization forces the liquid to flow continuously through pipes and heat exchanger plates to reach the desired temperature and time. The continuous method is often used commercially because it is more time and cost efficient.

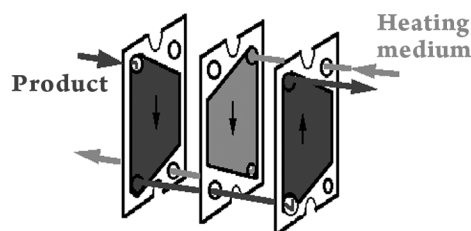
According to the Michigan State University Extension Service, the pasteurization process in milk destroys microorganisms that grow rapidly in milk, but does not destroy organisms that grow slowly or produce spores. It is also possible for milk or other liquids to become contaminated after pasteurization if the food product is not safely handled or properly stored.

BATCH PASTEURIZER



Credit: University of Guelph, Dairy Science & Technology

FLOW PATTERN IN CONTINUOUS PASTEURIZATION



Credit: University of Guelph, Dairy Science & Technology

PASTEURIZATION

Pasteurization, the application of heat to liquids and other food products to destroy harmful bacteria, is one of the most important operations in food, dairy, and beverage processing. Vat pasteurization, also known as "batch" processing, is used to process smaller quantities. When continuous pasteurization methods are used, pressurized liquids flow through metal plates or tubes that are heated from the outside by hot water or steam.

The minimum temperature and the minimum amount of time the product is held at that temperature depends on type of product and the pasteurization method used.

Pasteurization requirements for milk:

Vat (also known as "batch" processing) – 30 minutes at 145°F

High temperature short time processing – 15 seconds at 161°F

Higher-heat shorter-time processing – 1 second at 191°F

Ultra pasteurization – 2 seconds at 280°F

Source: International Dairy Foods Association



Dehydrated Fruit

Credit: James Gathany, CDC

DEHYDRATION

Dehydration is one of the oldest methods of food preservation. This type of processing removes water from food in order to prevent microorganism growth or spoilage. Without water, the microorganisms that cause food spoilage and decay are unable to grow and multiply and many of the enzymes that cause undesired changes in the chemical composition of the food cannot function. Dehydration is usually accomplished by vaporizing the water contained in the food.

Simple dehydration methods can be performed in the home or commercially because they are easy and cost efficient. Regardless of the method used, the ideal temperature for drying food is 140 degrees Fahrenheit, according to Clemson Cooperative Extension. Higher temperatures may cause the food to cook rather than dry. That may result in "case hardening," which seals moisture in the food, eventually causing the food to mold. Therefore, the drying process should never be accelerated by raising the drying temperature.

There are many dehydration methods, including air drying, freeze drying, and spray drying, as well as drum drying, puff drying, and microwave drying. Each of these food processing methods is unique and used for specific food products.

DEHYDRATION METHODS

Air drying – transferring heat through food to turn water in the food into water vapor, which is removed with air.

Freeze drying – removing water vapor from frozen foods; also known as lyophilization.

Spray drying – atomizing a liquid in a heated chamber to quickly dry it into a particulate (powder) form.

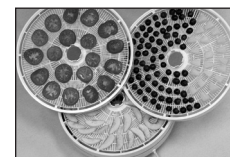
DEHYDRATING FOOD AT HOME

Solar drying is one simple drying method that can be used at home. Food is dried outdoors, often on a screen or between two screens. However, this process may take several days because the weather cannot be controlled. Warm, breezy, dry days are best, and the food should be brought inside overnight so moisture is not added back into the food as cooler night air condenses. Because the food is outdoors, it may be exposed to insects, birds, and other animals, so caution should be taken during the drying process. Solar drying is not recommended for meats and vegetables.

Using a food dehydrator is another simple drying method for home use. A food dehydrator is a small electrical appliance that dries foods using a combination of heat and air circulation. Dehydrators can dry foods more quickly than solar drying because the temperature remains consistent and there is constant air movement. An oven may be used in place of a dehydrator. While a convection oven has a fan to circulate the air, the dehydrating process may take longer in a conventional oven that does not have a fan.



Food Dehydrator



Prepared Trays for Food Dehydrator

Source: National Center for Home Food Preservation

Air Drying

Air drying transfers heat through the food, either by using heated air or by heating surfaces around the food. The water in the food turns into water vapor, which is removed with the air. Home food preservation methods such as solar drying or dehydrating foods in an oven or food dehydrator are examples of air drying foods.

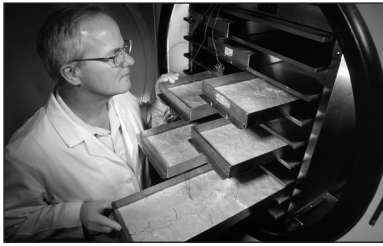


Preparing Jerky Meat

Source: National Center for Home Food Preservation

Freeze Drying

Freeze drying, also known as lyophilization, is a method of food preservation that removes moisture from foods so that spoilage microorganisms cannot flourish. According to the Purdue University Cooperative Extension Service, freeze drying is a form of dehydration in which the food product is frozen and water is removed as vapor.



Small Commercial-scale Freeze-dryer

Credit: Keith Weller, USDA ARS



Freeze Drying Fruit

Credit: Keith Weller, USDA ARS

through a process called sublimation. Because so much moisture is removed from freeze-dried foods, they weigh very little. This quality makes them the perfect foods for astronauts and campers, especially since they can easily be reconstituted with water or other liquids like milk. Freeze-dried foods include instant coffee, vegetables found in dried soup mixes, eggs, food flavorings, as well as fruits, many of which are incorporated into granola bars and breakfast cereals.

Spray Drying

Like freeze drying, spray drying is another method of food preservation that removes significant amounts of moisture from foods to create unsuitable environments for microorganisms that cause spoilage. According to the Purdue University Cooperative Extension Service, spray drying is a method that quickly dries liquids to particulate form by atomizing the liquid in a heated chamber. Examples of spray-dried food products include powdered cheese (found in many macaroni and cheese products) and powdered milk. These powdered, or spray-dried products, can be easily reconstituted with water or other liquids.



Blueberry Powder on Yogurt

Credit: Peggy Greb, USDA ARS

LOW TEMPERATURE PRESERVATION

Using low temperatures to preserve foods extends their shelf life because it reduces the growth rate of microorganisms and slows down any physical or enzymatic reactions that are occurring. Low temperature preservation methods include refrigeration and freezing.

Refrigeration

Refrigeration is a temporary food preservation method that relies on keeping foods in temperatures below 40 degrees Fahrenheit, whether in a home refrigerator, a refrigeration unit at the supermarket, or when being transported by refrigerated trucks and railcars or in refrigerated containers aboard ships. The U.S. Department of Agriculture's Food Safety and Inspection Service reports bacteria grow most quickly between 40 degrees and 140 degrees Fahrenheit, also known as the "Danger Zone," so a refrigerator set at 40 degrees Fahrenheit or below will protect most foods.

Transferring Milk to Refrigerated Tanker

Credit: Purdue Dairy Page



LOW TEMPERATURE FOOD PRESERVATION

Refrigeration – temporarily preserving food by keeping it in temperatures below 40 degrees Fahrenheit; inhibits microbial growth, but many microorganisms can still grow and reproduce slowly at the low temperatures.

Freezing – storing food at zero degrees Fahrenheit; inactivates microorganisms but does not kill them.

Flash freezing – subjecting food to temperatures well below the freezing point (32 degrees Fahrenheit), causing the water inside the food to freeze very quickly.

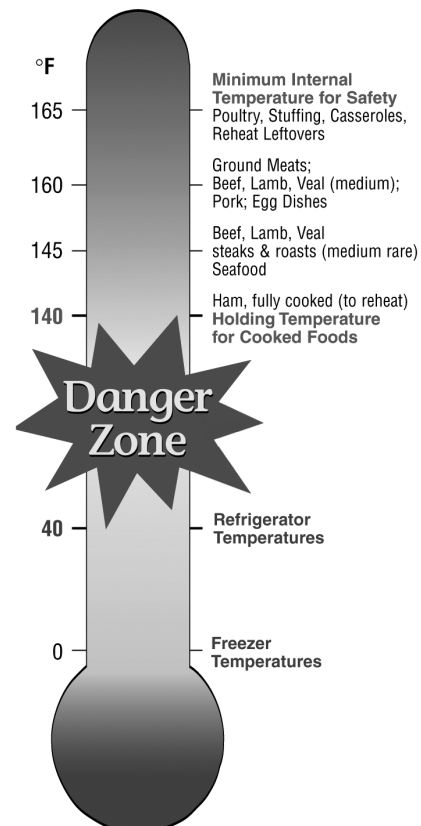
According to Utah State University Cooperative Extension, refrigeration can inhibit microbial growth; however, it is only a temporary method of food preservation because many food spoilage microorganisms can still grow and reproduce slowly at these low temperatures.

At home, hot foods should always be cooled immediately, and they should always be covered in the refrigerator. If large portions of food are being refrigerated, the food should be divided into smaller portions and cooled in separate containers so they reach the desired temperature in a shorter amount of time.



Refrigerated Foods

Credit: USDA FSIS



Credit: USDA FSIS

Freezing

Freezing is another example of a low temperature food preservation method. According to the Food Safety and Inspection Service, food stored constantly at zero degrees Fahrenheit will always be safe. The cold temperatures in freezers slow the movement of molecules, which inactivates microorganisms. Although freezing inactivates bacteria, it does not kill them. Microorganisms may begin growing again when conditions are favorable, like in thawing or thawed foods. While foods remain safe while frozen, the quality of the food will suffer with lengthy storage in a freezer. Examples of how freezing can affect quality include changes in color or odor and freezer burns. Freezer burns, which show up as grayish-brown leathery spots, happen when air comes into contact with the surface of the food and dries the food out. Any freezer-burned portions of food may have to be discarded, even though the freezer burns do not make the food unsafe to eat.



Frozen Foods

Credit: USDA FSIS

As with refrigerating foods, foods should be frozen as quickly as possible to maintain quality. If moisture collects in the food, it can lead to the formation of large ice crystals that affect the quality of the food. When food is frozen rapidly, there is less time for moisture in the food to collect or pool together. Clarence Birdseye developed the first quick-freezing procedures, also known as "flash freezing," resulting in the first frozen vegetables being offered to the public in 1929. Today, many food manufacturers freeze food items rapidly by subjecting them to temperatures well below the freezing point, causing water inside the food to freeze in a very short period of time.



Flash Frozen Berries

Credit: Stephen Ausmus, USDA ARS

FERMENTING AND PICKLING

Fermenting and pickling are two more methods of food preservation. These methods are also referred to as acidification. An acidic environment in a food is created when the food's pH level is lowered by adding acid to the food product. This produces conditions unsuitable for many microorganisms that cause foods to spoil (decay). The acid is either added by pickling or produced during fermentation.



Pickles

Source: National Center for Home Food Preservation



Pickling Beets

Credit: National Garden Bureau



Cheese

Credit: Scott Bauer, USDA ARS

Cheese-making

Credit: Keith Weller, USDA ARS

Pickling preserves perishable foods by marinating and storing the food in an acid solution, usually vinegar. Many pickled fruits and vegetables can be found on grocery store shelves.

During fermentation, the carbohydrates in the food are converted into acids through the desired action of microorganisms such as yeast or bacteria. Dairy products like yogurt, buttermilk, sour cream, and cheese are examples of fermented foods, as well as sauerkraut and some sausages.

FOOD SAFETY

The World Health Organization recognizes that food safety is an increasingly important public health issue, and as a result, governments all over the world are increasing their efforts to improve food safety. The food supply in the United States is one of the safest in the world, and although the government and the food industry are continually working to ensure a safe food supply at the national and state levels, food safety begins in the home. Consumers must take responsibility and implement good food safety practices when preparing, serving, and storing foods.



Food Safety is Everyone's Responsibility

Credit: Scott Bauer, USDA ARS

PREVENTING FOODBORNE ILLNESS

The key to preventing foodborne illness is good personal hygiene, including thoroughly washing hands for at least 20 seconds with hot, soapy water.

The four simple steps to safely prepare, serve, and store foods are: clean, separate, cook, and chill.

PERSONAL HYGIENE

Good personal hygiene is the key to staying healthy and preventing foodborne illness. Thorough hand washing is important, and hands should be washed for at least 20 seconds with hot, soapy water. According to the Partnership for Food Safety Education, hands should always be washed after using the bathroom, changing a diaper, cleaning a litter box, or handling a pet. Extra precaution should be taken when a person is experiencing symptoms related to the common cold or seasonal flu: sneezes should be directed towards the inside of the elbow, hands should be washed often, and touched surfaces should be disinfected frequently.



Always Use Soap
Credit: Cade Martin, CDC



Cover Mouth When Sneezing
Credit: James Gathany, CDC



Wash Hands Before and After Touching Food
Credit: James Gathany, CDC



Clean Countertops
Credit: USDA FSIS



Rinse Fruits and Vegetables Well
Credit: Cade Martin, CDC



Keep Utensils Clean
Credit: Cade Martin, CDC

FOOD SAFETY AT HOME

Practices related to food safety are extremely important in the home, especially in the kitchen where food is prepared and served. Promoting a clean and safe environment is easy, especially if four simple steps are followed: clean, separate, cook, and chill.



Food Preparation
Credit: USDA FSIS

be food safe.



clean. separate.
cook. chill.

www.befoodsafe.org

Source: Partnership for Food Safety Education, www.fightbac.org

Clean

Bacteria can be easily spread, getting onto hands, cooking surfaces, utensils, and food. Washing hands thoroughly is extremely important. Hands should be washed before and after food is touched, especially when handling raw meat. Cooking surfaces, utensils, and gadgets should also be cleaned with hot, soapy water after preparing each food item and before preparing the next food item. Using a vegetable brush if necessary, fruits and vegetables should be rinsed well with tap water before consuming or serving to prevent foodborne illness. Fruits and vegetables with skins or rinds that are not eaten should also be rinsed well with tap water.

Separate

Keeping raw meats, poultry, seafood, and eggs separate from other foods is essential to avoiding cross-contamination, which is contamination of a food from another source. Raw meats, poultry, and seafood should be stored properly in sealed containers so their juices do not drip in the refrigerator or onto other foods. Never place cooked or prepared foods on a plate or surface that previously held raw meat, poultry, seafood, or eggs. Use two cutting boards if produce and raw meat are simultaneously being prepared.



Use Separate Cutting Boards
Credit: USDA FSIS

Cross-contamination – contamination of a food from another source, which is possible when cooked or prepared foods are placed on an unwashed plate or surface that previously held raw meat, poultry, seafood, or eggs or when the same cutting board is used for fresh produce (fruits or vegetables) and raw meat.

SAFELY COOKED FOOD

Food is safely cooked when it reaches a high enough internal temperature, as measured with a food thermometer, to kill harmful bacteria that can cause illness.

Internal temperatures for safely cooked meat, poultry, seafood, and eggs:

All whole cuts of meats – **minimum 145° F***

All poultry – **minimum 165° F**

Ground meats – **minimum 160° F**

Fish – **minimum 145° F**

Eggs – **must be firm and not runny**

Leftovers – **165° F**

**Meat must be allowed to rest for three minutes before carving or consuming. Includes roasts, steaks, and chops.*



Cooking Food Safely

Credit: USDA FSIS

Source: Partnership for Food Safety Education

Cook

Meat, poultry, seafood, and eggs must reach a critical temperature to kill bacteria. A food thermometer is used to measure the internal temperature of foods. The food thermometer should be inserted into the center of the food, where it takes the longest for heat to reach. It is extremely important to remember that the color of a cooked food is not an indicator of doneness; a food thermometer is the only way to truly tell if a food has reached a safe internal temperature. Also, avoid cold spots in food, especially if a microwave oven is used to prepare the food. Rotating the food and stirring it often is the best way to ensure even cooking.



Food Thermometer

Credit: USDA FSIS



Microwaving Food Safely

Credit: USDA FSIS

Chill

Cold temperatures slow the growth of bacteria. Refrigerating or freezing foods as quickly as possible is necessary, whether it is right after a trip to the grocery store or within two hours after a food is cooked or served. It is important that a refrigerator's temperature is below 40 degrees Fahrenheit and a freezer's temperature is below zero degrees Fahrenheit. Frozen foods should never be defrosted at room temperature; instead, defrosting should be done in a refrigerator, cold water, or in the microwave. However, if the food is



Refrigerating Food

Credit: USDA FSIS



Food Safety Away from Home

Credit: USDA FSIS



Checking Refrigerator Temperature

Credit: USDA FSIS

defrosted in cold water or the microwave, it should be cooked right away. To avoid foodborne illness, refrigerated foods should be used or discarded on a regular basis.

COMMERCIAL FOOD SAFETY

Just as food safety is important in the home, it is equally important in every food processing facility and each business that prepares and sells food products.

Companies that process food are required by law to have plans in place to ensure food is safe for consumption. These plans address the cleanliness of the facility and operating equipment, the condition of operating equipment, and personnel hygiene so that food products being sold or produced are of high quality and permissible for consumption.

One quality assurance process called Hazard Analysis and Critical Control Point (HACCP) is used to determine the potential danger points in food production and to define a strict management and monitoring system to ensure safe food products for consumers. According to the U.S. Department of Agriculture, HACCP is designed to prevent potential microbiological, chemical, and physical hazards, rather than catch them. HACCP has been established for juice, meat, poultry, and seafood processing, and these processes are regulated at the federal level. However, the use of HACCP in other food industries is currently voluntary.



Taking Samples from Fresh-Cut Produce Washer

Credit: Peggy Greb, USDA ARS

FARMER'S MARKETS

All retail food sales in Kansas, including farmers' markets, are regulated by the Kansas Department of Agriculture. Sales of items like fresh fruits and vegetables, honey, nuts, and baked goods are permitted. In addition, jams or jellies, frozen meats (as long as they are sold from an inspected source), and eggs maintained at 45° F may also be sold. However, sales of fresh meat or meat products, poultry, or seafood are not allowed.



Sweet Corn

Credit: Julia Debes

Source: Kansas Department of Agriculture

A Safe Food Supply

Under state law, the Kansas Department of Agriculture is responsible for ensuring a safe food supply in Kansas. This includes licensing and inspecting businesses that sell or process food, as well as responding to consumer food safety concerns.

Currently, there are four federal regulatory agencies in the United States that work to ensure that the food that reaches the table is safe for consumption. The duty of the Food Safety and Inspection Service is to ensure the commercial supply of meat, poultry, and egg products is safe, healthy, and correctly packaged and labeled. The U.S. Environmental Protection Agency works to ensure drinking water is safe for consumption, setting standards for public water systems throughout the country. In the U.S. Department of Health and Human Services, the Food and Drug Administration is responsible for protecting public health by assuring the safety and security of the nation's food supply. The mission of the Centers for Disease Control and Prevention in the U.S. Department of Health and Human Services includes the prevention of illness, disability, and death due to foodborne illness. This agency tracks cases of foodborne illness and investigates outbreaks.

FEDERAL FOOD SAFETY AGENCIES

Centers for Disease Control and Prevention – responsible for investigating outbreaks and tracking cases of foodborne illness.

Food and Drug Administration – responsible for protecting public health by assuring that foods are safe, wholesome, sanitary, and properly labeled.

Food Safety and Inspection Service – responsible for ensuring the commercial supply of meat, poultry, and egg products is safe, healthy, and correctly packaged and labeled.

U.S. Environmental Protection Agency – responsible for ensuring that drinking water is safe for consumption.

KANSAS DEPARTMENT OF AGRICULTURE FOOD SAFETY PROGRAMS

Food Safety and Lodging Program – food safety inspections at grocery stores, restaurants, convenience stores, schools, senior meal sites, mobile food units, food wholesalers and warehouses, food processors, and food manufacturers.

Meat and Poultry Inspection – licenses and inspects meat and poultry processing facilities, verifies that meat and poultry products are safe and properly labeled, and responds to consumer food safety concerns involving meat or poultry products.

Dairy Inspection – regulates the production, transportation, processing, and distribution of milk and dairy products, including the inspection of facilities and equipment and the collection and testing of samples; also regulates and inspects pasteurization plants, bottlers, beverage manufacturers, and ice plants.

Weights and Measures – inspects and certifies large and small scales, including those at grocery stores, grain elevators, and livestock sale barns; also verifies that in-store scanners scan the correct price and that packages contain the quantity stated on the label.

Source: Kansas Department of Agriculture

FOODBORNE ILLNESS

The food supply in the United States is one of the safest in the world. Agricultural producers, food processing companies, and food businesses work hard to keep disease-causing microorganisms out of the food supply. Once foods reach consumers, consumers must do their part to protect the food supply by practicing good personal hygiene and following food safety procedures.

Foodborne illnesses are taken very seriously in the United States because they can require medical treatment, hospitalization, and, in rare cases, even result in death. Symptoms of foodborne illness are specific to each pathogen. The biggest contributors to foodborne illness include *Escherichia coli* O157:H7, *Salmonella*, *Listeria monocytogenes*, and Norovirus.

Escherichia coli O157:H7

Escherichia coli, known commonly as *E. coli*, are a group of diverse bacteria, some of which are not harmful and some that result in serious illness. One particular strain of *E. coli*, the O157:H7 strain, is particularly harmful and may result in symptoms that include diarrhea, severe stomach cramps, and vomiting.



Shopping for Food

Credit: Stephen Ausmus, USDA ARS



**Cluster of *E. coli* Bacteria
(Magnified)**

Credit: Eric Erbe, USDA ARS

Pathogen – a microscopic organism like a bacteria or a virus that can cause an infection or disease.

THE TOP CONTRIBUTORS TO FOODBORNE ILLNESS IN THE UNITED STATES

***E. coli* 0157:H7** – one particular strain of the *E. coli* bacteria that can result in serious illness in individuals; can result from contact with the fecal material of ruminant animals.

Salmonella – a group of bacteria that can cause diarrhea and related illnesses in people; can pass from the fecal material of people and animals to other people and animals.

Listeria – a group of bacteria that can cause a serious illness in people, especially at-risk individuals with weakened immune systems and pregnant women; can be passed from water, soil, and animals to fresh produce and meat products.

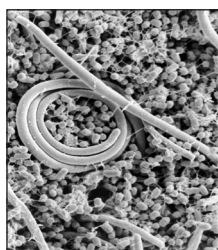
Noroviruses – a group of extremely contagious viruses that can cause severe vomiting, diarrhea, and stomach pain; found in the vomit or fecal material of infected people and spread from person to person; the leading cause of foodborne disease outbreaks in the United States.

E. coli live in the intestines of ruminant animals like cattle and sheep, and while they do not make these animals sick, the bacteria is passed through the animals' fecal material. Consequently, those foods that come in contact with fecal material may be contaminated with this pathogen. Therefore, hands should always be washed thoroughly after touching animals, produce should be rinsed well, and meat – especially ground meat – should be cooked to the recommended temperature. In addition, unpasteurized milk and dairy products as well as unpasteurized juices should be avoided.

Salmonella

Salmonella is a group of bacteria that can cause diarrheal illness in people. Besides causing diarrhea, *Salmonella* may also cause abdominal cramping and fevers, and its symptoms are much greater in at-risk persons, like babies and small children, the elderly, and individuals with weakened immune systems.

Salmonella bacteria pass from the fecal material of people and animals to other people and animals. As is the case with *E. coli*, those foods that come in contact with fecal material may be contaminated with this microorganism. Smart sanitation practices should be followed, including diligent hand-washing and cross-contamination prevention. Raw or undercooked meat, raw or undercooked eggs, and unpasteurized dairy products should not be consumed.



***Salmonella* Bacteria (Magnified)**

Credit: Jean Guard-Petter, USDA ARS

Listeria monocytogenes

Listeria monocytogenes can cause a serious illness called listeriosis in individuals infected with this pathogen. At-risk individuals include the elderly, pregnant women, newborns, and individuals with weakened immune systems. Symptoms of listeriosis include muscle aches, fever, nausea, and diarrhea. However, this infection can also spread to the nervous system and cause symptoms such as headaches,

confusion, and even convulsions. Listeriosis is serious in pregnant women, as it can lead to miscarriage, stillbirth, premature labor, or an infection in the newborn.

Listeria bacteria can be found in water and soil, and animals can carry it without showing any signs of sickness. It can be passed from water, soil, and animals to fresh produce and meat products. It is possible for processed foods to become contaminated after processing. Avoiding raw or undercooked meat and unpasteurized dairy products



***Listeria Monocytogenes* on Radish Sprout (Magnified)**

Credit: Lisa Gorski, USDA ARS

should be practiced. In addition, for at-risk individuals, processed meats, like hot dogs or deli meats, should be reheated until they are steaming hot and soft cheeses like feta, Brie, blue-veined cheeses, or Mexican-style cheeses (queso blanco or queso fresco) should not be consumed unless they are made from pasteurized milk.

Noroviruses

While *Escherichia coli*, *Salmonella*, and *Listeria monocytogenes* are bacteria, noroviruses are viruses, meaning they cannot grow outside a person's body or be treated with antibiotics. In addition, noroviruses are extremely contagious. Noroviruses are a family of viruses that cause symptoms associated with the stomach flu: diarrhea, vomiting, stomach cramping, chills, headaches, and fatigue. These viruses are not associated with the influenza virus, which causes the seasonal flu.

Noroviruses are found in the vomit or fecal material of infected people. A person may become infected with a norovirus in a number of ways, which include eating contaminated foods, touching a surface that is contaminated and then touching the mouth, or having direct contact with an infected person. In healthy people, a norovirus infection is usually brief, but the vomiting and diarrhea associated with it may lead to dehydration.

There is no vaccine to prevent a norovirus infection, and there are no drugs to treat a person with a norovirus infection.²² However, people can take preventive measures to lower the risks of becoming infected with a norovirus. Norovirus infections can be prevented by thorough hand-washing, rinsing fruits and vegetables well, and cleaning and disinfecting exposed surfaces. The Centers for Disease Control and Prevention also recommends that persons infected with a norovirus should not prepare food while they have symptoms and for three days after they recover from their illness.

FOOD FACTS

The United States produces one-fourth of the world's beef and nearly one-fifth of the world's grain, milk, and eggs.

Each U.S. farmer produces enough food and fiber for 155 people in the United States and abroad.

American consumers spend a smaller percentage of their personal income on food than the citizens of any other country in the world.

The food supply in the United States is one of the safest in the world.

Sources: American Farm Bureau Federation, U.S. Department of Agriculture

FEEDING PEOPLE

The United States produces one-fourth of the world's beef and nearly one-fifth of the world's grain, milk, and eggs.²³ The agricultural products grown in Kansas not only feed and nourish Kansans, but also feed many more people in the United States and around the world. According to the American Farm Bureau, each U.S. farmer produces enough food and fiber for 155 people in the United States and abroad.

Kansas farmers produce a variety of crops that contribute to the wide selection of food products available to American consumers. The Economic Research Service of the U.S. Department of Agriculture reports that American consumers spend a smaller percentage of their personal income on food than the citizens of any other country in the world. At the same time, the food supply in the United States is one of the safest in the world.

Agricultural producers, food processors, and businesses that prepare and sell food products continue to employ new technologies as they strive to provide consumers with a variety of safe and nutritious foods. Kansas crops play an important role in those efforts. ■



U.S. Agricultural Products

Credit: USDA FSIS



Pizza

Credit: Scott Bauer, USDA ARS



Apple Pie

Credit: Scott Bauer, USDA ARS

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TEACHER'S RESOURCES

The Kansas Foundation for Agriculture in the Classroom (KFAC) offers lesson plans and other educational resources on the KFAC website: www.ksagclassroom.org.

NOTES:

