Products of Corn

Cornstarch

Industrial Uses

Abrasive paper and cloth
Adhesives (glues, mucilages, gums, etc.)
Batteries, dry cell
Binder or binding agents
Board (corrugating, laminating, solid fiber-board, cardboard)
Boiler compounds
Bookbinding
Briquettes Ceramics (as clay binder)
Chemicals Cleaners, detergents
Coatings on wood, metal and paper
Color carrier (in paper and textile printing)
Cord polishing, sizing
Cork products
Crayon and chalk (as a binder)
Dispersing and standard- izing agent
Dressing, surgical
Dyes (as a bodying agent, carrier diluent, etc.)
Fermentation processes
Fiberglass size
Fireworks
Insecticide powders
Insulating material (glass wool, rock wool, etc.)
Lubricating agents
Oilcloth
Oil-well drilling (drilling mud)
Ore refining (electrolytic reduction process, flotation process, etc.)
Paints (cleaning compounds, cold-water and latex paints, poster lacquers, etc.)
Paper and paper products manufacture
Plastics (molded)
Plywood (interior)
Printing
Protective colloids (emulsions)
Textiles (warp sizing and finishing)
Tile, ceiling
Tires, rubber
Wallboard and wallpaper
Water recovery, industrial

Food, Drug or Cosmetic Uses

Antibiotics
Aspirin
Baby foods
Bakery products (bread, rolls cakes, pies, crackers and cookies)
Baking powder
Beverages, brewed (beer, ale, etc.)

Corn Syrup

Industrial Uses

Adhesives (plasticizing agent)
Chemicals
Dyes and inks
Explosives
Leather tanning (chrome process)
Metal plating
Paper, glassine and parchment
Plasticizer
Polish, shoe
Rayon (viscose process)
Textiles, for finishing
Theatrical makeup
Tobacco and tobacco products

Food, Drug Uses; liquid or dried form

Baby foods
Bakery products (bread, rolls, biscuits, doughnuts, pies, cakes, cookies, pretzels, etc.)
Beverages, brewed (beer, ale, etc.)
Beverages, carbonated
Breakfast foods
Catsup, chili sauce, tomato sauce
Cereals, prepared
Cheese spreads and foods
Chewing gum
Chocolate products
Coffee whiteners
Condensed milk, sweetened
Confectionery
Cordials and liqueurs
Desserts
Eggs, frozen or dried
Extracts and flavors
Frostings and icings
Fruit butters and juices
Fruit drinks
Fruits (canned, candied, fillings, frozen, etc.)
Ice cream, water ices and sherbets
Jams, jellies, marmalades and preserves
Licorice
Malted products
Marshmallows and related products
Meat products (sausage, etc.)
Medicinal preparations (drugs, pharmaceuti-cals)
Mixes, prepared (cakes, infant foods, pie fillings, pudding, powders, ice cream, etc.)
Peanut butter
Pickles and pickle products
Salad dressing
Sauces (seasoning, specialty, etc.)

Industrial Uses

Acids, commercial (lactic, acetic, gluconic, etc.)
Adhesives
Amino acids
Chemicals (calcium, lactate, sodium lactate, etc.)
Citric
Dyes
Electroplating and galvanizing
Enzymes
Lactic acid polymers
Leather tanning
Lysine
Mannitol
Paper manufacturing
Rubber (cold process)
Sizing materials
Sorbitol
Textiles, dyeing and finishing
Threonime
Tryptophan

Food, Drug Uses

Antibiotics
Baby foods
Bakery products (biscuits, bread, crackers, fillings, icings, macaroons, pretzels, cookies, crackers, wafers, etc.)
Berries, canned and frozen
Beverages, brewed (beer, ale, etc.)
Beverages, carbonated
Breakfast foods
Caramel color
Cheese foods and spreads
Chewing gum
Chocolate products
Citric acid
Citrus juices
Coloring, pure food mix
Condensed milk
Confectionery
Cordials, liqueurs and brandy
Cream, frozen
Dairy products
Desserts
Dietetic preparations
Distillation products
Doughnuts (cake, yeast)
Drugs (fermentation process)
Eggs, frozen or dried
Fish, pickled
Flavoring extracts
Food acids (citric, etc.)
Fruit juices
Fruits and vegetables (canned)
Fruits (candied, glace, frozen)

Products of Corn

Chewing gum
Chocolate drink
Confectionery
Cosmetics
Desserts (puddings, custards, etc.)
Drugs and pharmaceuticals
Flours, prepared (including prepared mixes)
Food and drug coatings
Gravies and sauces
Meat products
Mixes, prepared (pancake, waffle, cake, candy, etc.)
Mustard, prepared
Pie filling
Precooked frozen meals
Salad dressing
Soaps and cleaners
Soups
Sugar, powdered
Vegetables, canned
Dextrins
Industrial Uses
Adhesives (glues, pastes, mucilages, gums)
Bookbinding
Briquettes
Candles
Ceramics
Cord polishing
Core binder (castings, molds, etc.)
Cork products
Crayon and chalk (as a binder)
Dyes (dry, cake, etc.)
Envelopes
Fireworks
Inks, printing
Insecticides
Insulation, fiberglass
Labels
Leather
Linoleum
Magazines
Matches (on head and side of box)
Oil-well drilling
Ore separation
Paints (cold-water, poster, etc.)
Paper and paper products
Plastics (molding)
Plywood
Sandpaper
Shoes (counter pastes, polish, etc.)
Silvering compounds
Soaps
Straws (drinking)
Textiles, sizing, finishing and printing
Twine (cord, string, etc.)
Wallboard and wallpaper
Window shades and shade cloth

Seafood, frozen
Soups, dehydrated
Syrups (table, chocolate, cocoa, fruit,mmedicinal, soda fountain, cordials, etc.)
Toppings
Vinegar

High Fructose Corn Syrup

Food Uses

Bakery products
Canned fruits
Canned juices
Condiments
Confectionery products
Frozen desserts
Jams, jellies and preserves
Soft drinks
Wine
Yeast

Maltodextrins

Food Uses
Bakery mixes
Beverage powders
Condiments
Dehydrated foods
Dry soup mixes
Gum confections
Icings and glazes
Instant tea
Instant breakfast foods
Low calorie sweeteners
Marshmallows
Nougats
Pan coatings
Sauce and gravy mixes
Snack foods

Gelatin desserts
Ice cream, water ices and sherbets
Infant and invalid feeding
Jams, jellies, marmalades and preserves
Lactic acid
Meat products (bacon, bologna, hams, sausage, frankfurters, mincemeat)
Medicinal preparations and intravenous (injections, pills, tablets, drugs, etc.)
prepared (cake, icings and frosting, infant foods, pie fillings, toppings, etc.)
Peanut butter
Peas, canned
Pectin, fruit
Pickles and pickle products
Prepared mixes
Powders (ice cream, prepared dessert, pudding, summer drink, powders, etc.)
Sauces (catsup, tomato, etc.)
Seasoning mixes, dry
Sorbitol (in candies, toothpaste, etc.)
Soups, dehydrated
Spices and mustard preparations
Syrups (table, fountain, medicinal, etc.)
Vinegar
Wine
Xanthan gums
Yeast

Hydrol

Corn-sugar molasses

Leather tanning
Livestock feed
Organic acids
Organic solvents
Tobacco

Ethanol

Alcoholic beverages
Industrial alcohol
Octane enhancer
Oxygenate in motor fuels

Personal care products

Mouthwash
Toothpaste

Co-Products of Corn

SOLUBLES

Steepwater
Antibiotics
Chemicals
Pharmaceuticals
Yeast

GLUTEN AND HULLS

Steepwater for Feed
Gluten Feed and Meal
Oil Meal

Products Used by Livestock, Poultry and Dairy

Corn germ meal
Corn gluten feed
Corn gluten meal
Corn oil by-products
Corn sugar (crude and refined)
Hydrol (corn-sugar molasses)
Steepwater for feed (condensed fermented corn extractives)
Corn Germ Meal, Corn Gluten Feed, Corn Gluten Meal
Other Uses

Amino acids
Fur cleaner
Zein and other protein products

GERM

Corn Oil

Corn Oil, Refined
Food, Drug Uses
Carriers for vitamins and other medicinal preparations in capsule form
Cooking oil
Margarine
Mayonnaise
Potato chips
Salad dressing
Sauces, seasoning
Shortening
Soups

Corn Oil and Free Fatty Acids
Industrial Uses
Chemicals and insecticides
Lecithin (for pharmaceuticals, cosmetics, linoleum, printing inks, etc.)
Paint and varnish
Rubber substitutes
Rust preventative (surface coatings)
Soap
Soluble oil (leather and tanning use)
Textiles

The Four Parts of a Kernel of Corn

THE ENDOSPERM

The endosperm is about 82 percent of the kernel's dry weight and is the source of energy (starch) and protein for the germinating seed. There are two types of endosperm, soft and hard. In the hard endosperm, starch is packed tightly together. In the soft endosperm, the starch is loose. When corn dries in the field before harvest, the moisture loss causes the soft endosperm to collapse and form a dent in the top of the kernel, thus the term "dent" corn.

THE PERICARP

The pericarp is the outer covering of the kernel that protects it from deterioration. It resists water and water vapor and is undesirable to insects and microorganisms.

THE GERM

The germ is the only living part of the corn kernel. It contains the essential genetic information,enzymes, vitamins and minerals for the kernel to grow into a corn plant. About 25 percent of the germ is corn oil. Corn oil is the most valuable part of the corn kernel. It is high in linoleic fatty acid (polyunsaturated fat) and has a bland taste.

THE TIP CAP

The tip cap is the only area of the kernel not covered by the pericarp. It was the attachment point of the kernel to the cob.

Corn Components	
Starch	61.0%
Feed	19.2%
Oil	3.8%
Water	16.0%

Connect The Dots

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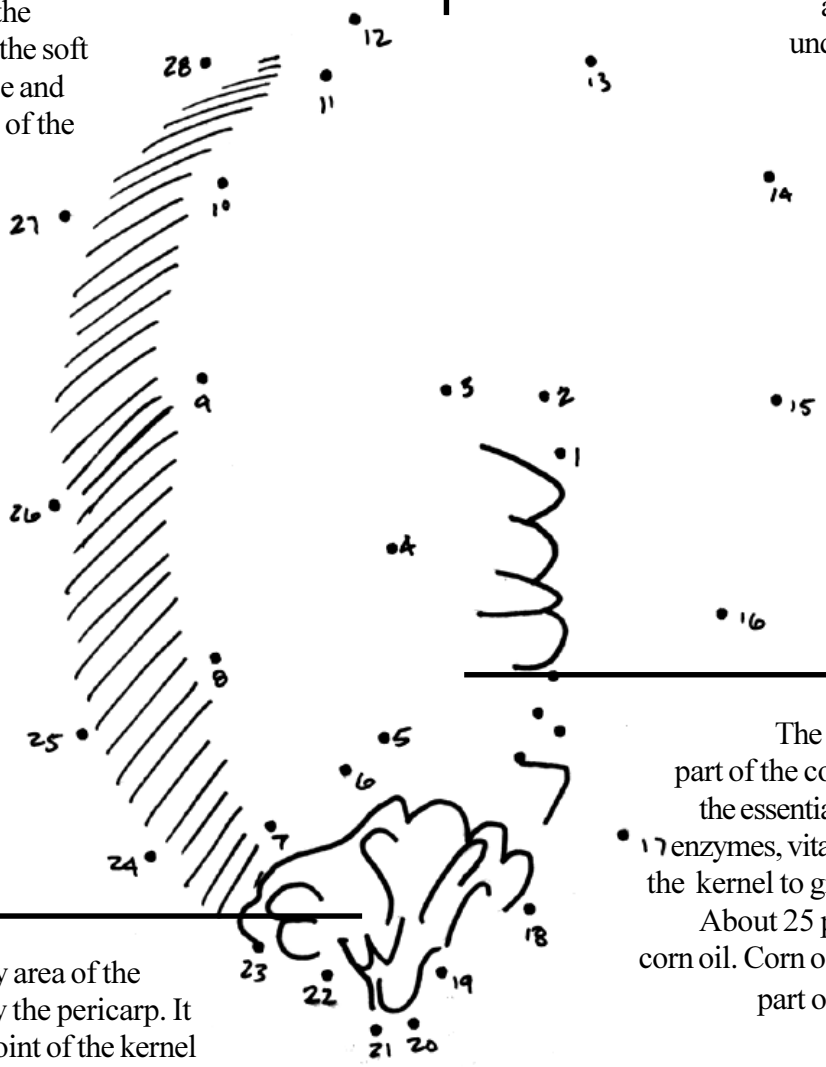

THE GERM

The germ is the only living part of the corn kernel. It contains the essential genetic information, enzymes, vitamins and minerals for the kernel to grow into a corn plant. About 25 percent of the germ is corn oil. Corn oil is the most valuable part of the corn kernel. It is

THE TIP CAP

The tip cap is the only area of the kernel not covered by the pericarp. It was the attachment point of the kernel to the cob.

STARCH YOUR DAY RIGHT

Discovering the Starch in a Kernel of Corn:

1. Thaw a package of frozen corn and place in a bowl.

2. Crunch up the corn with a potato masher and cover with water.

3. Let stand about 24 hours.

4. Remove the corn from the bowl with a slotted spoon.

5. Allow the water to stand another 15 minutes.

6. Very slowly, gently pour the water through a piece of cheesecloth (allowing the starch to become trapped in the cloth).

7. You can feel and see the starch left in the cloth.

8. On a small portion of the cheesecloth place a drop of iodine. (If starch is present, the iodine changes from a reddish-brown to a blue-black.)

9. Allow the remainder of the cheesecloth to dry overnight.

10. In the morning, feel and taste the powder remaining on the cheesecloth.

11. You've made cornstarch!! (For experiments using cornstarch to make plastic see Unit 7, Lesson 4).

STARCH YOU DAY RIGHT

REFINING CORN

INTRODUCTION:

Corn refiners purchase shelled corn from farmers, corn elevators, or grain companies.

The first purpose of corn refining is to separate the four parts of the corn kernel:

1. The pericarp, the outer skin-like covering of the kernel.
2. The tip cap, the point where the kernel was attached to a corncob.
3. The germ, the living part of a corn kernel containing genetic information and corn oil.
4. The endosperm, the protein and starch that make up over 80% of the mass of a kernel of corn.

The next purpose is to convert these parts into higher value products. Today the most important refined corn products are corn sweeteners, starch, oil, ethanol, and feed products.

STEP ONE: STEEPING

1. At the refinery, the corn is inspected and cleaned.

2. Then the corn is steeped, or soaked, in cool water for 30 to 40 hours.

3. The kernels double in size as they absorb the water.

4. As the kernels swell, the gluten (protein) bonds loosen and the starch is released.

5. The steep water is drained and used in animal feeds.

6. The corn is coarsely ground to separate the germ from the rest of the kernel.

STEP TWO: GERM SEPARATION

7. The coarsely ground corn is mixed with a small amount of water.

8. The mixture is moved to a germ separator that spins the corn germ out of the water.

9. The germ is screened to make sure no starch is present.

10. Corn oil is then extracted from the germ.

11. Any remaining germ is used in animal feeds.

STEP THREE: STARCH AND GLUTEN SEPARATION

12. After the germ has been removed from the coarsely ground corn, the rest of the kernel is ground again.

13. It is mixed with a little more water.

14. The fiber is screened out of the corn, so that only a starch-gluten mixture remains.

15. The gluten has a lower density than starch so a centrifuge is used to separate the two.

16. The gluten is a protein used in animal feed.

17. The starch can be dried and marketed as unmodified cornstarch, or

18. it can be modified into specialty corn starch, or

19. it can be converted into corn syrup or sugar, or

20. it can be processed into biodegradable plastics, or

21. it can be fermented and used in ethanol.

RESULTS

One bushel of shelled corn weighs about 56 pounds. Through refining, one bushel of corn can make :

31 pounds of starch,
or
33 pounds of sweetener (enough to sweeten 324 cans of cola),
or
2.5 gallons of ethanol fuel,
PLUS
11 pounds of animal feed,
and
over 2.5 pounds of gluten meal,
and
1.6 pounds of corn oil.

Nothing is wasted!

REFINING CORN

Fill-in-the-Blank:

One bushel of corn weighs approximately __ pounds.
(Answer: 56)

Corn oil is found in the _____ of the kernel.
(Answer: germ)

The endosperm contains _____ and makes up over 80% of the mass of the corn kernel.
(Answer: gluten protein and starch)

The five most important refined corn products are
_____
(Answer: corn sweeteners, ethanol, starch, oil, and feed products.)

_____purchase shelled corn and separate the parts of a kernel of corn during the refining process.
(Answer: Corn refiners)

In the _____ process the corn is soaked in cool water for 30-40 hours, where the kernels swell to double their size.
(Answer: Steeping)

One bushel of corn can be refined into __ pounds of cornstarch plus __ pounds of animal feed, ___ pounds of gluten meal, and ___ pounds of corn oil.
(Answers: 31, 11, 2.5, 1.6)

The starch can be dried and marketed as unmodified or specialty cornstarch, or it can be converted into
_____
(Answer: corn syrup or sugar, biodegradable plastics or ethanol)

BUBBLES

1 cup dishwashing detergent
3 cups water
6 tablespoons white **corn syrup**

- Combine ingredients in a large jar or container, cover, and shake well.
- Let the mixture settle for four hours.
- Pour the bubble soap into a large pan or plastic tub.
- After using the bubble soap, store it covered and labeled in the refrigerator.
- Try to let the bubble soap come to room temperature before you use it again.
- Enjoy!

    - Make your own blower by cutting the bottom off a polyfoam cup, place the wide end in the soap, and blow from the cut end.
    - Or make a gigantic wand by bending a wire coat hanger into a circle.

COOKED PLAYDOUGH

Mix together:
1 cup flour
½ cup salt
2 teaspoons cream of tartar

Then add:
1 cup water
1 tablespoon **corn oil**
Food coloring*

**You may use food coloring paste (used for cake decorating) for more vivid colors.*

- Cook over medium heat, stirring constantly until a ball forms.
- Knead until smooth.
- Store in an airtight covered container.

EASY S'MORES

5 small marshmallows (*They're made from* ***corn syrup***!)
2 squares of graham crackers
10 chocolate chips

- Place the marshmallows on one graham cracker.
- Put the chocolate chips around the marshmallows.
- Microwave on high for 30 seconds.
- Place the other graham cracker on top.
- Enjoy!

FREEZER CORN

20-22 cups of raw **sweet corn** (approximately 2½ to 3 dozen ears)
1 pound butter
1 pint half and half

- Mix ingredients and place in a large roaster.
- Bake at 350 degrees for 1 hour, stirring two or three times.
- Eat!
- Or cool, then divide into freezer bags and freeze.