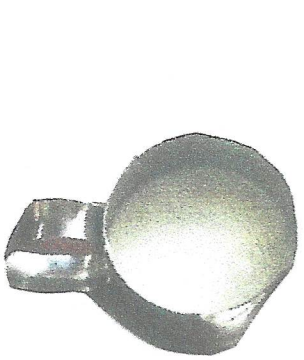

FOOD CHEMISTRY

What Does The Ingredients In A Recipe Do?

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What Does The Ingredients In A Recipe Do?

Have you ever asked yourself why certain ingredients are included in recipes and what is their purpose? Have you had a recipe not turn out right and you wondered what happened? Do you strictly follow the recipe or do you figure that the recipe is just a rough guide. Baking is a science and certain ingredients need an exact measurement. Our ancestors that never measured things must have known exactly how much was needed. Even if you're not a scientist, understanding the science of baking will help you to create the best possible recipes and ensure you don't mindlessly substitute ingredients thinking it doesn't matter. In this lesson we will look at some common ingredients and how it affects a recipe.

Flour

Flour holds the ingredients together in baking. When flour protein is combine with moisture and heat, it develops into gluten. This elastic gluten contains the expanding leavening gases during rising. The protein content of flour affects the strength of the dough. The different wheat flour types contain varying amounts of the gluten forming proteins. Hard wheat, mainly grown in midwestern United States, has high protein content. Soft wheat, grown in southern United States has less protein. In yeast breads, a strong gluten framework is desirable. In cakes, quick breads and pastries, high protein flour makes a tough product.

Gluten Flours

Bread flour is hard wheat flour with about 12% protein. Bread flour is used for yeast raised bread because the dough it produces has more gluten than dough made with other flours. Sufficient gluten produces a light loaf with good volume. Slices hold together, rather than crumble.

Cake flour is soft wheat flour that is 7.5% protein. The lower gluten content causes products to have a tender, more crumbly texture that is desirable in cake.

All-purpose flour is blended during milling to achieve a protein content of 10.5%. This medium protein flour can be used for all baking purposes. If using all purpose flour in place of cake flour in a recipe, substitute 1 cup minus 2 Tablespoons all purpose flour for 1 cup cake flour.

Whole wheat flour may be substituted for part of the white flour in yeast and quick bread recipes. Whole wheat flour contains the nutrition germ and bran as well as the endosperm of the wheat kernel. Bran particles cut through the gluten during mixing and kneading of bread dough, resulting in a smaller, heavier loaf. If you use a coarsely ground whole wheat flour for all-purpose flour, use 1 cup plus 2 Tablespoons whole wheat flour for every cup of all-purpose flour. In a white bread recipe you can use half whole wheat and half bread flour for best results.

Wheat germ is not flour, but is often used in place of the flour in recipes for flavor and fiber. Protein, vitamins, minerals and polyunsaturated fats are concentrated in the germ of the grain kernels. Wheat germ, preferably toasted, can be used in place of up to 1/3 of the flour in a recipe.

Rye flour is often used in combination with wheat flour for bread. Light rye flour can be substituted for 40% of wheat flour in a recipe. Medium and dark rye flour should be limited to 30% and 20%, respectively, of the total flour content.

Triticale flour is a hybrid of wheat and rye. It has an average protein content higher than that of wheat flour. In yeast bread dough, triticale flour has better handling properties than rye flour

because it will form gluten, but does not handle as well as wheat dough. For good quality dough, ferment yeast dough made with triticale flour for a shorter period than wheat flour dough.

Gluten Free Flours

Oat flour has relatively high protein content, 17%, but does not form gluten. Oat flour can be substituted for as much as 1/3 of wheat flour in bread.

Corn Meal is coarsely ground dried corn. Corn flour is more finely ground corn. Both corn flour and corn meal contain 7 to 8 % protein on a dry basis. Neither corn meal nor corn flour will form gluten. A grainy texture in cornbread can be avoided by mixing the cornmeal with the liquid from the recipe, bring to a boil and cooking before mixing with the other ingredients.

Rice flour has about 6.5 to 7% protein and does not form gluten. For people who do not tolerate gluten, rice flour is a good substitute for wheat, barley, rye or oat flours. In baked products, 7/8 cup of non waxy rice flour can be used in place of 1 cup all-purpose wheat flour.

Potato starch flour, another non-gluten forming flour, is usually used in combination with other flours. It has a mild potato taste. For substitution, 5/8 cup of potato flour can be used for 1 cup of all-purpose flour.

Soy flour contains 50% protein and is used primarily to boost the protein content of baked goods. Soy flour cannot form gluten and does not contain starch. Used in large amounts it affects the taste of baked goods and causes them to brown quickly. You can substitute by taking 2 tablespoons flour out of each cup of flour in a recipe and add 2 tablespoon soy flour.

Sugar

Table sugar, Sucrose, is made from either sugar cane or beets and is refined to get rid of impurities. Sugar has many functions in food other than providing sweetness. Many baking disasters can be traced to one little mistake, tinkering with sugar in a recipe. Using less or more sugar than a recipe calls for can really affect your results. Even substituting honey for table sugar can also cause a disaster.

When sugar molecules meet water molecules, they form a strong bond. This union of sugar and water affects the texture of baked goods in two important ways: softness and tenderness.

Softness – The bond between sugar and water allows sugar to lock in moisture so that items such as cakes, muffins, brownies and frostings don't dry out too quickly.

Tenderness – Baked goods get their shape and structure from proteins and starches, which firm up during baking and transform soupy batters and soft dough into lofty muffins and well-formed cookies. Structure, proteins and starches can make baked goods tough. The sugar in a batter or dough pulls water away from proteins and starches, which helps control the amount of structure-building they can do. Because of this you get a tenderer treat.

Sugar helps make cakes and quick breads batters rise during baking. When you mix up a cake batter and beat sugar into fat, eggs and other liquid ingredients, the sugar crystals cut into the mixture, creating thousands of tiny air bubbles that lighten the batter. During baking these bubbles expand and lift the batter, causing it to rise in the pan. In small amounts, added sugar helps yeast begin producing gas for raising yeast dough.

Sugar tenderizes dough and batter products and may help the baked products to brown. In the oven, moisture evaporates from the surface of baked goods, allowing dissolved sugars to re-crystallize. This creates the crunchy, sweet crust on brownies, pound cakes and some kinds of muffins and cookies. It is the sugar in cookie dough that causes spreading to occur during baking.

It's best to dust moist cakes with confectioners' sugar right before serving, because, over time, the sugar will attract even more moisture and become sticky.

Without sugar, flour proteins can join in the baking process and make gluten. This is why you'll often find many gluten free foods have a higher than normal sugar content. This same factor is why you can usually find ingredients labeled as "low fat" but with high sugar content. When there's sugar in a recipe, the flour joins with the sugar rather than itself.

Fructose, in crystal form is nearly twice as sweet as sucrose and is more expensive. Fructose attracts more water than sugar, therefore, fructose sweetened products tend to be moist. Baked products made with fructose will be darker than if they were made with sucrose.

Honey is sweeter than sugar because it contains fructose. When using honey in place of sugar, use ¾ cup plus 1 Tablespoon in place of 1 cup sugar and reduce the other liquid ingredients by 2 Tablespoons. Even when liquid is reduced, a product that contains honey will be moist because the fructose absorbs moisture from the atmosphere. Too much honey may cause the product to become too brown.

Molasses imparts a dark color and strong flavor to baked goods. It is not as sweet as sugar. When using molasses in place of sugar, use 1 1/3 cups molasses for 1 cup sugar and reduce the amount of liquid in the recipe by 5 Tablespoons. Because molasses has more acid than sugar, it may be necessary to add ½ teaspoon baking soda for each cup of molasses used in substitution for sugar. Replace no more than ½ the sugar called for in the recipe with molasses.

Brown sugar is only partially refined, which means it still has some molasses clinging to it. (Some manufacturers just add molasses to refined sugar and package it as brown sugar.) Brown sugar makes baked goods moister than white sugar because of the molasses content. You may have to adjust some of the other proportions in the recipe. Slightly decrease the wet ingredients or increase the dry ones. Brown sugar will also add a hint of rich caramel flavor and affect the color. Brown sugar is more "hygroscopic", meaning it draws in water more easily from the air. Cookies made with brown sugar will absorb moisture from the atmosphere and soften on standing.

To make your own brown sugar, mix 1 cup of granulated sugar with 1 ½ tablespoons molasses (for light brown sugar) or ¼ cup molasses (for dark sugar). You can just measure what you need from this mixture.

Turbinado or Demerare is the "natural" brown sugar usually sold as "raw sugar". This sugar doesn't work as well as granulated white or brown sugar in a recipe because of the crystal size. Take advantage of the texture of these bigger crystals by using them to crust cakes or cookies.

The following artificial sweeteners are available for home use. They provide sweetness to homemade foods but lack the browning, tenderizing and moisture retaining properties provided by table sugar. Specially formulated recipes are often needed to make a product with acceptable texture and appearance when using artificial sweetness. Because the different low-calorie sweeteners vary in sweetness and bulk, package directions must be followed for the amount to use in place of sugar.

Saccharin is a heat stable non-calorie sweetener that in its pure form is 200-300 times as sweet as sucrose. Bulking agents are added to saccharin products to aid in measuring. Saccharin has a bitter aftertaste.

Acesulfame K (Sweet One sm) is a very low calorie sweetener that is 200 times as sweet as sucrose. It is heat stable so it can be used in baked goods. For improved texture in baked products, use Acesulfame K in combination with granulated sugar. Acesulfame K reportedly has no unpleasant after taste.

Aspartame commonly known as NutraSweet, is not heat stable so it is not an appropriate sweetener for baked goods.

Salt

Salt is very important in the science of baking and does so much more than just contributing to the flavor. Salt helps preserve the color and flavor of flour. It also strengthens the gluten protein in dough and the fermentation rate of yeast. Without salt, holes will form in your bread as the bread rises faster and air pockets enlarge where the gluten has broken. Without salt your bread will taste bland. Salt also indirectly contributes to crust coloring. Without salt the yeast quickly consumes the available sugars and the crust on baked bread is pale and dull. It seems salt is out of place in sweet recipes but if you omit it; your product will taste very bland because salt also enhances flavor. If you do omit or reduce salt, the other spices or flavoring in the recipe should be increased slightly.

Baking Soda

Baking soda is a leavening agent that produces carbon dioxide so the baked goods will rise. Baking soda is pure sodium bicarbonate and needs to be paired with an acidic ingredient like honey, chocolate, yogurt, vinegar, lemon juice or molasses. Use too much and you'll have a soapy coarse cake. The volume of quick breads, cookies and some candies depends largely on the amount of baking soda added to the batter or dough. Reducing the amount of baking soda without replacing it with another leavening agent will reduce the volume and lightness of the finished product. It is important that when you use only pure baking soda, you should bake your goods immediately because a chemical reaction (bubbles) occurs and they will expand upon baking. Waiting too long and your baked goods will be flat. You cannot substitute baking soda for baking powder.

Baking Powder

Baking Powder is a leavening agent and is made from Cream of Tartar (an acidifying agent) and starch (a drying agent). Baking Powder produces carbon dioxide so the baked goods will rise. Batters made with double acting baking powder rise twice; once when dry and moist ingredients are mixed together and again when it is baked. Too much baking powder results in a bitter tasting product, while too little results in a tough cake with little volume. You can substitute baking powder for baking soda in a slightly higher amount than the recipe calls for.

Yeast

Yeast is a living microorganism until it is destroyed by heat. As yeast grows and multiplies it gives off carbon dioxide which causes the dough to rise. Its action is affected by the addition or deletion of other ingredients such as salt and sugar. Using less yeast than specified in a recipe causes the dough to take longer to reach the desired volume in the rising stages.

Cornstarch

This ingredient has multiple purposes depending on the type of dish it's being used in. Cornstarch is usually either a thickener or a binder, but can also be an anti-caking agent. It's great to use in gluten-free cooking instead of flour to thicken sauces, custards or cake fillings.

Fat

Fat in the form of shortening, margarine, butter, or oil contributes tenderness, moisture and a smooth mouth feel to baked goods. Fat enhance the flavor of other ingredients as well as contributing its own flavor, as in the case of butter. In baked goods, such as muffins, reducing the amount of fat in a recipe results in a tougher product because gluten develops more freely. Another tenderizing agent such as sugar can be added or increased to tenderize in place of the fat. A small amount of fat in yeast dough helps the gluten to stretch, yielding a loaf with greater volume.

What are fats? A fatty acid is a long carbon chain that interacts with hydrogen atoms differently and can be saturated, polyunsaturated and monounsaturated based on this relationship. Three of these fatty acid chains together form a triglyceride. Different types of triglycerides behave differently in baking. Triglycerides high in saturated fat tend to come from animals and are solid at room temperature, like butter or lard. Triglycerides high in unsaturated fats usually come from plants and are liquid at room temperature, like vegetable oil.

Butter

Butter is made from cream and has a fat content of at least 80%. The remaining 20% is water with some milk solids. Butter imparts a good flavor without a greasy mouth feel to baked goods because it melts at body temperature.

Margarine

Margarine is made from fat or partially hydrogenated oil, water, milk solids and salt. Vitamins and coloring are added. The fat or oil can be of animal or vegetable origin. Margarine has the same ratio of fat to non-fat ingredients as butter (80% to 20%) and can be used interchangeably with butter. Reduced fat substitutes have less than 80% fat. These do not work the same as butter or margarine in baked goods. Specially formulated recipes can be found on the packages of these products. Fat free margarines are also available and contain no fat but are best used as spreads.

Oil

Oil is used in some muffins, bread and cake recipes. Oil pastry is mealy rather than flaky. To substitute oil for butter or margarine, use 7/8 cup oil for 1 cup butter or margarine. If oil is used in place of a solid fat for some cake recipes, the texture will be heavier unless the sugar and egg is increased.

In **bread making** fat provides flavor and more importantly, lubricates the dough. This helps to retain the gases released during baking, thus ensuring a well risen loaf which will have a soft crumb and will stay fresh longer.

In **cake making** the function of fat is more complex. Cakes are usually made by either the creaming method or the all in one method. The role of fat is different in each case. In the creaming method the fat is beaten with the sugar until it becomes light, fluffy and pale in color. The water in oil emulsion changes to an oil in water emulsion. During this process air is being incorporated into the batter and the volume increases. The air in the batter is important because it forms nuclei into which other gases and water vapor from the moisture and carbon dioxide from the baking powder, migrate and expand on heating.

Cake or muffins made by the all in one method generally mix together all the liquid ingredients with baking soda in one bowl and all the dry ingredients including baking powder in another bowl. The two are then combined together before baking. In this method the rising agents are the baking soda and the baking powder. The fat has no aeration function but, as in bread making, it will help to retain the gases released during baking.

Biscuits and pastries are made with "shortening". The fat is rubbed into the flour. The molecules of fat surround the flour particles and gets rid of the water. This prevents the development of gluten in the dough. The fat is used to shorten the dough. Any increase in water in the mixture will tend to encourage development of gluten, which will make biscuits hard and pastry heavy.

Eggs

When a recipe calls for an egg, the best size to use is a Grade A large egg. A large egg still in its shell weighs about 2 oz. total. A large egg has about 3 ¼ Tablespoons of total egg matter.

Eggs do a lot in baking. They are a leavening agent (adding volume) and are a binder, meaning they keep the finished product together. The whole egg adds flavor, thickening or glazing. Egg whites are a drying agent and because of the water content they also add moisture and stability. The egg yolks contribute to texture and flavor. They contribute to structure, incorporate air when beaten, provide liquid, fat and protein and emulsify fat with liquid ingredients. Reducing or omitting egg yolks can result in less tenderness. Reducing or omitting egg whites can result in less volume. Cakes made without the emulsifying action from the egg yolk may not have a uniform flavor and texture. If a low fat, low cholesterol baked product is desired, use 2 egg whites for 1 whole egg. The egg white has very little fat or cholesterol.

The nutritional value in eggs is protein, vitamin D and choline. Choline is an important nutrient for the brain, nervous system and cardiovascular system. The whites are primarily albumin protein (see appendix).

Over-whipped whites will become clumpy, grainy and difficult to fold into your batter. Also, using too many whites in a batter can make the final product dry.

Room temperature eggs bind and emulsify better than cold ones and the egg whites whip up better. If you need to separate your eggs, do while they are cold; the yolks are less likely to break and it's easier to separate the yolk from the whites.

Liquids

Liquids are necessary in baked goods for hydrating protein, starch and leavening agents. When hydration occurs, water is absorbed and the chemical changes necessary for structure and texture development can take place. Liquids contribute moisture to the texture and improve the mouth feel of baked products. When water vaporizes in a batter or dough, the steam expands the air cells, increasing the final volume of the product.

Milk contributes water and valuable nutrients to baked goods. The protein in milk softens and contributes to moisture and adds color and flavor. It gives the dough or batter strength, structure, tenderness, flavor and moisture. It also helps browning to occur. When making yeast dough, milk should be scalded and cooled before adding to other ingredients. This is done to improve the quality of the dough and the volume of the bread.

Juice may be used as the liquid in a recipe. Because fruit juices are acidic, they are probably best used in baked products that have baking soda as an ingredient.

Appendix

Albumin protein is in the egg whites and is the common name for the clear liquid (albumin) contained within an egg. Egg white consists of water and protein (including albumin, mucoprotien and globulin). Depending on the size of the egg, albumen accounts for most of an egg's liquid weight, about 66%. The white contains more than half the egg's total protein, a majority of the egg is niacin, riboflavin, magnesium, potassium and sodium and none of the fat. The term albumen was once applied to water-soluble protein systems, such as egg white, containing proteins other than albumins.

Resources

https://www.thekitchn.com/baking-school-day-1-all-about-eggs-and-baking

https://www.completelydelicious.com/ingredient-spotlight-how-fats-are-used-in-baking/

https://www.oilsfats.org.nz/library/the-role-of-fats-in-baking/

https://www.finecooking.com/article/what-every-baker-needs-to-know-about-sugar

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https://www.thefreshloaf.com/node/51732/nine-different-functions-eggs-baking

Nebraska Cooperative Extension-Neb Fact- Function of Baking Ingredients

https://ucat.utoronto.ca/baking-ingredients-function/ University of Toronto

https://ohmysugarhigh.com/the-science-of-baking-what-do-your-ingredients-do/