

Eggs & Egg Products

Revised 2018

Thermal Properties

	Whole		Yolk		White	
	English	Metric	English	Metric	English	Metric
Moisture, %	75.33	--	48.81	--	87.81	--
Protein, %	12.49	--	16.76	--	10.52	--
Fat, %	10.02	--	30.87	--	0.0	--
Carbohydrate, %	1.22	--	1.78	--	1.03	--
Fiber, %	0.0	--	0.0	--	0.0	--
Ash, %	0.94	--	1.77	--	0.64	--
Specific Heat Above Freezing	0.87 Btu/lb*°F	3.63 kJ/(kg*K)	0.73 Btu/lb*°F	3.05 kJ/(kg*K)	0.93 Btu/lb*°F	3.91 kJ/(kg*K)
Specific Heat Below Freezing	0.47 Btu/lb*°F	1.95 kJ/(kg*K)	0.54 Btu/lb*°F	2.25 kJ/(kg*K)	0.43 Btu/lb*°F	1.81 kJ/(kg*K)
Latent Heat of Fusion	108 Btu/lb	252 kJ/kg	70 Btu/lb	163 kJ/kg	126 Btu/lb	293 kJ/kg

Storage Conditions

	Temperature		Relative Humidity	Storage Period
	°F	°C	%	
Shell	45	7.2	70-80*	2-3 weeks
Shell	29-31	-2 to -0.6	85-92*	5-6 months
Frozen	0°	-18	not critical	2 years +
Liquid	40	4	not critical	5 days
* Not critical if oiled				

Who inspects egg products?

The Egg Products Inspection Act (EPIS) was passed by the US Congress in 1970 and in 1995, the Food Safety and Inspection Service (FSIS) became responsible for the inspection of egg products. FSIS inspects all egg products, with and without added ingredients, with the exception of those products exempted under the Act. Officially inspected egg products will bear the USDA inspection mark.

The Department of Health and Human Services' FDA is responsible for the inspection of egg substitutes, imitation eggs, and similar products, which are exempted from continuous inspection under the EPIA.

The EPIA stipulates that egg products may not be imported into the United States except from countries which have an egg products inspection system equivalent to that of the US and Canada is currently the only country that exports egg products to the US.

Egg products in the EU are regulated by the General Food Law which requires that requires a tracking system and a salmonella control program be in place.

Requirements for Exporting Processed Egg Products

The United States Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS) is responsible for inspecting egg products under the authority of the Egg Products Inspection Act (EPIA) (21 U.S.C. 1031 et seq.).5). Some examples include Pasteurized Frozen Whole Egg with citric acid; plain Pasteurized Frozen Whole Egg without added ingredients; Pasteurized Liquid Yolk with 10% salt; Pasteurized Frozen Scrambled Egg Mix with Whole Egg and pepper, starch, and dried milk; Frozen Yolks with 10% sugar added; Frozen Egg Whites with whipping aids (such as sodium sulfate or triethyl citrate); Pasteurized Enzyme Modified Dried Egg Product with Egg Yolks and xanthan gum and citric acid to preserve color, and less than 1% silicon dioxide as an anticaking agent and phospholipase; Spray Dried Albumin; and Spray Dried Egg Whites with calcium citrate and salt (or other added ingredients).

USDA microbiological sampling methods for egg and egg products can be found at:

<https://www.fsis.usda.gov/wps/wcm/connect/c8b385ce-08b5-40c4-8ed6-f667f06f645e/09-Egg-Products-Sampling.pdf?MOD=AJPERES>

Fresh Shell Eggs

The US FDA Food Safety Rule (CFR Parts 16 and 118) requires processors hold and transport eggs at or below 45°F ambient temperature beginning 36 hours after time of lay.

Handling:

Both washed and unwashed eggs are stored under refrigeration. "AA" or "A" quality eggs are preferred for extended storage periods. If eggs are to be washed before storage, they should be cleaned, graded and oiled under sanitary conditions. The Egg Products Inspection Act of 1970 requires that all eggs moving in interstate commerce be candled and graded. No cracked, dirty or loose eggs may be sold except direct to consumers by producers in limited amounts or to an authorized breaking plant. Shell eggs moving only intrastate are not regulated by the United States Department of Agriculture (USDA) but most states have egg grading laws or regulations very similar or identical to those of the USDA. Some states operate under a cooperative federal-state egg grading program which provides supervision of the grading operation by federal personnel. The program is voluntary and a fee is levied to those who request the service. All eggs sold to the military or other federally operated establishments must be inspected for grade by a USDA representative. The USDA has established the specifications for quality of individual shell eggs, as well as specifications and tolerances for consumer, nest run and wholesale packs. The weight classifications, which are independent of quality, are shown in the tables below for consumers, nest run and wholesale grades, respectively.

U.S. Weight Classes for Consumer Grades for Shell Eggs			
Size or weight class	Minimum net weight per dozen	Minimum net weight per 30 dozen case	Minimum weight for individual eggs at rate per dozen
	Ounces	Pounds	Ounces
Jumbo	30	56	29
Extra Large	27	50-1/2	26
Large	24	45	23
Medium	21	39-1/2	20
Small	8	34	17
Peewee	15	28	--

Weight Classes for U.S. Nest Run Grade for Shell Eggs	
Weight classes	Minimum average net weight on lot basis 30-dozen cases (pounds)
Class XL	51
Class 1	48
Class 2	45
Class 3	42
Class 4	39
Note: No individual sample case may vary more than + or – 2 pounds (4.4 kg) from the lot average	

Weight Classes for U.S. Wholesale Grades for Shell Eggs				
Weight classes	Average net weight on a lot basis ¹	Minimum net weight individual case basis ²	Minimum weight at rate per dozen weight	Weight variation tolerance for not more than 10% by count of individual eggs
	Pounds At least	Pounds	Ounces	Ounces
Extra Large	50.5	50	26	Under 26 but not under 24
Large	45	44	23	Under 23 but not under 21
Medium	39.5	39	20	Under 20 but not under 18
Small	34	None	None	None
¹ Lot means any quantity of 30 dozen or more eggs.				
² Case means standard 30 dozen egg case as used in commercial practice in the U.S.				

Washing:

Nearly all eggs produced on commercial poultry farms are washed. High labor costs for separating the clean eggs from the dirty eggs and mistakes in judgment on cleanliness have made washing an almost

universal practice. Modern equipment properly operated is capable of safely cleaning most soiled eggs. Close supervision is essential, especially regarding water temperature, detergent-sanitizes use, rapid drying of the eggs and overall strict sanitation. Eggs for long term storage should come only from plants known to have adequate washing equipment operated in an approved manner at all times. If there is any doubt concerning the washing operation, the eggs should be marketed promptly or converted to egg products. Washing of shell eggs is not allowed in some countries. For these areas dry cleaning equipment is available. Such equipment is more labor intensive and can only be used with white shelled eggs.

Oiling:

Eggshell is porous. Water can evaporate through the shell, resulting in weight loss and lowering the quality grade. This happens more rapidly if the relative humidity of the surrounding air is low. To minimize this loss, most eggs are sprayed with a colorless, odorless, tasteless mineral oil available from poultry supply houses or oil companies. Perhaps even more important, oiling retards the escape of carbon dioxide from the interior of the egg. Retaining carbon dioxide in the egg white reduces quality losses during storage. In most commercial operations, the eggs are sprayed with a thin film of oil immediately after cleaning and drying. For holding periods of a few weeks or less, 1/2 to 2/3 of the shell surface is covered. Excess oil is wasteful and does not improve shelf life of the egg.

Casing:

Packaging of eggs is important to prevent physical damage, contamination and odor transfer. Eggs may be bulk packed or retail carton packed. In either instance, 30 dozen eggs are packed in a standard case measuring 24½" long, 12½" wide, and 13¾" high. With retail packaged eggs they are sometimes cased in 15 dozen cases which are one-half the length of the 30 dozen cases. For bulk packing, molded pulp trays are usually used. For retail packing the dozen cartons are either molded pulp or molded plastic, usually Styrofoam. All egg packing materials should be clean and odor free.

Cooler Storage:

Federal regulations mandate that all shell eggs be maintained in an ambient temperature of 45°F (7.2°C) at all times following grading and/or packaging. The regulation reads: "No shell egg handler shall possess any shell eggs that are packed into containers destined for the ultimate consumer unless they are stored and transported under refrigeration at an ambient temperature of no greater than 45°F (7.2°C)."

Eggs for long term storage should be held just above the freezing point which is about 31°F (-0.56°C). However, such low temperatures are seldom used because most eggs today are consumed within a short period. Also, when eggs are removed from that temperature, they may be below the dew point resulting in condensation on the shell surface, commonly called sweating. When eggs are removed from refrigerated storage, it may be necessary to temper them to a higher temperature to prevent sweating.

Control of relative humidity in egg storage rooms is a necessity. Eggs can lose weight by evaporation of moisture in low relative humidity. Even for oiled eggs, the relative humidity should not be lower than 70-80% for long term storage. Too high a relative humidity will result in mold growth which can penetrate the pores of the shell and contaminate the egg contents.

Mold will grow on eggs starting at a relative humidity of between 90 and 94%. Moving air inhibits this growth, so eggs for long term storage in still air rooms should be held at lower than 90% relative humidity, but can be held at up to 92% if the air is moving at about 40 feet per minute.

Liquid Egg Products

The production of liquid egg products continues to rise each year, while frozen egg products appear to have stabilized with respect to production. Most egg products, liquid or frozen, are used for further processing into other fabricated food items. Nearly all the commercial egg products are broken by machines which can sanitarly break the eggshell and either leaves the contents whole, separate the yolk from the white or mix the yolk and whites to produce specific blends. All liquid or frozen egg products are strained, churned, pasteurized and then frozen or sold unfrozen as a liquid.

Pasteurization:

The Egg Product Inspection Act became effective on July 1, 1972, and has put the egg product process under mandatory USDA inspection. Generally, all egg products are required by law to be pasteurized and free from pathogens before being shipped to the market or storage. The minimum required temperature and time for pasteurization of each type of egg product is specified by the US Department of Agriculture.

Pasteurization Requirements			
Liquid Egg Product	Minimum Temperature Requirements		Minimum Holding Time Requirements
	°F	°C	Minutes
Albumen (without use of chemicals)	134	57	3.5
	132	56	6.2
Whole egg	140	60	3.5
Whole egg blends (less than 2% added non egg ingredients)	142	61	3.5
Fortified whole eggs and blends (24-38% egg solids, 2-12%)	144	62	3.5
	142	61	6.2
Salt whole egg (with 2% or more salt added)	146	63	3.5
	144	62	6.2
Sugar whole egg (2-12% sugar added)	142	61	3.5
	140	60	6.2
Plain yolk	142	61	3.5
	140	60	6.2
Sugar yolk (2% or more sugar added)	146	63	3.5
	144	62	6.2
Salt yolk (2-12% salt added)	146	63	3.5
	144	62	6.2

The minimum storage temperatures required for various liquid egg products are shown in Table V.

Minimum Cooling and Temperature Requirements for Liquid Egg Products Unpasteurized product temperature within 2 hrs from time of breaking					
Product	Liquid (other than salt product) to be held 8 hours or less	Liquid (other than salt product) to be held in excess of 8 hours	Liquid salt product	Temperature within 2 hours after pasteurization	Temperature within 3 hours after stabilization
Whites (not to be stabilized)	55°F (13°C) or lower	45°F (7°C) or lower		45°F (7°C) or lower	
Whites (to be stabilized)	70°F (21°C) or lower	55°F (13°C) or lower		55°F (13°C) or lower	(¹)
All other product (except product with 10% or more salt added)	45°F (7°C) or lower	40°F (4.4°C) or lower		If to be held 8 hrs or less, 45°F (7°C) or lower. If to be held in excess of 8 hrs, 40°F (4°C) or lower	If to be held 8 hrs or less, 45°F (7°C) or lower. If to be held in excess of 8 hrs, 40°F (4°C) or lower
Liquid egg product with 10% or more salt added			If to be held 30 hrs or less, 65°F (18°C) or lower. If to be held in excess of 30 hrs, 45°F (7°C) or lower	65°F (18°C) or lower ²	
¹ Stabilized liquid whites shall be dried as soon as possible after removal of glucose. The storage of stabilized liquid whites shall be limited to that necessary to provide a continuous operation.					
² The cooling process shall be continued to assure that any salt product to be held in excess of 24 hrs is cooled and maintained at 45°F (7°C) or lower.					

Freezing:

Eggs cannot be frozen in the shell as expansion of the contents results in cracked shells. Frozen egg products include whole eggs, yolks, whites, blends of yolks and whites of any desired ratio, and any one of these used with one or more food ingredients such as salt, sugar, corn syrup, or glycerol.

Frozen whole eggs or yolks become highly viscous after thawing and sometimes can become gummy with lumpy particles. This phenomenon can be partially prevented by adding salt, sugar, corn syrup or glycerin. Frozen eggs intended for mayonnaise and salad dressing are usually salted. The baking, confectionery and ice cream industries generally prefer eggs with sugar or syrup added.

The time of freezing depends on the type and size of the container, the temperature of the freezer and the air flow surrounding the container. The U.S. Department of Agriculture regulations require that pasteurized egg products be solidly frozen or reduced to a temperature of 10°F (-12°C) or lower within 60 hours. For most frozen egg products these requirements can be met with freezer temperature at -15 to -20°F (-26 to -29°C) and with substantial air flow. On the other hand, freezing too fast will result in a center core expanding to raise the lid and cause contamination of the product or make stacking for subsequent storage difficult.

Packaging:

The most common packaging for frozen eggs and egg products is a 30-lb cylindrical plastic container with tapered walls and friction fit cover. The dimensions of the typical container are 10" diameter x 12 1/2" high. For foodservice use, frozen egg products are most commonly packed in 5-lb. milk-style cartons, 6 cartons per case. Other variations do exist such as the plastic "cook-in-the-bag" filled with raw eggs which can be thawed and cooked in the bag. Scrambled eggs can be served directly from the bag.

Liquid eggs and egg products are used primarily by industry because of their convenience. Five days at 40°F (4.4°C) is considered a fairly typical shelf life. The traditional 30-lb. "can," the newer 45-lb. plastic bag in a corrugated carton (dimensions 9-1/2"x9-1/2"x16-1/2"), 1800-lb. tanks with self-contained refrigeration apparatus, and insulated tank trucks of various sizes ranging up to 5000 gal capacity are used for "packaging" these products. Usually well-timed contracted commitments are the order of business here.

At retail, products that are raw were liquid in nature prior to freezing and are sold in milk-style cartons of various sizes ranging from as little as a pint to as much as 1 quart in size. The number of units per case will vary from manufacturer to manufacturer.

Further Processed Egg Products

In recent years the retail and foodservice sales frozen omelets, quiches, and other further processed egg products have increased. Unfortunately, very little public research has been done so not much is known about keeping qualities, shelf life, defects, and especially in relation to freezing. These products are all sold frozen to preserve them, except for hard-cooked eggs that are sold in weak acidic solutions of one composition or another.

Mandatory inspection by USDA's Food Safety and Inspection Service (FSIS) of these products is necessary only if they are produced from unpasteurized egg products or if they contain meat and/or poultry meat or are part of a meal, dinner, or breakfast containing meat and/or poultry meat. Otherwise, all other products are subjected to the usual U.S. Food and Drug Administration inspection. These types of egg products or egg-containing products are not defined as "egg products" under the U.S. Egg and Egg Product Inspection Act.

Further processed egg products usually consist of eggs and other food ingredients. Some of these products may contain food ingredients to as much as 25% of the total volume. The added ingredients will affect their taste and keeping qualities. The FSIS has set some standards-of-identity for omelets and certain filled omelets such as those containing ham, cheese, and bacon. Likewise, quiches also are

defined although there are a great many mixtures of eggs and other ingredients that make up a "quiche." Defining these products and trying to set standards is a real quagmire. For example, are omelets only to be made in the traditional way (partially cooked flat in a pan, filled, folded over and finished cooking) or can an omelet be essentially scrambled eggs with the filling all "mixed in?" They are available both ways and both raw and cooked.

Packaging is as varied as storage times and temperatures. Packaging may range from the common milk carton for raw omelet or quiche mixes to cooked varieties that are packed in special shaped plastic trays with 12 to 16 pockets and a plastic shrink top cover, 4-5 trays to a box.

Until some definitive research on storage times and temperatures becomes available, 0°F (-18°C) is recommended. Six months storage time maximum is suggested. Cooked eggs which are not protected by lower pH will turn green in frozen storage after about 3-4 months. Hard cooked eggs sold fresh in acidic solutions can retain color for as little as 3 weeks to as much as 5-7 weeks, assuming the holding temperature is 40°F (4.4°C). Sanitation at the manufacturing plant is the key to shelf life.

Eggs, Dried

Thermal Properties

	Whole (dried)		White (dried)	
	English	Metric	English	Metric
Moisture, %	3.10	--	14.62	--
Protein, %	47.35	--	76.92	--
Fat, %	40.95	--	0.04	--
Carbohydrate, %	4.95	--	4.17	--
Fiber, %	0.0	--	0.0	--
Ash, %	3.65	--	4.25	--
Specific Heat Above Freezing	0.49 Btu/lb*°F	2.04 kJ/(kg*K)	0.55 Btu/lb*°F	2.29 kJ/(kg*K)
Specific Heat Below Freezing	0.48 Btu/lb*°F	2.00 kJ/(kg*K)	0.50 Btu/lb*°F	2.10 kJ/(kg*K)
Latent Heat of Fusion	4 Btu/lb	10 kJ/kg	21 Btu/lb	49 kJ/kg

Storage Conditions

	Egg White Solids, Dried	Whole Egg and Yolk Solids, for Routine Storage	Dried, for Color and Nutrient Retention
Temperature	70-80°F (21-27°C)	40-50°F (4-10°C)	32 to 0°F (0 to -18°C)
Relative Humidity	75% or less	75% or less	
Storage Period	Indefinite	1-2 years	3 months-1 year

Egg White Solids:

Egg white solids are produced from deglucosed liquid egg albumen. The glucose is removed by either an enzymatic or fermentation process. Both pan dried, commonly called “flake”, and spray dried, commonly called “powder” are available. When packed in moisture vapor resistant containers, these products have an indefinite shelf life when stored under ordinary room temperature conditions. Refrigerated storage is not recommended. Moisture may condense on the cold product when it is removed from refrigeration. Keep containers tightly sealed - this prevents contamination and allows tampering to be detected.

Whole Egg and Yolk Solids:

Whole egg and yolk solids are produced from both natural (non-deglucosed) and deglucosed liquid whole egg or yolk products. The glucose is mostly removed by an enzymatic process. These products are produced by spray-drying. The composition of these products varies. They may be whole egg, yolk only, blends of whole egg or yolk with carbohydrates (sugar, corn syrup), or whole egg or yolk to which free-flow agents have been added to improve flavor, function, and/or physical texture. When packed with inert gas, hermetically sealed and stored at 40-50°F (4.4-10°C), a shelf life of 1-2 years or perhaps more can be expected. Lower storage temperatures can be used to extend shelf life. However, some products tend to cake if free-flow agents have not been added. Keep containers tightly sealed, since this prevents contamination and allows tampering to be detected.

Storage for Color and Nutrient Retention:

Whole eggs or yolk solids used for processing frequently require the rich deep yellow orange color provided by corn, alfalfa, or other feeds high in carotenoids. Seventy-five percent of the color can be retained for 3 months at 32°F (0°C) and for 1 year or longer at 0°F (-18°C).

Some of the carotenoid pigments are Vitamin A precursors. A 2 oz. portion of dehydrated whole eggs should provide nearly half the daily dietary allowance of Vitamins A, B1, B2, protein, iron, and smaller quantities of many other nutrients. Adequate nutrient protection can be provided for 3 months at 40-50°F (4.4-10°C) and for 1 year at temperatures less than 32°F (0°C).

Storage of Unpasteurized or Salmonella Positive Egg Products in Commercial Warehouse Pending Further Processing:

The United States Department of Agriculture (USDA) Egg Products Grading Branch, Agricultural Marketing Service (AMS), has some special procedures to be followed when unpasteurized or salmonella positive egg products are brought into the commercial warehouse. Generally speaking, the egg product must eventually be returned to either the same firm or sent to an approved USDA plant for further processing. The commercial warehouse receipt must provide the following information for the benefit of the USDA and plant management:

1. Warehouse receipt number
2. Name and address of warehouse
3. Warehouse lot number under which product is stored

4. Type of product, number of containers, and net weight
5. Name and address of the firm for which product is stored

Packaging:

Dried eggs for foodservice use or government or military purchases may be packed in plastic pouches (6-oz.), #10 cans, or 3-lb. and 25-lb. poly packs. Commercial/industrial use packs are 25-lb. and 50-lb. boxes, or 150, 175, and 200-lb. drums. All packaging must be a positive moisture barrier. A moisture proof, odor proof, packaging is preferred.

Odor Transfer:

Dried egg products are susceptible to absorbing foreign odors. They should not be stored with other products that give off strong odors, such as apples or onions.

Certification Requirements:

From time to time, a resident USDA Grader may be asked to certify that a particular lot of dried egg products have been analyzed using laboratory analyses, such as those appropriate to determine or measure salmonella, standard plate count, coliforms, moisture, color or salt. If so, a sample each lot should be collected as follows:

Number of Shipping Containers in Lot	Number of Shipping Containers to Select for Sampling	Quantity to be Analyzed
50 or less	4	(1) 100 grams
51-150	8	(2) 100 grams
151-500	12	(3) 100 grams
501-1,500	16	(4) 100 grams
over 1,500	20	(5) 100 grams

Containers are to be randomly selected from the lot and placed in groups of four. The grader will remove approximately 2 to 3 ounces of product from each of the four containers and combine them into one sample container for laboratory analysis. Although this procedure is for the official USDA Grading test, a warehouse operator can use the same procedure as a guideline should one of his customers request similar services.

WFLO is indebted to Dr. W. J. Stadelman, Professor Emeritus, Purdue University, Lafayette, Indiana, and Dr. Paul Dawson, Clemson University, Clemson, South Carolina, for the review and revision of this topic.