United States Department of Agriculture
Food Safety Inspection Service
Administrative Management
Human Resource Development Division

PROCESSING INSPECTORS' CALCULATIONS HANDBOOK

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Chapter 1

INTRODUCTION

OVERVIEW AND PURPOSE

The mission of the Food Safety and Inspection Service (FSIS) is to assure that meat, meat food, poultry, and poultry food products distributed in interstate commerce are wholesome, not adulterated, and properly marked, labeled, and packaged. FSIS enforces the Federal Meat Inspection Act (FMIA), the Poultry Products Inspection Act (PPIA), and the regulations implementing these laws. Documents such as the FSIS Directives, FSIS Notices, and the Meat and Poultry Inspection (MPI) Manual provide inspection personnel with specific instructions and policies to help them enforce the laws and regulations.

Whether meat and poultry products are in compliance with the laws and regulations is often determined by how the products are formulated and processed. Careful attention to the kind and amount of ingredients, their conditions of use, and the standards of product identity and composition are necessary to assure compliance.

The meat and poultry inspection regulations provide specific information on the permitted amounts and uses of various substances that are allowed to be used in meat and poultry products. These substances must not be used in a manner that would deceive the consumer by concealing spoilage or inferiority, or by causing the products to appear of a different size, weight, or quality than they actually are.

The regulations and policy memorandums also prescribe definitions and standards of identity, or composition, for certain meat and poultry products. Standards of identity set specific requirements for a product's make-up. For instance, these standards may specify the kind and amount of meat or poultry, the maximum amount of non-meat and non-poultry ingredients, and any other ingredients allowed, or expected, in the final product. Meat and poultry product standards are established to assure that consumer expectations are met for a product that is labeled with a certain name. Additional policies have been established to guide inspection personnel in determining whether products are being prepared in accordance with the laws and regulations.

FSIS inspectors carry out monitoring activities, including checks on product preparation, to assure that official establishments are maintaining control of their processes. Among the monitoring activities are food ingredient calculations, which are intended to help ensure that meat and poultry products are not adulterated or misbranded. From time to time, questions have been raised, and criticisms voiced, about the accuracy, reliability, and consistency of FSIS calculation methods. In some cases, the questions and criticisms--by field personnel, label reviewers, headquarters staff, and industry personnel--have resulted from the fact that different terminology was used in the regulations that were written and promulgated at different times. Of course, the meat and poultry industry has changed over the years, and the regulations have been updated to accommodate new products and processes. But whatever the reason for the inconsistencies, if they appear to impair the Agency's ability to administer the meat and poultry inspection program nationally in a uniform and equitable way, they must be reduced, explained, or eliminated.

Previous editions of the Processing Inspectors' Calculations Handbook have amounted to little more than grab bags of sample calculations, formulae, and definitions to help inspectors of processed foods in their work. This new edition is more thematic and has a threefold purpose. First, it is an expanded collection of sample calculation methods. Second, it identifies in a single document the various regulatory limitations on the use of restricted ingredients (e.g., cure agents, cure accelerators, binders and extenders, phosphates, antioxidants, and flavorings) in meat and poultry products, and illustrates the calculation method or methods for each specific ingredient. Third, it standardizes the interpretation of the regulations for calculation purposes and establishes consistent calculation methods for inspection and establishment personnel.

While the Handbook may refer to or reiterate Agency policy, it is not intended to replace it. The Handbook is intended primarily as a reference or aid to learning how to perform various calculations. It should also help provide insight into the reason why a given policy is needed and its relative importance in a science-based food safety program.

The Handbook is divided into chapters which cover specific subjects and calculation types. Several chapters have been broken down into subject matter sections that have an introduction, a formula (if applicable) and at least one procedure table. The procedure table contains the steps to be taken in performing the calculations presented in that section. In some sections, comments have been provided to further clarify the interpretation of the pertinent regulation or policy.

BACKGROUND

Restricted ingredients are controlled on an "ingoing basis" (at formulation), rather than waiting until the end of the process to check the finished product through laboratory analysis, so that the process can be controlled when the ingredients are added to the product. For some added ingredients, laboratory tests are nonexistent and others are unreliable because the results vary depending upon when the samples were taken (before cooking, after cooking, etc.).

Restricted ingredient calculation policies should not be confused with the policies for labeling meat and poultry products that contain added solutions or ingredients. Restricted ingredients are calculated the same way for cooked or uncooked products, regardless of the label statement. Added solution and added ingredient calculations ***for labeling purposes*** do depend on whether or not the product is cooked or uncooked. Refer to Chapter 10, PRODUCTS LABELED--"X% WATER" AND "X% OF WEIGHT IS ADDED INGREDIENTS".

One obstacle that inspection personnel encounter in ascertaining restricted ingredient compliance with the regulations, is that calculations for allowable ingoing amounts could be based on one of five different weights, all of which are referred to in various places in the MPI regulations. These different weights vary according to the type of ingredient, type of product, and purpose of the ingredient's use in the product. The five weights (or bases for restricted ingredient calculations) are:

! The "***green weight" of the meat and/or poultry and/or meat and/or poultry byproduct (meat block)*** component of the product at formulation.

Example:

- The ingoing amount of nitrite and nitrate used in comminuted, pumped, injected, massaged, dry-cured, and immersion-cured products is based on the weight of the meat, poultry, meat byproduct, or poultry byproduct at the time of formulation and are controlled on an ingoing basis.

! The ***"formulated weight"*** of the meat or poultry product.

Example:

- Poultry products (e.g., poultry meat, poultry, and poultry byproducts) may be added to certain cooked sausage products at a rate not to exceed 15 percent of the total weight of all the ingredients at the time of formulation, excluding the water and ice.

! The ***"finished weight"*** of the entire meat or poultry product.

Example:

- The amount of batter and breading used as a coating for breaded products shall not exceed 30 percent of the weight of the finished breaded meat or poultry product.

! The ***"projected finished weight"*** of the entire meat or poultry product.

Example:

- The ingoing amounts of binders and extenders, such as nonfat dry milk (NFDM), soy flours, and cereals are calculated on the basis of the projected finished weight.

- The ***"weight of the fat content"*** of a fresh meat or poultry product.

  Example:

  - The ingoing amount of an individual antioxidant used in a fresh sausage product shall not exceed 0.01 percent of the fat content of the product.

Depending upon which weight base is used, the same restricted ingredient calculation could give a different result for the allowable ingoing amount. Therefore, it is imperative that inspection personnel use the correct weight base when checking compliance.

ESTABLISHMENT RESPONSIBILITIES

When Federal inspection is granted to an establishment, a responsible plant official signs a statement agreeing to conform strictly to all Federal regulations and orders pertaining to inspection. This statement emphatically establishes that the establishment management has the responsibility to produce a product that is safe, wholesome, unadulterated, and properly labeled. This also includes cooperating with inspection personnel and providing information necessary for them to do a proper inspection job.

Establishment management is expected to have process control procedures and checks in place to identify, correct, and prevent any conditions that could lead to violations. For example, the establishment:

- Will assign a competent individual(s) to be responsible for product formulation.
- Will use and adhere to specific tested and proven formulas that will produce products in compliance.
- Will accurately measure and identify all ingredients, mixtures, and emulsions through all phases of production.
- Should maintain formulation records of meat and poultry products.

INSPECTION RESPONSIBILITIES

The Food Labeling Division's (FLD) Label Review Staff is responsible for checking formulations before approving product labels.

Inspection personnel assigned to the establishment are responsible for:

- Evaluating formulation records and verifying the weighing and addition of ingredients at the time of formulation.

- Monitoring fat content of various products. If a product has less than its standard of identity fat content or targeted fat content, but the antioxidant calculations were based on the standard of identity fat content or targeted fat content, then the product would be out of compliance for antioxidants.

- Performing calculations for ingredients permitted in meat and poultry products to determine compliance with the product standard, or approved formula, at the time of formulation.

Chapter 2

CONVERSION TO PARTS PER MILLION (PPM)

Limits for restricted ingredients permitted in meat and poultry products are expressed in terms of ounces (oz) or pounds (lb) per pounds of the meat/poultry or gallons of pickle solution, or as percentages (%) in the Tables of Approved Substances shown in the MPI Regulations, sections 318.7(c)(4) and 381.147(f)(4). The same limits are expressed in parts per million (ppm) in other references where there is a need to express very small quantities of food additives in more convenient units.

Ppm may be easily converted to percent (parts per hundred) as follows:

1	ppm =	1/1,000,000	= 0.000001	= 0.0001%
10	ppm =	10/1,000,000	= 0.00001	= 0.001%
200	ppm =	200/1,000,000	= 0.0002	= 0.02%
5000	ppm =	5000/1,000,000	= 0.005	= 0.5%
20,000	ppm =	20,000/1,000,000	= 0.02	= 2.0%

Conversely, the conversion of **percent (parts per hundred) to ppm** is performed as follows:

$$0.02\% = 0.0002$$
$$0.0002 \times 1{,}000{,}000 = 200 \text{ ppm}$$

The calculations in Table 1 illustrate that the amounts of the various restricted ingredients shown as weight and percentages in both of the Tables of Approved Substances for meat and poultry products are equivalent to the amounts shown as ppm in other references. One gallon of water weighs 8.33 pounds, but 1 gallon of pickle weighs more, because of the added weight per volume of other ingredients in the solution. When the regulations were written, a weight estimate of 10 pounds was used for 1 gallon of pickle--partly to make illustrative calculations easy. However, the true weight of any volume of pickle can be easily and accurately determined by adding the weights of actual ingredients and the water (8.33 lb/gal) listed in the pickle formulation. This actual weight of the pickle, probably somewhat less than 10 pounds per gallon, should be used for all calculations.

TABLE I
CONVERSION OF RESTRICTED INGREDIENT WEIGHT OR PERCENT LIMITATIONS TO PPM LIMITATIONS

Nitrite in Regulations	**Converted to ppm**
2 lb to 100 gal pickle at 10% pump	If 1 gal pickle weighs 10 lb 100 gal pickle weigh 1000 lb $\frac{2 \times 0.10 \times 1{,}000{,}000}{1000} = 200$ ppm
1 oz to 100 lb meat or poultry product (dry cure)	1 oz = 1/16 = 0.0625 lb $\frac{0.0625 \times 1{,}000{,}000}{100} = 625$ ppm
¼ oz to 100 lb chopped meat and/or meat byproduct or poultry meat	¼ oz = .25/16 = 0.0156 lb $\frac{0.0156 \times 1{,}000{,}000}{100} = 156$ ppm
Nitrate in Regulations	**Converted to ppm**
7 lb to 100 gal pickle at 10% pump	If 1 gal pickle weighs 10 lb 100 gal pickle weigh 1000 lb $\frac{7 \times 0.10 \times 1{,}000{,}000}{1000} = 700$ ppm
3 ½ oz to 100 lb meat or poultry product (dry cure)	3 ½ oz = 3.5/16 = 0.2187 lb $\frac{0.2187 \times 1{,}000{,}000}{100} = 2187$ ppm
2 ¾ oz to 100 lb chopped meat or poultry meat	2 ¾ oz = 2.75/16 = 0.1718 lb $\frac{0.1718 \times 1{,}000{,}000}{100} = 1718$ ppm

Cure Accelerators in Regulations **Ascorbic Acid and Erythorbic Acid** 75 oz to 100 gal pickle at 10% pump ¾ oz to 100 lb meat or meat byproduct or poultry product	 **Converted to ppm** If 1 gal pickle weighs 10 lb 100 gal pickle weigh 1000 lb 75 oz. = 75/16 = 4.687 lb $\frac{4.687 \times 0.10 \times 1,000,000}{1000} = 469$ ppm ¾ oz = .75/16 = .04687 lb $\frac{.04687 \times 1,000,000}{100} = 469$ ppm
Ascorbate and Erythorbate 87.5 oz to 100 gal pickle at 10% pump f oz to 100 lb meat or meat byproduct or poultry product	**Converted to ppm** If 1 gal pickle weighs 10 lb 100 gal pickle weigh 1000 lb 87.5 oz = 87.5/16 = 5.468 lb $\frac{5.468 \times 0.10 \times 1,000,000}{1000} = 547$ ppm f oz = .875/16 = 0.0547 lb $\frac{0.0547 \times 1,000,000}{100} = 547$ ppm
Fumaric Acid 0.065 percent or 1 oz to 100 lb meat or poultry or meat byproducts or poultry byproducts	**Converted to ppm** 0.065% = 0.00065 0.00065 × 1,000,000 = 650 ppm or 1 oz = 1/16 = 0.0625 lb $\frac{0.0625 \times 1,000,000}{100} = 625$ ppm

Glucono delta-lactone	**Converted to ppm**
8 oz to 100 lb meat or meat byproducts	8 oz = 8/16 = 0.5 lb $\frac{0.5 \times 1{,}000{,}000}{100}$ = 5000 ppm
16 oz (1 lb) to 100 lb meat or 1% (Genoa salami only)	16 oz = 1 lb $\frac{1 \times 1{,}000{,}000}{100}$ = 10,000 ppm
Sodium Acid Pyrophosphate	**Converted to ppm**
8 oz in 100 lb meat or meat and meat byproducts	8 oz = 8/16 = 0.5 lb $\frac{0.5 \times 1{,}000{,}000}{100}$ = 5000 ppm (reminder: 5000 ppm = 0.005 = 0.5%)
Phosphates in Regulations	**Converted to ppm**
Used to decrease cooked out juices:	
5 percent of phosphate in pickle at 10% pump (meat regulations)	5% in pickle = 5 lb in 100 lb $\frac{5 \times 0.10 \times 1{,}000{,}000}{100}$ = 5000 ppm
0.5% of total product (poultry regulations)	5000 ppm = 0.005 = 0.5%
0.5% of phosphate in product (meat regulations)	5000 ppm = 0.005 = 0.5%
Used to protect flavor:	
0.5% of total product (meat regulations)	5000 ppm = 0.005 = 0.5%

Flavorings in Regulations	Converted to ppm
Corn Syrup and Similar Flavorings	
2% (dry basis) (meat regulations) = 2 ½% (wet basis - 80% solids) (meat regulations)	2% = .02 × 1,000,000 = 20,000 ppm 20,000 ÷ .80 = 25,000 ppm
levels sufficient for purpose (poultry regulations)	
Sorbitol	
2% (dry basis) (meat regulations) = 2.86% (wet basis - 70% solids) (meat regulations)	2% = .02 × 1,000,000 = 20,000 ppm 20,000 ÷ .70 = 28,600 ppm
Binders and Extenders in Regulations	**Not Converted to ppm**
3 ½%, 8%, or 12% individually or collectively depending on the type of meat food product, except for isolated soy protein (ISP) and sodium caseinate, which are limited to 2% in certain meat products	
1½% or 2% individually in certain cured pork products	
levels sufficient for purpose except for sodium caseinate which is limited to 3% in cooked product and 2% in raw product (poultry regulations)	

Note: *If you are unable to convert units of measurement, e.g., ounces to pounds, turn to the Appendix, Converting Units of Measurement, pages 109 to 114.*

Chapter 3

CURING AGENT (NITRITE AND NITRATE) CALCULATIONS

INTRODUCTION

Calculations for curing agents are based on the ***green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block),*** used in the formulation of the product. Because nitrite and nitrate, after being converted to nitric oxide, function by reacting chemically with the meat or poultry myoglobin, the amounts of nitrite or nitrate permitted in the cure must be based on the meat block used in the formulation, ***not*** the finished weight of the product. Using finished weight as the weight base for these calculations would be unacceptable because more curing agent than is allowed could be added to the product. Excess nitrite or nitrate can be toxic.

Either the sodium or the potassium salt of nitrite may be used for curing products, but the weight limitation (based on sodium) is the same for both salts. This limitation was established when the sodium salt was the only one permitted. Later, the potassium salt was allowed to be added at the same level. This level is safe, but rather conservative because potassium is a heavier element than sodium and a greater weight of a potassium salt must be used for the equivalent amount of nitrite or nitrate to be in the product. The bacon regulation, which is more recent than those governing other cured products, also permits both salts, but at different limits for each salt.

There are some recently introduced processes, such as injecting emulsion into the meat or poultry; and there are processes not specifically addressed in the regulations (such as immersion curing of products other than bacon). Nevertheless, the amount of curing solution permitted in these processes is also based on the green weight of the meat or poultry because FSIS believes that all the curing agent used is taken up by the meat or poultry. Table II, on the next page, lists the maximum parts per million (ppm) for each of the four curing agents permitted in products, based on the curing method used. The limits vary among curing methods because the methods differ in the efficiency with which the curing agent is brought in contact with the meat and/or poultry. Limits for nitrite/nitrate combinations and combination procedures (such as pumping and dry curing) are discussed on pages 32 and 33. Bacon, with respect to both curing ingredients and cure accelerators, is discussed on pages 27-31.

TABLE II
MAXIMUM INGOING NITRITE AND NITRATE LIMITS (IN PPM)
FOR MEAT AND POULTRY PRODUCTS*

Curing Agent	Curing Method			
	Immersion Cured	Massaged or Pumped	Comminuted	Dry Cured
Sodium Nitrite	200	200	156	625
Potassium Nitrite	200	200	156	625
Sodium Nitrate	700	700	1718	2187
Potassium Nitrate	700	700	1718	2187

* There are more stringent limits for curing agents in bacon to reduce the formation of nitrosamines. For this same reason, nitrate is no longer permitted in any bacon (pumped and/or massaged, dry cured, or immersion cured). Refer to page 27, Nitrite used in Bacon, for specific information.

As a matter of policy, the Agency requires a ***minimum*** of 120 ppm of ingoing nitrite in ***all*** cured "Keep Refrigerated" products, unless the establishment can demonstrate that safety is assured by some other preservation process, such as thermal processing, pH or moisture control. This 120 ppm policy for ingoing nitrite is based on safety data reviewed when the bacon standard was developed.

There ***is no*** regulatory minimum ingoing nitrite level for cured products that have been processed to ensure their shelf stability (such as having undergone a complete thermal process, or having been subjected to adequate pH controls, and/or moisture controls in combination with appropriate packaging). However, 40 ppm nitrite is useful in that it has some preservative effect. This amount has also been shown to be sufficient for color-fixing purposes and to achieve the expected cured meat or poultry appearance. Some thermally processed shelf-stable (canned) products have a minimum ingoing nitrite level that must be monitored because it is specified as a critical factor in the product's process schedule.

Nitrite and nitrate are not permitted in baby, junior or toddler foods.

NITRITE USED IN CURED, COMMINUTED PRODUCTS

Introduction

The amount of ingoing nitrite permitted in comminuted products, such as bologna, specific and nonspecific loaves, salami, etc., is based on the green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block) used in the product formulation. Shrinkage is not a factor in the calculation. If nitrate is used in conjunction with nitrite, the limits of the two compounds are calculated separately and the permitted maximum of each may be used.

Nitrite Used in Pure Form

! **Calculation Formula**

▸ $$\frac{\text{lb nitrite} \times 1{,}000{,}000}{\text{green weight of meat block}} = \text{ppm}$$

In comminuted products, this formula can be used to determine:

(1) The permitted weight of the nitrite, if you know the weight of the meat block.

(2) The minimum weight of the meat block that must be used in the formula, if you know the weight of the nitrite being used.

(3) Whether or not a formula will be in compliance with the regulations, if you know the weight of the nitrite and the weight of the meat block.

▸ **Procedure Table.**

By using the procedure table below, one can determine the amount of nitrite and/or the ppm of ingoing nitrite allowed in a comminuted product.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the nitrite in the formulation and identify the meat and/or poultry and/or meat/poultry byproducts that make up the meat block from the label transmittal form or establishment formulation records.	Wiener Formula Beef 230.00 lb Pork 230.00 lb Water 70.00 lb Rework (has nitrite and erythorbate) 50.00 lb Chicken 40.00 lb NFDM 18.00 lb Corn Syrup Solids (CSS) 15.00 lb Salt 5.00 lb Flavorings 4.50 lb Sodium Erythorbate 0.422 lb (6.75 oz.) Sodium Nitrite 0.078 lb (1.25 oz.) Total Batch Weight 663.00 lb

2	Determine the weight of the meat block.	Beef 230 lb Pork 230 lb Chicken + 40 lb Total Meat Block 500 lb
	The following example will illustrate the use of this calculation formula. We know the weight of the meat block and that sodium nitrite is limited to 156 ppm in comminuted products (see Table II, page 12). Substitute these values into the formula and solve for ***n***, the weight of the sodium nitrite.	We have a 500 lb meat block. What is the maximum amount of sodium nitrite that can be added to the formula without exceeding the 156 ppm limit? $\frac{n \times 1,000,000}{500} = 156$ ppm $n = \frac{156 \times 500}{1,000,000}$ n = 0.078 lb of nitrite is the maximum amount that could be used in this formula
3	When both factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the product is in compliance. The product ***is*** in compliance.	We have 0.078 lb of sodium nitrite being added to a sausage formula that has a 500 lb meat block. Will this product be in compliance? $n = \frac{0.078 \times 1,000,000}{500}$ n = 156 ppm

Note: *If you are unable to solve equations with one unknown, turn to the Appendix, Solving Equations that Have an Unknown Value, pages 115 to 123.*

! **Calculation Formula** (using nitrite limit of ¼ oz per 100 lb of meat block)

Alternatively, one could use the following calculation formula that uses the nitrite limit of ¼ ounce/100 lb of meat and/or poultry and/or meat/poultry byproduct (meat block) to determine the maximum amount of nitrite that can be added to a known amount of meat block.

- $\frac{\text{green weight of meat block}}{100} \times 0.25 = \text{lb nitrite}$

► **Procedure Table**

The procedure table below may also be used for determining the amount of nitrite allowed in a comminuted product.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the meat block.	Sausage Formula (from page 13) Beef 230 lb Pork 230 lb Chicken + 40 lb Total Meat Block 500 lb
2	Convert this figure into 100 lb units by dividing by 100.	500 lb ÷ 100 = 5.0 units
3	Determine the weight of sodium nitrite allowed by multiplying these units by the decimal equivalent of nitrite allowed per 100 lb. (¼ oz = .25 oz nitrite allowed)	5.0 × 0.25 oz = 1.25 oz or 0.078 lb of nitrite is the maximum amount that can be used with 500 lb of meat and poultry.

! **Comment**

Any rework in the formulation already containing nitrite shall not be added to the meat block. On the other hand, if the rework does not contain nitrite, the green weight of the meat and/or poultry portion of the rework may be added to the meat block total.

Nitrite in Curing Compounds or Mixes

When curing agents, nitrites and nitrates, are brought into the establishment, they may already be mixed with salt, sugar, corn syrup solids, or monosodium glutamate. If curing agents are mixed with these ingredients, the result is commonly referred to as a curing compound or mix. The curing compound or mix must have the percentage of nitrite and/or nitrate indicated on the container.

! **Calculation Formula**

► $$\frac{\text{lb cure mix} \times \text{\% nitrite in mix} \times 1{,}000{,}000}{\text{green weight of meat block}} = \text{ppm}$$

In comminuted products, this formula can be used to determine:

(1) The permitted weight of the cure mix, if you know the weight of the meat block.

(2) Whether or not a formula will be in compliance with the regulations, if you know the weight of the cure mix, % of the nitrite in the mix, and the weight of the meat block.

! **Procedure Table**

Use the following procedure table to determine the amount of cure mix allowed in a comminuted product and/or the ppm of ingoing nitrite in a comminuted product when nitrite is added via a cure mix.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the cure mix added to the formula and identify the meat block from the label transmittal form or establishment formulation records. Identify the percentage of nitrite in the cure mix (the cure mix label may need to be examined).	Cotto Salami Formula Pork 220.00 lb Beef hearts 100.00 lb Beef 60.00 lb Water 50.00 lb Rework (has nitrite) 50.00 lb Salt 7.50 lb CSS 4.00 lb Flavorings 3.00 lb Dextrose 2.00 lb Sodium phosphates 2.00 lb Cure Mix (6.25% sodium nitrite w/salt carrier) 1.30 lb Sodium Erythorbate 0.20 lb (3.20 oz) Total Batch Weight 500.00 lb
2	Determine the weight of the meat block.	Pork 220 lb Beef hearts 100 lb Beef + 60 lb Total Meat Block 380 lb

	The following example will illustrate the use of this formula. We know the weight of the meat block, the percentage of sodium nitrite in the cure mix (6.25%), and that sodium nitrite is limited to 156 ppm in comminuted products. Substitute these values into the calculation formula and solve for ***n***, the weight of the cure mix.	If we have a 380 lb meat block, what is the maximum amount of cure mix that can be added to the formula without exceeding the 156 ppm limit? $\frac{n \times 0.0625 \times 1{,}000{,}000}{380} = 156 \text{ ppm}$ $n = \frac{156 \times 380}{0.0625 \times 1{,}000{,}000}$ n = 0.94 lb of cure mix is the maximum amount that could be used in this formula
3	When all factors are known, one can just solve for *ppm* and compare the answer with the regulation to determine if the product is in compliance. The product ***is not*** in compliance.	We have 1.30 lb of cure mix being added to a sausage formula that has a 380 lb meat block. Will this product be in compliance? $n = \frac{1.30 \times 0.0625 \times 1{,}000{,}000}{380}$ n = 213.81 ppm nitrite

! Comment

The maximum amount of cure mix allowed in a specified amount of meat block can also be determined by first calculating the maximum amount of nitrite permitted in ***pure form,*** and then dividing this amount by the percentage of the nitrite in the cure mix.

Remember that nitrite is limited to 156 ppm or a ¼ oz (0.25 oz) per 100 lb of meat block. Therefore, the maximum amount of nitrite allowed in a 380 lb (from above) meat block would be 0.95 oz (380 ÷ 100 × 0.25) which is equivalent to 0.059 lb (0.95 oz ÷ 16 oz per lb).

Take the percentage of the nitrite in the cure mix and express it as a decimal (move the decimal two places to the left). For example, the cure mix containing 6.25% sodium nitrite would be expressed as 0.0625.

Next, divide the amount of pure nitrite allowed by the percentage of the nitrite in the cure mix. In this case,

$$0.059 \text{ lb} \div 0.0625 = 0.94 \text{ lb cure mix}$$

0.94 lb of the cure mix would be allowed in this batch containing 380 lb of meat or meat byproducts.

Nitrite in Liquid Curing Compounds or Mixes

Liquid cures are a combination of a basic cure mix (dry form) and water. To determine the maximum amount of liquid cure mix permitted in a product formula or whether a product formulated with a liquid cure mix is in compliance, you use the same calculation formula as that in the description for nitrite in cure (dry form) mixes. However, you will first need to calculate the percentage of nitrite present in such a solution.

- **Procedure Table**

STEP	PROCEDURE	EXAMPLE
1	Examine the cure mix formula to determine the percentage of nitrite it contains.	450 lb Salt - 90% 50 lb Sodium Nitrite - 10%
2	Now examine the makeup of the cure solution.	90 lb Water 25 lb Cure Mix 115 lb Total
3	Find the weight of the nitrite used in the liquid cure solution by multiplying the cure mix weight in the solution by the percentage of nitrite it contains.	25 lb Cure Mix × .10 2.5 lb Nitrite
4	Compute the percentage of nitrite in the solution by dividing the weight of the nitrite by the total weight of the solution and then multiply the result by 100.	2.5 ÷ 115 = .0217 (2.17% sodium nitrite in the solution)

5	Now that we know the percentage of sodium nitrite in the liquid cure mix, it can be inserted into the calculation formula (refer to Nitrite in Curing Compounds or Mixes, page 15) and we can solve for ***n***, the weight of the liquid cure mix.	Using the cotto salami example given earlier, we have a 380 lb meat block. What is the maximum amount of liquid cure mix that can be added to the formula without exceeding the 156 ppm limit? $\frac{n \times 0.0217 \times 1{,}000{,}000}{380} = 156 \text{ ppm}$ $n = \frac{156 \times 380}{0.0217 \times 1{,}000{,}000}$ n = 2.73 lb of liquid cure mix is the maximum amount that can be used with a 380 lb meat block.

NITRITE USED IN CURED, PICKLED PRODUCTS

Introduction

The amount of ingoing nitrite used in pumped, massaged, injected, or immersion-cured products, such as hams, poultry breasts, poultry rolls, corned beef, etc., is based on the green weight of the meat and/or poultry used in the product formulation. Shrinkage is not a factor in the calculation. If nitrate is used in conjunction with nitrite, the limits of the two compounds are calculated separately and the permitted maximum of each may be used (see pages 32 and 33).

Nitrite in Pumped or Massaged Products

- **Calculation Formula**

  - $$\frac{\text{lb nitrite} \times \%\text{ pump} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

  In pumped products, this formula can be used to determine:

  (1) The permitted weight of nitrite allowed, if you know the weight of the pickle solution and the percent pump to be used.

  (2) The minimum weight of the pickle solution that can be made, if you know the weight of the nitrite and the percent pump to be used.

(3) The maximum percent pump, if you know the weight of the nitrite and the weight of the pickle solution (refer to Chapter 11, pages 80-82, for this type of calculation).

(4) Whether or not a procedure will be in compliance with the regulations, if you know the weight of the nitrite, the weight of the pickle solution, and the percent pump to be used.

! Procedure Table

The procedure table below may be used for determining the amount of nitrite allowed in a pumped or massaged product and/or the ppm of ingoing nitrite in a pumped or massaged product. It may also be used to determine the minimum pounds of pickle necessary to produce a pumped or massaged product in compliance with the 200 ppm nitrite limit.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the total weight of the pickle solution, and the percent pump from the label transmittal form or establishment formulation records. *If any two of these quantities are known, the third can be calculated by substituting the known values into the calculation formula.*	Pickle Formula Water 1310.00 lb Salt 132.00 lb Dextrose 18.00 lb Phosphate 35.00 lb Sodium Erythorbate 3.25 lb Sodium Nitrite 1.75 lb Total 1500.00 lb
2	Two examples will illustrate the use of this formula. We know the weight of the nitrite, the percent pump, and that nitrite is limited to 200 ppm in pumped products (See Table II, page 12). Substitute these values into the formula and solve for ***n***, the lb of pickle.	(A) We have 1.75 lb of sodium nitrite and we want to pump semi-boneless hams at 25%. How much pickle must be made? $200 = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{n}$ $n = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{200}$ n = 2,187.50 lb of pickle solution

	We know the percent pump and the weight of the pickle. Substitute these values into the formula and solve for ***n***, the weight of the sodium nitrite.	**(**B) We want to pump at 25% level and make 1,500 lb of pickle. What is the maximum amount sodium nitrite that may be added to the pickle without exceeding the 200 ppm limit? $200 = \frac{n \times 0.25 \times 1{,}000{,}000}{1500}$ $n = \frac{200 \times 1500}{0.25 \times 1{,}000{,}000}$ n = 1.2 lb of nitrite is the maximum amount that can be added to 1500 lb of pickle that will be pumped into product at a level of 25%.
3	If all 3 factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the procedure is in compliance. Since only 200 ppm sodium nitrite is permitted, this procedure ***is not*** in compliance.	We have 1.75 lb of sodium nitrite and want to make 1,500 lb of pickle and pump at the 25% level. Is this in compliance? $n = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{1500}$ $n = \frac{437{,}500}{1500}$ n = 291.66 ppm nitrite

Note: *If you are unable to solve equations with one unknown, turn to the Appendix, Solving Equations that Have an Unknown Value, pages 115 to 123*.

Nitrite in Immersed Products

In immersion curing, the submerged meat or poultry absorbs the cover pickle solution, slowly, over a long period of time. There are two recognized methods for calculating the allowable ingoing amount of nitrite in immersion cured products. The method used depends on the mechanism of movement of nitrite within the meat and/or poultry/pickle system and into the meat, meat byproduct, or poultry tissue itself.

! **Method One**

The first method assumes that the meat or poultry absorbs not more than the level of nitrite in the cover pickle. Hence, the calculation for nitrite is based on the green weight of the meat or poultry (as is the case with pumped products), but uses percent pick-up as the percent pump. The percent pick-up is the total amount of cover pickle absorbed by the meat or poultry. It is used in the calculation for immersion cured products in the same way percent pump is used in the (previous) calculation for pumped products.

- **Calculation Formula** (using % pick-up)

$$\frac{\text{lb nitrite} \times \text{\% pick-up} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

! **Method Two**

The second method assumes that the submerged meat, meat byproduct, or poultry and the cover pickle act as a single system. Over time, the ingredients in the pickle, such as nitrite and salt, migrate into the meat, meat byproduct, and poultry until levels in the tissue and in the pickle are balanced. This system is actually very complex and dynamic, with components in constant motion, but it will reach and maintain a state of equilibrium. Therefore, the calculation for ingoing nitrite is based on the green weight of the meat block, using the percent added as a relevant amount.

- **Calculation Formula** (using the green weight and pickle weight)

$$\frac{\text{lb nitrite} \times 1{,}000{,}000}{\text{green weight (lb) meat block} + \text{lb pickle}} = \text{ppm}$$

In immersion cured products, this formula can be used to determine:

(1) The permitted weight of nitrite, if you know the green weight of the meat block and the weight of the pickle solution.

(2) The minimum weight of the meat block that can be submerged in the cover pickle, if you know the weight of the nitrite and the weight of the pickle solution.

(3) Whether or not a procedure will be in compliance with the regulations, if you know the weight of the nitrite, the green weight of the meat block to be immersed, and the weight of the pickle solution.

Note: *Method One is used for hams, shoulders, bellies, etc., because it takes weeks for these large items to reach equilibrium. Method Two is primarily used with small items with large surface areas such as pigs' ears, tails, snouts, etc.*

- **Procedure Table**

Use the following procedure table to determine the maximum amount of nitrite allowed in a cover pickle used to cure small items with large surface areas and/or the ingoing ppm of nitrite in a small item with a large surface area that has been submerged in a cover pickle.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the green weight of the meat, meat byproduct, or poultry and the weight of the pickle solution from the label transmittal form or establishment formulation records. *If any two of these quantities are known, the third can be calculated by substituting the known values into the calculation formula.*	Cover Pickle Formula Water 700.00 lb Salt 70.00 lb Phosphate 18.00 lb Dextrose 9.75 lb Sodium Erythorbate 2.00 lb Sodium Nitrite 0.25 lb Total 800.00 lb
2	The following example will illustrate the use of this formula. We know the weight of the cover pickle, the green weight of the meat byproduct, and that nitrite is limited to 200 ppm in immersion cured products (see Table II, page 12). Substitute these values into the formula and solve for ***n,*** the weight of the sodium nitrite.	We have 800 lb of pickle solution and we want to immersion cure 600 lb of pork snouts. How many pounds of sodium nitrite can be added to the cover pickle without exceeding the 200 ppm limit? $200 = \frac{n \times 1{,}000{,}000}{600 + 800}$ $n = \frac{200 \times 1400}{1{,}000{,}000}$ n = 0.28 lb of nitrite

3	When all 3 factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the procedure is in compliance. This product ***is*** in compliance	We have 0.25 lb of sodium nitrite and want to make 800 lb of cover pickle, and add 600 lb of pork snouts to the cover pickle. Will this product be in compliance? $n = \frac{0.25 \times 1{,}000{,}000}{600 + 800}$ n = 178.57 ppm nitrite

Note: *If you are unable to solve equations with one unknown, turn to the Appendix, Solving Equations that Have an Unknown Value, pages 115 to 123.*

NITRITE USED IN CURED, DRY PRODUCTS

Introduction

The amount of ingoing nitrite used in dry cured products, such as country ham, country style pork shoulder, prosciutto, etc., is based on the green weight of the meat or poultry in the product formulation. These products are prepared from a single intact piece of meat or poultry that has had the curing ingredients directly applied to the surface, and has been dried for a specified period of time. For large pieces of meat, the curing ingredients must be rubbed on the surface several times during the curing period. The rubbed meat or poultry cuts are placed on racks or in boxes and allowed to cure. Nitrite is applied to the surface of the meat or poultry as part of a cure mixture.

- **Calculation Formula** (using lb of cure mix)

  - Dry cured product formulation compliance can be monitored using the familiar % pump and pounds of pickle equation used in the **Nitrite in Pumped or Massaged Products** section (page 19), substituting "% cure mix applied" for "% pump" and "lb cure mix" for "lb pickle".

$$\frac{\text{lb nitrite} \times \text{\% cure mix applied} \times 1{,}000{,}000}{\text{lb cure mix}} = \text{ppm}$$

► **Procedure Table**

STEP	PROCEDURE	EXAMPLE
1	From establishment formulation records, determine the weight of the dry cure mix that will be applied to the meat or poultry.	Dry Cure Mixture Salt 42.5 lb 85% Sugar 5.0 lb 10% Sodium nitrate 2.0 lb 4% Sodium nitrite 0.5 lb 1% Total 50.0 lb 100% Use 4 lb of dry cure mix per 100 lb of ham or pork shoulder
2	Convert the amount of dry cure mix per 100 lb of meat or poultry to a percent. Your answer will be the % applied.	$(4 \div 100) \times 100 = 4.0\%$ dry cure applied
3	When all factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the product is in compliance. Since nitrite is permitted up to a level of 625 ppm in dry cured products, this product ***is*** in compliance.	We have 50 lb of dry cure mix containing 0.5 lb nitrite applied to hams or pork shoulders at a rate of 4%. Will the product be in compliance? $n = \frac{0.5 \text{ lb} \times .04 \times 1{,}000{,}000}{50 \text{ lb}}$ n= 400 ppm nitrite

! **Calculation Formula** (using green weight of the meat or poultry)

► When checking nitrite compliance in dry cured products, you may also use the same equation given in the **Nitrite in Curing Compounds or Mixes** section (page 15).

$$\frac{\text{lb cure mix} \times \text{\% nitrite in mix} \times 1{,}000{,}000}{\text{green weight meat or poultry (meat block)}} = \text{ppm}$$

In dry cured products, this formula can be used to determine:

(1) The permitted weight of the cure mix, if you know the green weight of the meat or poultry and the percentage cure agent in the mix.

(2) Whether or not a formula will be in compliance with the regulations, if you know the weight of the cure mix, % of the nitrite in the mix, and the green weight of the meat or poultry.

- **Procedure Table**

Use the following procedure table to determine the maximum amount of a cure mix that can be applied to the surface of a dry cured product and/or the ppm of ingoing nitrite in a dry cured product.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the cure mix applied to the meat or poultry and the weight of the meat or poultry from the label transmittal form or establishment formulation records. Identify the percentage of nitrite in the cure mix (the cure mix label may need to be examined). *If one of these quantities is known, the other can be calculated by substituting the known value into the equation.*	Country Ham Ham 500.00 lb Cure mix (1.00% sodium nitrite) + 20.00 lb Total 520.00 lb Use 4 lb of cure mix per 100 lb of meat or poultry.
2	The following example will illustrate the use of this calculation formula. We know the weight of the meat, the percentage of sodium nitrite in the cure mix, and that sodium nitrite is limited to 625 ppm in dry cured products. Substitute these values into the calculation formula and solve for ***n***, the weight of the cure mix.	If we have 500 lb of ham, what is the maximum amount of cure mix that can be added to the formula without exceeding the 625 ppm limit? $\frac{n \times 0.01 \times 1{,}000{,}000}{500} = 625$ ppm $n = \frac{625 \times 500}{0.01 \times 1{,}000{,}000}$ n = 31.25 lb of cure mix is the maximum amount that could be used in this formula. OR 6.25 lb of cure mix per 100 lb of meat or poultry [31.25 ÷ 5 (100 lb units) = 6.25 lb]

3	When all factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the product is in compliance. Because dry cured products can contain sodium nitrite up to a level of 625 ppm, this product ***is*** in compliance.	We have 20 lb of cure mix that has nitrite in it at a level of 1.00% being applied to 500 lb of ham. Will this product be in compliance ? $n = \frac{20 \times 0.01 \times 1{,}000{,}000}{500}$ n = 400 ppm nitrite

! Comment

The maximum amount of cure mix allowed in a specified amount of meat or poultry to be dry cured can also be determined by first calculating the maximum amount of nitrite permitted in ***pure form,*** and then dividing this amount by the percentage of the nitrite in the cure mix.

Remember that nitrite is limited to 625 ppm or 1 oz per 100 lb of meat or poultry. Therefore, the maximum amount of nitrite allowed in 500 lb of hams (from page 26) would be 5 oz [(500 ÷ 100) × 1.0] which is equivalent to 0.312 lb (5 oz ÷ 16 oz per lb).

Take the percentage of the nitrite in the cure mix and express it as a decimal. For example, the cure mix containing 1.00% sodium nitrite would be expressed as 0.01.

Then divide the amount of pure nitrite allowed by the percentage of the nitrite in the cure mix. In this case,

0.3125 lb ÷ 0.01 = 31.25 lb maximum cure mix

31.25 lb of the cure mix (nitrite 1.00%) would be allowed in the batch containing 500 lb of hams.

NITRITE USED IN BACON

Introduction

Because of problems associated with nitrosamine formation in bacon, MPI Regulations, section 318.7(b)(1) and (3) prescribe the amounts of nitrite and sodium ascorbate or sodium erythorbate (isoascorbate) to be used in pumped and massaged bacon. For the immersion curing and dry curing of bacon, maximum amounts of sodium and potassium nitrite are prescribed in section 318.7(b)(5) and (6) of the MPI Regulations.

Establishment management must submit pickle formulas and the method(s) of preparing ***pumped and/or massaged bacon*** to the processing staff officer at the appropriate regional office. The pickle formula and targeted percent pump or pick-up must meet the limits listed below. Once the procedure is approved, production may begin.

Regardless of the curing method used, restricted ingredient calculations for bacon are based on the ***green weight*** of the skinless belly. For rind-on bacon, e.g., where the skin is sold as part of the finished product, a restricted ingredient conversion calculation is necessary. ***Nitrate is no longer permitted in any curing method for bacon.***

! **Ingredient Limits**

- ***Pumped and/or Massaged Bacon (rind-off):*** An amount of 120 ppm sodium nitrite (or 148 ppm potassium nitrite), ingoing, is required in pumped and/or massaged bacon, except that 100 ppm sodium nitrite (or 123 ppm potassium nitrite) is permitted with an appropriate partial quality control program, and except that 40 - 80 ppm sodium nitrite (or 49 - 99 ppm potassium nitrite) is permitted if sugar and a lactic acid starter culture are used. ***550 ppm sodium ascorbate or sodium erythorbate (isoascorbate), ingoing, is required in pumped and massaged bacon, in addition to any prescribed amount of nitrite.***

- ***Immersion Cured Bacon (rind-off):*** A maximum of 120 ppm of nitrite or equivalent of potassium nitrite (148 ppm) can be used in immersion cured bacon. ***Note:*** *the calculation method for nitrite in immersion cured bacon is the same as that for nitrite in other immersion cured products. Refer to pages 21-24.*

- ***Dry Cured Bacon (rind-off):*** A maximum of 200 ppm of nitrite or equivalent of potassium nitrite (246 ppm) can be used in dry cured bacon. ***Note:*** *the calculation method for nitrite in dry cured bacon is the same as that for nitrite in other dry cured products. Refer to pages 24-27.*

- ***Pumped, Massaged, Immersion Cured, or Dry Cured Bacon (rind-on):*** The maximum limit for ingoing nitrite and sodium ascorbate or sodium erythorbate must be adjusted if bacon is prepared from pork bellies with attached skin (rind-on). A pork belly's weight is comprised of approximately 10 percent skin. Since the skin retains practically no cure solution or cure agent, the maximum ingoing nitrite and sodium ascorbate or erythorbate limits must be reduced by 10 percent. For example, the maximum ingoing limit for nitrite and sodium ascorbate or erythorbate for pumped pork bellies with attached skin would be 108 ppm [120 ppm – 12 ppm (120 × .10)] and 495 ppm [550 ppm – 55 ppm (550 × .10)], respectively.

When determining ***pumped and/or massaged*** product compliance with the nitrite and ascorbate (or erythorbate) limits, the Agency allows a ***plus or minus*** 20% ppm allowance at the time of injecting or massaging due to variables in pumping procedures, draining, purge, etc.

For example: 20% = 0.20, thus 0.20 × 120 ppm nitrite = 24 ppm

120 ppm	120 ppm
− 24 ppm	+ 24 ppm
96 ppm minimum nitrite	144 ppm maximum nitrite

The same calculation can be done for ascorbate or erythorbate (440 ppm minimum, 660 ppm maximum).

Note: *The additional solution added to the product from the higher effective or actual % pump than the establishment's target % pump would be considered negligible because the finished product weight must return to green weight.*

! **Calculation Formulae**

- The formula for determining nitrite compliance in a proposed pumped or massaged bacon processing procedure is:

$$\frac{\text{lb nitrite} \times \text{\% pump} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

In pumped and/or massaged bacon, this formula can be used to determine:

(1) The permitted weight of nitrite allowed, if you know the weight of the pickle solution and the targeted percent pump to be used.

(2) The minimum weight of the pickle solution that can be made, if you know the weight of the nitrite and the targeted percent pump to be used (refer to the Procedure Table on page 20 for this type of calculation).

(3) The maximum percent pump, if you know the weight of the nitrite and the weight of the pickle solution (refer to Chapter 11, pages 80-82, for this type of calculation).

(4) Whether or not a procedure will be in compliance with the regulations, if you know the weight of the nitrite, the weight of the pickle solution, and the targeted percent pump to be used.

- To determine nitrite compliance based on the ***effective or actual % pump***, you can use the formula above by replacing the targeted pump with the effective or actual % pump. ***Alternatively***, you could use the following variations to the formula on the previous page:

$$\frac{\text{lb nitrite} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm nitrite in the pickle}$$

ppm nitrite in the pickle × effective or actual % pump = ppm nitrite in the bacon

! Procedure Tables

Use the following procedure table to determine compliance of a proposed bacon processing procedure.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the total weight of the pickle solution, and the targeted % pump from the FSIS Form 10,520-1 that the establishment has prepared.	Pickle Formula Water 1996.3 lb Salt 302.2 lb Sugar 156.3 lb Sodium Phosphate 31.3 lb Sodium Erythorbate 11.4 lb Sodium Nitrite 2.5 lb Total 2500 lb *Targeted pump is 12%*
2	If all three factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the procedure is in compliance. ***Note:*** *The ingoing ppm of sodium erythorbate can be determined by replacing the pounds of nitrite with the pounds of sodium erythorbate and performing the mathematics.*	We have 2.5 lb of nitrite and want to make 2500 lb of pickle and pump at a level of 12%. Is this in compliance? $n = \frac{2.5 \times 0.12 \times 1{,}000{,}000}{2500}$ n = 120 ppm nitrite (in compliance)

Use the following procedure table to determine the compliance of bacon at the time of pumping and/or massaging. The pickle formula in the procedure table on the previous page will be used as the example in this procedure table.

STEP	PROCEDURE	EXAMPLE
1	Multiply the weight of the sodium nitrite by 1,000,000.	2.5 lb sodium nitrite × 1,000,000 = 2,500,000 ppm nitrite.
2	Divide this figure by the weight of the pickle solution.	2,500,000 ÷ 2,500 = 1000 ppm nitrite in the pickle solution.
3	Multiply this figure by effective or actual % pump to obtain ppm. Refer to Chapter 11, page 78, to learn how to determine the effective or actual % pump (percent gain).	1000 ppm × 0.096 (9.6 % effective pump) = 96 ppm ingoing nitrite in the pork bellies. Product ***is*** in compliance with the 20% ppm allowance.

NITRATE USED IN CURED COMMINUTED, PICKLED, AND DRY PRODUCTS

Introduction

Nitrate is used as a source of nitrite. If nitrate is used as the curing agent, the conversion (reduction) of nitrate to nitrite by bacteria in the meat or poultry is a necessary step in the development of the cured color. The amount of nitrate that is reduced to nitrite is dependent upon the numbers of nitrate-reducing bacteria and several environmental conditions such as temperature, moisture content, salt content, and pH. Hence, the conversion rate and subsequent amount of nitrite that is formed is difficult to control. Similarly, the further reduction of nitrite to nitric oxide, which reacts with myoglobin (muscle pigment) to produce the cured color, is also affected by the same environmental conditions. If nitrite is used as the curing agent, there is no need for the nitrate reduction step, and the development of the cured color is much more rapid.

The poor control associated with the reduction of nitrate to nitrite, coupled with the fact that most processors today demand faster curing methods, has lead to the diminished use of nitrate in meat and poultry products.

Calculations for nitrate are the same as those for nitrite described on pages 11 through 27. Different limits apply, depending upon the curing method used, and are illustrated in Tables I (see page 7) and II (see page 12).

! **Example**

Using the same cure mix formula for dry cured hams or pork shoulders shown in the Procedure Table on page 25, calculate the amount of sodium nitrate. There are 2 pounds of sodium nitrate in 50 pounds of cure mix and the cure mix is applied at the level of 4 pounds per 100 pounds of ham or pork shoulder, or at a 4% level.

► **Calculation**

$$\frac{\text{lb sodium nitrate} \times \%\ \text{cure mix applied} \times 1{,}000{,}000}{\text{lb cure mix}} = \text{ppm}$$

$$\frac{2 \times 0.04 \times 1{,}000{,}000}{50} = 1600 \text{ ppm sodium nitrate}$$

Since the 1600 pm is less than 2187 ppm (the maximum permitted), the amount of sodium nitrate ***is*** in compliance.

NITRITE AND NITRATE USED TOGETHER IN A SINGLE CURING METHOD

Introduction

When nitrite and nitrate are used together in a single curing method, each one is calculated independently and each one is permitted to be used up to the maximum individual limits listed in Table II (see page 12).

! **Limit**

Although nitrite and nitrate are calculated on an ingoing basis and the calculations are based on the green weight of the meat/poultry, the use of nitrites, nitrates, or a combination ***must not*** result in more than 200 ppm of nitrite, calculated as sodium nitrite, in the ***finished product.*** Therefore establishment operators using both compounds must take care to observe this limit. Violations are determined by laboratory analysis.

! **Control**

Laboratory analyses for nitrite yield varying results because the nitrite reacts at varying rates depending on a number of factors, such as temperature, pH, and duration of storage, and thus becomes unavailable and undetectable by current analytical methods. Also, sodium ascorbate interferes with nitrite analysis. Formulation is therefore the primary control. However, sampling for residual nitrite is still performed, especially where both nitrite and nitrate have been added to the formulation.

NITRITE AND NITRATE USED TOGETHER WITH MORE THAN ONE CURING METHOD

Introduction

Some processors use ***both*** nitrite and nitrate in a cure mix and more than ***one*** curing method for a single product. In these situations, nitrite and nitrate are first calculated independently for each curing method. Each curing agent must be calculated as a percentage of the maximum permitted for the method of curing used, and the total percentage of each curing agent ***cannot*** exceed 100% (see Table II, page 12).

- **Example One**

Westphalian Style Hams are dry cured and then immersed in a cover pickle solution. The sodium nitrite limit for dry curing is 625 ppm and for immersion curing the limit is 200 ppm; and the sodium nitrate limit is 2187 ppm for dry curing and 700 ppm for immersion curing.

If the establishment dry cured the hams with 400 ppm nitrite (see page 27), it has used 400 ÷ 625 or 64% of the maximum amount of nitrite that is permitted in the drying procedure. Since 200 ppm is the maximum amount of nitrite permitted in immersion curing, the establishment can only use 36% (100% - 64%) of that amount of nitrite, or (200 ppm × .36) 72 ppm nitrite in the immersion cure. If the establishment dry cured the same hams with 1600 ppm nitrate (see page 32), it has used 1600 ÷ 2187 or 73.15% of the maximum amount of nitrate that is permitted in the drying procedure. Since 700 ppm is the maximum amount of nitrate permitted in immersion curing, the establishment can only use 26.85% (100% - 73.15%) of that amount of nitrate, or (700 ppm × .2685) 187.95 ppm nitrate in the immersion cure.

- **Example Two**

In Black Forest Brand Hams that are pumped and then immersed in a cover pickle solution, the limits are the same (200 ppm for nitrite, 700 ppm for nitrate). Therefore, if 200 ppm nitrite is used in the pumping process, no additional nitrite is permitted in the cover pickle. If 350 ppm nitrate (or 50% of that permitted) is added to the pump cure, up to 350 ppm nitrate (the other 50%) is permitted in the cover pickle.

Chapter 4

CURE ACCELERATOR CALCULATIONS

INTRODUCTION

Cure accelerators speed up the color development (color fixing) of cured products by accelerating the chemical conversion of nitrite to nitric oxide. In addition, cure accelerators aid in keeping myoglobin (muscle pigment) in the reduced state so that it can readily combine with nitric oxide to form nitric oxide myoglobin. During heating, nitric oxide myoglobin is converted to nitrosohemochrome, which is responsible for the bright pink color characteristic of cured meat. Since cure accelerators aid the curing agents in cure color development, they may only be used in combination with the curing agents.

The amounts of curing accelerators are calculated on the basis of the ***green weight of the meat and/or poultry and/or meat/poultry byproducts*** in the formulation and are controlled on an ingoing basis. ***All the methods for calculating nitrite and nitrate amounts also apply in the calculation of cure accelerator amounts.*** When a product undergoes two curing methods, the maximum amount of cure accelerators that may be used in the product may be no greater than the greater of the two single cure accelerator maximums associated with the curing methods. The calculation method used will be the same as that applied for nitrite and nitrate in Chapter 3, pages 32 and 33.

CURE ACCELERATOR LIMITS

The amounts listed in Table III, on the next page, are the permitted maximums for accelerators used alone ***and*** in combination in the curing of pumped, massaged, immersed, comminuted, and dried meat or poultry products other than bacon. Maximums for sodium ascorbate and sodium erythorbate (isoascorbate) in bacon are given in Chapter 3, page 28. The cure accelerators listed in Table III are also permitted in a 10% solution (up to the stated limit) to spray surfaces of cured cuts prior to packaging, as long as the use of the solution does not result in the addition of a significant amount of moisture to the product.

TABLE III
MAXIMUM INGOING CURE ACCELERATORS (IN PPM)
FOR MEAT AND POULTRY PRODUCTS

Cure Accelerator	Maximum Limit
Ascorbic Acid	469 ppm
Erythorbic Acid	469 ppm
Sodium Ascorbate	547 ppm
Sodium Erythorbate (isoascorbate)	547 ppm
Citric Acid or Sodium Citrate	may replace up to half of any one of the above

Fumaric acid is permitted as a cure accelerator at the maximum level of 650 ppm ***only*** in cured, comminuted meat and poultry products.

Glucono delta-lactone (GDL) and sodium acid pyrophosphate (SAPP) are each permitted as cure accelerators at the maximum level of 5000 ppm of the finished product in cured, comminuted ***meat products only***. ***Note:*** *SAPP is limited to 5000 ppm either alone* ***or*** *in combination with other cure accelerators. GDL is limited to 1% or 10,000 ppm in Genoa salami.*

CURE ACCELERATORS USED IN CURED, COMMINUTED PRODUCTS

Introduction

The amount of ingoing cure accelerator used in comminuted products, such as bologna, specific and nonspecific loaves, salami, etc., is based on the green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block) used in the product formulation. Shrink is not a factor. Calculations for cure accelerators are the same as those for nitrite described in Chapter 3, pages 12-19. Different limits apply, depending upon which cure accelerator is used.

! Example

Using the same wiener formula in the Procedure Table on page 13, calculate the amount of ingoing sodium erythorbate. The batch weighs 663 lb, and contains 0.422 lb of sodium erythorbate. The meat block weighs 500 lb.

► **Calculation**

$$\frac{\text{lb sodium erythorbate} \times 1{,}000{,}000}{\text{green weight of meat block}} = \text{ppm}$$

$$\frac{0.422 \times 1{,}000{,}000}{500} = 844 \text{ ppm sodium erythorbate}$$

This formulation ***is not*** in compliance because the permitted limit for sodium erythorbate is 547 ppm.

Alternatively, one could use the following calculation formula that uses the sodium erythorbate limit of **f** ounce/100 lb of meat and/or poultry and/or meat/poultry byproduct (meat block) to determine the maximum amount of sodium erythorbate that can be added to a known amount of meat block.

$$\frac{\text{green weight of meat block}}{100} \times 0.875 \text{ oz (} \mathbf{f} \text{ oz)} = \text{lb sodium erythorbate}$$

$$\frac{500 \text{ lb}}{100} \times .875 \text{ oz} = 4.375 \text{ oz or } 0.273 \text{ lb maximum amount of sodium erythorbate}$$

Comment

Any rework that already contains sodium erythorbate is not added to the green weight of the meat or poultry, since the weight of the sodium erythorbate has already been controlled in that previous batch.

CURE ACCELERATORS USED IN CURED, PICKLED PRODUCTS

Introduction

The amount of ingoing cure accelerators used in cured, pickled products, such as ham, corned beef, turkey ham, etc., is based on the ***green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block)*** used in the product formulation. Shrinkage is not a factor in the calculation. Calculations for cure accelerators are the same as those for nitrite described in Chapter 3, pages 19-24. Different limits apply, depending upon which cure accelerator is used.

! Example

Using the same cover pickle formula in the Procedure Table on page 23, determine whether the product is in compliance for sodium erythorbate. The pickle solution weighs 800 lb, and contains 2 lb of sodium erythorbate. Hams that are immersed in the cover pickle pickup 10% solution.

▸ **Calculation**

$$\frac{\text{lb sodium erythorbate} \times \text{\% pick-up} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

$$\frac{2 \text{ lb} \times .10 \times 1{,}000{,}000}{800 \text{ lb}} = 250 \text{ ppm sodium erythorbate}$$

This formulation ***is*** in compliance; the permitted limit is 547 ppm for sodium erythorbate.

REPLACING CURE ACCELERATORS WITH CITRIC ACID OR SODIUM CITRATE

Introduction

Citric acid or sodium citrate may replace up to 50% of cure accelerators (ascorbic acid, erythorbic acid, sodium ascorbate, or sodium erythorbate) used in the preparation of cured, pumped, massaged, immersed, comminuted, and dried meat and poultry products. Citric acid and sodium citrate cannot be used if no cure accelerators are being used.

- **Procedure Table**

The procedure table below will allow you to determine how much citric acid or sodium citrate can be used in place of a cure accelerator listed in Table III on page 35.

STEP	PROCEDURE	EXAMPLE
1	Determine the amount of cure accelerator being used in the product formulation, pickle solution, cure mix, etc.	3.6 lb (57.6 oz) of ascorbic acid in a pickle solution.
2	Determine the maximum amount of sodium citrate or citric acid that can be used to replace the cure accelerator by multiplying the amount of accelerator by 0.50 (50%).	3.6 lb × 0.50 1.8 lb (28.8 oz) citric acid or sodium citrate allowed
3	Subtract the permitted amount of citric acid or sodium citrate from the amount of cure accelerator being used, to determine the maximum amount of the cure accelerator permitted with the citric acid or sodium citrate.	3.6 lb - 1.8 lb (50%) 1.8 lb (28.8 oz) ascorbic acid allowed.

Chapter 5

PHOSPHATE CALCULATIONS

INTRODUCTION

Phosphates are frequently added to curing solutions and cured product formulations because of the numerous beneficial effects they have in meat and poultry curing. Phosphates increase the water retention (water binding capacity) of the meat and poultry, which reduces the shrinkage (moisture loss) and purge (cook-out) of pickle-cured and cured comminuted products during further processing. The improved water binding results from the reaction of the phosphate ions with the meat and poultry proteins. Phosphates also improve the sensory characteristics of the product (texture, juiciness, and tenderness), improve the stability and uniformity of the cure color, and suppress the development of rancidity in cured products.

There are several phosphates approved for use in meat and poultry products. They appear in the Tables of Approved Substances for meat and poultry [MPI Regulations sections 318.7(c)(4) and 381.147(f)(4)]. All of the phosphates are limited to 5000 ppm. There are no provisions in the regulations for variances from the 5000 ppm limit based on differences in the amount of dissociation among the various phosphate compounds.

PHOSPHATE LIMITS

Phosphates are permitted to be used at the level of "Sufficient for Purpose" as denuding agents, hog scald agents, and rendering agents in the meat regulations and as poultry scald agents in the poultry regulations. It is not necessary to calculate the amount of phosphate when it is used for these purposes.

Sodium acid pyrophosphate (SAPP), when used to accelerate color fixing in cured, comminuted meat and meat food products, is permitted at a level no greater than 8 ounces per 100 pounds of meat or meat byproduct content of the formula. (*Note: SAPP cannot be used to accelerate color fixing in a cured poultry product.)* When SAPP, or any other approved phosphate, is used to decrease the amount of cooked-out juices from a meat or poultry product, it is limited to a maximum of 5% in a pickle at a 10% pump level. Calculations of these two limits are based on the ***green weight of the meat block*** component of the product formulation. Shrink is not a factor in the calculation. The calculation methods are the same as that for nitrite in comminuted products and nitrite in pickle-cured products (refer to Chapter 3).

A phosphate used as a cure accelerator in a meat product is limited to 0.5% of the finished product. If used to protect flavor, it is limited to 0.5% of the total product. If used to decrease cooked-out juices in a meat product, it is limited to 0.5% in the final product, and if used to decrease cooked-out juices in poultry products, it is limited to 0.5% of the total product. Calculation of the phosphate maximums for these uses is based on the ***projected finished weight (PFW) of the product***.

If requirements in the previous paragraphs apply to the same product, the product must comply with whichever requirement is the most restrictive.

Note: *As stated in the regulations, phosphates are limited to "5% in a pickle at a 10% pump level", "0.5% in the finished product", "0.5% in the product", and "0.5% of the total product". As illustrated in Table I, pages 7 through 10, these limits are equivalent to 5000 ppm.*

PHOSPHATES USED IN COMMINUTED PRODUCTS

Introduction

Phosphates are permitted in meat and poultry products, unless otherwise prohibited by the regulations, to reduce the amount of cooked-out juices. For instance, phosphates are permitted in cooked sausage, but are not permitted in fresh sausage. Comminuted meat and poultry products such as cooked sausage, luncheon meat, specific and nonspecific loaves, etc., may contain 0.5% phosphates in the ***total or final*** product. The ***PFW*** is an acceptable basis for this calculation. The procedure tables below explain how to determine the maximum amount of phosphates allowed in such products. In order to determine phosphate compliance with the regulations at the time of formulation, you will need to determine a PFW. Refer to Chapter 14, pages 100-102, if you do not know how to calculate a PFW.

! **Procedure Table** (meat product)

STEP	PROCEDURE	EXAMPLE
1	Using establishment formulation records, calculate the projected finished weight for the product.	The PFW for the bologna product in Chapter 14, page 101, is 607.14 lb.
2	Determine the maximum amount of phosphates allowed by multiplying the PFW by the percent of phosphates allowed. Since 3 pounds of phosphates were used in the formula, this product ***is*** in compliance.	607.14 lb × .005 (0.5%) 3.03 lb is the maximum amount of phosphates allowed.

- **Procedure Table** (poultry product)

STEP	PROCEDURE	EXAMPLE
1	Determine the total batch weight of the establishment's formulation. This weight represents 100% of the product ingredients (if no "like product" rework is in the formula). ***Note:*** *Because of the "Binders Added" statement, ISP is not restricted in this product. If the statement was not on the label, then the weight of the ISP and its percent limit (3%) would also need to be subtracted in Step 2.*	Cooked White Turkey Rolls with Broth -- Isolated Soy Protein Added Turkey Breast Meat 300 lb Turkey White Trim Meat 300 lb Water 90 lb Turkey Skin 80 lb ISP 30 lb Salt 15 lb Seasoning 10 lb Sodium Phosphates 5 lb Total Batch Weight 830 lb
2	From this weight and percentage, subtract the weight and maximum percentage of the phosphate.	830 lb 100% − 5 lb Phosphates − 0.5% 825 lb 99.5%
3	To find the PFW, divide this weight by the percentage of the formula weight that it represents. ***Note****: The PFW could also have been determined by subtracting the* ***expected*** *pounds of shrink from the batch weight. Refer to page 101.*	825 ÷ .995 = 829.14 lb PFW
4	Determine whether or not the phosphates are in compliance by multiplying the PFW by the maximum percentage allowed and comparing the answer to the formula. OR Determine the percentage of the phosphates in the finished product by dividing the weight of the phosphates in the formula by the PFW, and then multiply the result by 100.	829.14 lb PFW × .005 (0.5%) 4.14 lb phosphates allowed Since 5 pounds of phosphates were used in the formula, this product ***is not*** in compliance. (5 lb ÷ 829.14) × 100 = 0.6% phosphates in the finished product.

PHOSPHATES USED IN PICKLED PRODUCTS

Introduction

Phosphates are permitted in meat and poultry products, unless otherwise prohibited by the regulations, to reduce the amount of cooked-out juices. Phosphates in pickle-cured meat and poultry products such as ham, corned beef, bacon, turkey ham, etc., are limited to 5% in a pickle at a 10% pump level, which is equivalent to 5000 ppm ingoing. The maximum phosphate limit is based on the green weight of the meat, meat byproduct, or poultry in the product formulation. Calculations for phosphate(s) are the same as those for nitrite in pickle-cured products. Refer to Chapter 3, pages 19-24.

! **Example**

Using the same pickle formula in the Procedure Table on page 20, calculate the amount of ingoing phosphate. The pickle solution weighs 1500 lb and contains 35 lb of phosphate. Semi-boneless hams are pumped at a level of 25%.

▸ **Calculation**

$$\frac{\text{lb phosphate(s)} \times \text{\% pump} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

$$\frac{35 \text{ lb} \times 0.25 \times 1{,}000{,}000}{1500 \text{ lb}} = 5833.33 \text{ ppm phosphate}$$

This product ***is not*** in compliance because the permitted limit for ingoing phosphate is 5000 ppm.

Chapter 6

BINDER AND EXTENDER CALCULATIONS

INTRODUCTION

Binders and extenders are used by the meat and poultry industry because they improve product quality and yield. Binders and extenders improve the sensory characteristics of the product (texture, juiciness, and flavor). Like phosphates, binders and extenders increase the water retention of the meat and poultry which reduces the shrinkage of cured comminuted products and purge of pickle-cured products during further processing. Improved water retention leads to higher product yields. When binders and extenders are included in a product's formulation, a higher product yield is attained because more pounds of product can be produced for a given weight of meat or poultry.

There are several binders and extenders approved for use in meat and poultry products. They appear in the Tables of Approved Substances for meat and poultry [MPI Regulations sections 318.7(c)(4) and 381.147(f)(4)]. Because binders and extenders affect the entire product and not just the meat and poultry portion, most calculations are based on the ***finished weight*** of the product. A ***projected finished weight (PFW)*** is an acceptable basis for calculation.

BINDER AND EXTENDER LIMITS

Various binders and extenders are permitted, individually or collectively, in comminuted meat products (sausages and bockwurst in Part 319 of the regulations) at a ***maximum level of 3.5% of the finished product weight***. Because of their high protein content, isolated soy protein (ISP) and sodium caseinate are limited to 2% of the finished product weight. Policy Memo 123 allows the use of water and binders and extenders ("fat reducing" ingredients) at higher levels in modified, substitute versions of standardized or traditional cooked, fermented, and breakfast sausages that have been formulated and processed to reduce the fat content to qualify for the use of a nutrient content claim, e.g., "Reduced Fat Frankfurter".

Various binders and extenders are permitted, individually or collectively, in comminuted meat products such as meat loaf, meat balls, and Salisbury steak at a ***maximum level of 12% of the finished product weight.*** Because of its high protein content, ISP is limited to 6.8% of the finished product weight.

Carrageenan is permitted in cured pork products labeled "Ham--Water Added" and "Ham and Water Product--X% of Weight is Added Ingredients" at a ***maximum level of 1.5% of the product formulation.*** Modified food starch, sodium caseinate, and ISP are permitted in cured pork products labeled "Ham--Water Added" and "Ham and Water Product--X% of Weight is Added Ingredients" at a ***maximum level of 2% of the product formulation.*** These binders and extenders ***cannot*** be used in combination.

Several binders may be individually or collectively added ***to poultry rolls*** in amounts ***not to exceed 3% (cooked rolls) or 2% (raw rolls)*** of the ***finished product weight.*** When binders are added in excess of these levels, a product name qualifier is required (refer to section 381.159).

Sodium caseinate is permitted in various cooked poultry products at a ***maximum level of 3% of the finished product weight.*** It is permitted in various raw poultry products at a ***maximum level of 2% of the finished product weight.*** Other binders and extenders are permitted in various ***poultry products*** at levels ***sufficient for purpose*** (unrestricted).

BINDERS AND EXTENDERS USED IN COMMINUTED MEAT PRODUCTS

Introduction

The procedure for determining compliance with the restrictions on binders and extenders in comminuted meat products is the same as that for phosphates. The procedure tables below explain how to determine the maximum amount of binders and extenders in comminuted meat products. In order to verify binder and extender compliance with the regulations at the time of formulation, you will need to determine a PFW. Refer to Chapter 14, pages 100-102, to learn how to calculate a PFW.

- ! **Procedure Table** (cured comminuted product)

STEP	PROCEDURE	EXAMPLE
1	Using the formulation record(s), calculate the projected finished weight for the product.	The PFW for the bologna product in Chapter 14, page 101, is 607.14 lb
2	Determine the maximum amount of binders and extenders by multiplying the PFW by the percent of binders and extenders allowed. OR Determine the percentage of the binders and extenders in the finished product by dividing the weight of the binder(s) and extender(s) in the formula by the PFW, and then multiply the result by 100.	607.14 lb × .035 (3.5% NFDM) 21.24 lb is the maximum amount of NFDM allowed. Since 18 lb of NFDM was used in the formula, this product ***is*** in compliance. (18 ÷ 607.14) × 100 = 2.96% NFDM in the finished product.

! **Procedure Table** (fresh comminuted product)

STEP	PROCEDURE	EXAMPLE
1	Determine the total batch weight of the establishment's formulation. This weight represents 100% of the product ingredients.	Bratwurst Sausage Pork Lean Trimmings 200 lb Pork Jowls (skinned) 100 lb Pork Fat 25 lb Water 10 lb Salt 8 lb ISP 3 lb White Pepper 1 lb Sage 8.00 oz Ground Celery Seed 4.00 oz Mace 3.75 oz BHA 0.25 oz Total batch weight 348 lb
2	From this weight and percentage, subtract the weight and the maximum percentage allowed of the restricted ingredient for which you are checking the product's compliance. ***Note:*** *When determining the projected finished weight, always subtract the weight of all the restricted ingredients that are based on finished product weight and the maximum percentage allowed of each ingredient.*	348 lb 100% - 10 lb Water 3% 338 lb 97% 338 lb 97% - 3 lb ISP 2% 335 lb 95%
3	To find the PFW, divide this weight by the percentage of the formula weight that it represents.	335 ÷ 0.95 (95%) = 352.63 lb PFW

4	Determine whether or not the ISP is in compliance by multiplying the PFW by the maximum percentage allowed and comparing the answer to the formula. OR Determine the percentage of the ISP in the finished product by dividing the weight of the ISP in the formula by the PFW, and then multiply the result by 100.	352.63 lb PFW <u>× 0.02 (2.0%)</u> 7.05 lb ISP allowed Since 3 pounds of ISP were used in the formula, this product ***is*** in compliance. (3 lb ÷ 352.63 lb) × 100 = 0.85% ISP in the finished sausage.

! ISP/Sodium Caseinate and Other Binders and Extenders Used in Combination

Because ISP and sodium caseinate contain more protein than other binders/extenders, 2% of ISP or sodium caseinate is equivalent to 3.5% of other binders and extenders. The regulations specify binders and extenders, singly or in combination, are limited to 3.5% of the finished product weight. Therefore, when ISP or sodium caseinate is used in addition to other binders and extenders in a formula, an adjustment must be made for the ISP or sodium caseinate.

- **Binders/Extenders Substituted for a Portion of ISP/Sodium Caseinate**

Suppose the establishment uses another binder in place of the other 4.05 lb of ISP allowed (7.05 lb allowed – 3 lb used) in the Bratwurst sausage formula on the previous page. To check compliance, you will need to convert the amount of binder to an equivalent amount of ISP. By dividing the amount of binder allowed (3.5%) by the amount of ISP allowed (2.0%), you obtain a constant value (1.75) that can be used to determine binder/ISP equivalency. Therefore, the binder equivalent of 4.05 lb ISP is:

4.05 lb ISP × 1.75 = 7.08 lb of another 3.5% limit binder is allowed

If the establishment formulates the bratwurst sausage with 3 lb of ISP, they could use up to 7.08 lb of another binder (except sodium caseinate) and not violate the 3.5% binder limit in the finished product.

- **ISP/Sodium Caseinate Substituted for Portion of Another Binder(s)/ Extender(s)**

Suppose the establishment uses 10 lb of the 21.24 lb of NFDM allowed in the formula of the bologna product in the Procedure Table on page 43. How much ISP or sodium caseinate could be used in the formula in place of the 11.24 lb of NFDM (21.24 lb – 10 lb) not used in the formula and be in compliance with the 3.5% limit? To check compliance, you will need to convert the amount of ISP or sodium caseinate to an equivalent amount of NFDM. By dividing the amount of ISP or sodium caseinate allowed (2.0%) by the amount of NFDM allowed (3.5%), you obtain a constant value (.57) that can be used to determine ISP/sodium caseinate/NFDM equivalency. Therefore, the ISP or sodium caseinate equivalent of 11.24 lb NFDM is:

$$11.24 \text{ lb NFDM} \times 0.57 = 6.40 \text{ lb ISP/sodium caseinate allowed}$$

If the establishment formulates the bologna with 10 lb of NFDM, they can use up to 6.40 lb of ISP/sodium caseinate and not violate the 3.5% binder limit in the finished product.

BINDERS USED IN PICKLE-CURED MEAT PRODUCTS

Introduction

Many meat and poultry products are pumped with a pickle solution in an amount equal to various percentages of the green weight. These products are normally packaged in clear plastic and enclosed by a vacuum seal. As the brine drains from the product, it settles in the package around the product. This drained brine solution may appear to consumers as excessive and may create an aesthetically unappealing product. As a result, some retailers remove and discard these products well before their shelf life expiration date, creating economic loses for both industry and consumers. None of the ingredients in the brine solution, either alone or in combination, serves to completely control the purging of the moisture in theses products.

FSIS permits the use of modified food starch, sodium caseinate, isolated soy protein, and carrageenan as binders individually, but not in combination, in cured pork products labeled as "Ham Water Added" and "Ham and Water Product--X% of Weight is Added Ingredients." The use of such binders reduces purging of the pumped brine solution from these products. Calculations for these binders are based on total product formulation.

Calculation Formula

$$\frac{\text{\% binder in pickle solution} \times \text{effective or actual \% pump}}{\text{\% yield}} = \text{\% binder in the product formulation}$$

Note: % pick-up or % gain could be substituted for effective or actual % pump in the above formula depending upon the method in which the pickle solution is applied.

Procedure Table

The procedure for determining compliance with the restrictions on binders in pickle-cured meat products ***is not*** the same as that for comminuted meat and poultry products. The procedure table on the next page explains how to determine the percentage of binder in a pickle-cured meat product. In order to determine binder compliance with the regulations at the time of formulation, you will need to determine the effective or actual % pump, the % yield, and the % of the binder in the pickle formula. Refer to Chapter 11, page 78, if you need assistance in calculating an effective or actual % pump. Refer to Chapter 13, pages 88-90, if you need assistance in calculating a % yield. Refer Chapter 14, page 91, if you need assistance in calculating the % of an ingredient in a formula.

<table>
<tr><th>STEP</th><th>PROCEDURE</th><th>EXAMPLE</th></tr>
<tr><td>1</td><td>Using establishment formulation records, calculate the percentage of the binder in the pickle formula.</td><td>ISP is added to the pickle formula in Chapter 14, page 91, at a level of 11%.</td></tr>
<tr><td>2</td><td>Determine the effective % pump, actual % pump, % pick-up, or % gain.</td><td>The effective % pump for the fifteen boneless hams in Chapter 11, page 78, is 19.11%.</td></tr>
<tr><td>3</td><td>Add the effective % pump, actual % pump, or % pick-up to 100% to obtain the % yield for the cured product.</td><td>Applying the pickle solution to the boneless hams increases their weight by 19.11% over the weight of the fresh uncured hams (100%). Therefore, the % yield for the cured boneless hams is:

19.11% + 100% = 119.11% yield</td></tr>
<tr><td rowspan="2">4</td><td>Substitute the % binder in the pickle formula, effective % pump, and the % yield into the calculation formula to solve for the % binder in the formulated product.</td><td>$\frac{11\% \times 19.11\%}{119.11\%} = 1.76\%$ ISP

There is 1.76% ISP in the boneless ham formulation.</td></tr>
<tr><td colspan="2">Note: Since 2% ISP is allowed in the boneless ham formulation, this product is in compliance.</td></tr>
</table>

Chapter 7

FLAVORING CALCULATIONS

INTRODUCTION

Flavor is of great concern to the meat and poultry processor. Spices, sweeteners, and liquid smoke added to meat and poultry mixtures impart flavor characteristics which make each product unique. Some sweeteners contribute more than just flavor. In cured meat or poultry products, sweeteners not only counteract the harshness of salt, but sweeteners such as corn syrup (CS) and corn syrup solids (CSS--dehydrated form of corn syrup) also increase water holding capacity (water retention) and casing peelability. Sugars (sucrose and dextrose) are the primary food source for starter cultures (lactic acid-producing bacteria) that produce the characteristic tangy flavor of fermented sausages. Hence, the primary function of sugar in these products is to drive the fermentation process.

There are several flavorings approved for use in meat and poultry products. They appear in the Tables of Approved Substances for meat and poultry [MPI Regulations, sections 318.7(c)(4) and 381.147(f)(4)]. Because flavorings affect the entire product and not just the meat and poultry portion, calculations for restricted flavorings are based on the ***finished weight*** of the product. A ***projected finished weight (PFW***) is an acceptable basis for calculation.

FLAVORING LIMITS

Sugars (sucrose and dextrose) are not limited because adding excessive amounts would make the product unpalatable (too sweet). Other sweeteners such as CS, CSS, malt syrup (MS), glucose syrup (GS) and sorbitol have restrictions on their use because they are not as sweet as sucrose or dextrose.

CS, CSS, MS, or GS are permitted, individually or collectively, in pickle-cured meat products not Protein Fat Free (PFF)-controlled or controlled by percent-added-solution ("X% Added Ingredients") labeling, and comminuted meat products (MS is allowed in ***cured*** comminuted meat products only), at a maximum level of 2% (dry basis), or 20,000 ppm of the ***finished weight*** of the product. Since CS and MS are 80% solids, they are permitted at the 2½% level (2% ÷ .8) or 25,000 ppm.

$$2\% = 0.02 \times 1{,}000{,}000 = 20{,}000 \text{ ppm}$$
$$2\% \div .80 \text{ (80\% solids)} = 2.5\% = 0.025 \times 1{,}000{,}000 = 25{,}000 \text{ ppm}$$

CS, CSS, MS, and GS are permitted in pickle-cured red meat products, such as hams. There are ***no restrictions*** on these sweeteners when they are used in PFF-controlled pork products or in meat products controlled by a percent-added-solution ("X% Added Ingredients") label statement. The finished product control on the added ingredients makes restrictions on individual ingredients unnecessary (refer to Chapter 10, pages 72-75).

CS, CSS, MS, and GS are permitted in various ***poultry products*** at levels ***sufficient for purpose*** (unrestricted).

As an exception to the rule, sorbitol is permitted for use in cooked comminuted red meat products at a maximum of 2% (dry basis) based on the ***weight of the formulation, excluding the water/ ice***. Sorbitol in solution is 70% solids. Therefore, the limit on sorbitol solids is 2% (20,000 ppm) of the formulated weight, excluding the water, and the limit on sorbitol in solution is 2.86% (2 ÷ .7) or 28,600 ppm of the formulated weight, excluding the water. ***Sorbitol is not permitted in poultry products.***

FLAVORINGS USED IN COMMINUTED MEAT PRODUCTS

Introduction

The procedure for determining compliance with the 2% (dry basis) restriction on sweeteners (except sorbitol) in comminuted meat products is the same as that for phosphates and binders and extenders. The procedure tables below explain how to determine the maximum amount of CS, CSS, MS, and GS in comminuted meat products. In order to verify CS, CSS, MS, and GS compliance with the regulations at the time of formulation, you will need to determine a PFW. Refer to Chapter 14, pages 100-102, to learn how to calculate a PFW.

! **Procedure Table** (cured comminuted product)

STEP	PROCEDURE	EXAMPLE
1	Using the formulation record(s), calculate the projected finished weight for the product.	The PFW for the bologna product in Chapter 14, page 101, is 607.14 lb.

2	Determine the maximum amount of restricted flavoring(s) by multiplying the PFW by the percent of flavoring(s) allowed. OR Determine the percentage of the flavoring(s) in the finished product by dividing the weight of the flavoring(s) in the formula by the PFW, and then multiply the result by 100.	607.14 lb × .02 (2% CSS) 12.14 lb is the maximum amount of CSS allowed. Since 15 lb of CSS was used in the formula, this product ***is not*** in compliance. (15 lb ÷ 607.14 lb) × 100 = 2.47% CSS in the finished product.

! **Procedure Table** (fresh comminuted product)

STEP	PROCEDURE	EXAMPLE
1	Determine the total batch weight of the establishment's formulation. This weight represents 100% of the product ingredients.	Italian Sausage Pork Trimmings 260 lb Pork Jowls (skinned) 140 lb Pork Fat 25 lb Water 12 lb Spice Mix (0.11% BHA) 11 lb Green Peppers 10 lb CS 6 lb Salt 3 lb Paprika 2 lb Dehydrated Parsley 1 lb Total batch weight 470 lb
2	From this weight and percentage, subtract the weight and the maximum percentage allowed of the ingredient in which you are checking compliance. ***Note:*** *When determining the projected finished weight, always subtract the weight of* ***all*** *of the restricted ingredients that are based on finished product weight and the maximum percentage allowed of each ingredient.*	470 lb 100% − 12 lb Water 3% 458 lb 97% 458 lb 97.0% − 6 lb CS 2.5% 452 lb 94.5%

3	To find the PFW, divide this weight by the percentage of the formula weight that it represents.	452 lb ÷ 0.945 (94.5%) = 478.30 lb PFW
4	Determine whether or not the CS is in compliance by multiplying the PFW by the maximum percentage allowed and comparing the answer to the formula. OR Determine the percentage of the corn syrup in the finished product by dividing the weight of the corn syrup in the formula by the PFW, and then multiply the result by 100.	478.30 lb PFW <u>× 0.025 (2.5%)</u> 11.95 lb corn syrup allowed Since 6 pounds of corn syrup were used in the formula, this product ***is*** in compliance. (6 lb ÷ 478.30 lb) × 100 = 1.25% corn syrup in the finished sausage.

! CSS and CS Used in Combination

Because it contains no water, 2% CSS alone is equivalent to 2½% CS in function. The regulations state that ***flavorings, singly or in combination, are limited to 2% (dry basis) of the finished product weight.*** Therefore, when CSS are used in a formula, in addition to CS, an adjustment must be made for the CSS.

▸ ***CSS* Substituted for a Portion of *CS***

Suppose the establishment uses CSS in place of the other 5.95 lb of CS allowed (11.95 lb allowed – 6 lb used) in the Italian sausage formula on the previous page. To check compliance, you will need to convert the amount of CSS to an equivalent amount of CS. By dividing the amount of CSS allowed (2%) by the amount of CS allowed (2.5%), you obtain a constant value (0.80) that can be used to determine CSS/CS equivalency. Therefore, the CSS equivalent of 5.95 lb CS is:

5.95 lb CS × 0.80 = 4.76 lb CSS is the maximum allowed

If the establishment formulates the Italian sausage with 6 lb of CS, they could use up to 4.76 lb of CSS and not violate the 2% (20,000 ppm) flavoring limit in the finished product.

▸ ***CS* Substituted for a Portion of *CSS***

Suppose the establishment uses 6 lb of the 12.14 lb of CSS allowed in the formula of the bologna product in the Procedure Table on page 50. How much CS could be used in the formula in place of the 6.14 lb of CSS (12.14 lb – 6 lb) not used in the formula and be in compliance with the 2% (20,000 ppm) limit? To check compliance, you will need to convert the amount of CS to an equivalent amount of CSS. By dividing the amount of CS allowed (2.5%) by the amount of CSS allowed (2.0%), you obtain a constant value (1.25) that can be used to determine CS/CSS equivalency. Therefore, the CS equivalent of 6.14 lb CSS is:

$$6.14 \text{ lb CSS} \times 1.25 = 7.67 \text{ lb CS is the maximum allowed}$$

If the establishment formulates the bologna with 6 lb of CSS, they can use up to 7.67 lb of CS and not violate the 2% (20,000 ppm) flavoring limit in the finished product.

Chapter 8

ANTIOXIDANT CALCULATIONS

INTRODUCTION

Oxidative rancidity occurs when the double bonds of polyunsaturated meat and poultry fats are exposed to oxygen (present in air) and undergo oxidation (breakdown) to form aldehydes, acids, and ketones. This process results in the development of "off" odors and flavors in the cooked product. Antioxidants are chemicals that react with oxygen before it can react with meat and poultry fats, and thereby retard oxidative rancidity and protect the flavor.

Antioxidants are normally added to food products as part of a mixture of specific antioxidants, a synergist, and a carrier. This mixture may be added in a dry form, for example, to a fresh sausage product or in a liquid form, for example, to a rendered product.

The base of control for antioxidant use varies with the product. For animal fats, dry sausage and dried meats, the amount of antioxidants (except for tocopherols) used is based on the ***total weight*** of the product. When antioxidants are added to fresh sausage and other fresh products, the amount is based on the ***weight of the fat content*** of the product at the time of formulation. A synergist, such as citric acid, may be used with antioxidants to increase their effectiveness.

ANTIOXIDANT LIMITS

As detailed in the MPI Regulations, section 318.7(c)(4), butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), tertiary butylhydroquinone (TBHQ), and propyl gallate are permitted in dry sausage singly at 0.003% on the basis of the ***total weight*** or 0.006% in combination. In rendered fat they are limited to 0.01% singly, or 0.02% in combination. Margarine may contain 0.02% antioxidants (singly or in combination). Dried meats may only contain 0.01% (singly or in combination), on the basis of the ***total weight***. ***Total weight*** has been interpreted to mean the weight of the formulation or batch weight.

In fresh sausage, other fresh meat products, and poultry products [MPI Regulations, sections 318.7(c)(4) and 381.147 (f)(4)], these antioxidants are limited to 0.01% singly, or 0.02% in combination, on the basis of the ***fat content of the product at the time of formulation.*** The establishment's ***target fat content*** of a product at the time of formulation is used for this calculation.

Tocopherols, as listed in section 318.7(c)(4) of the MPI Regulations, are limited to 0.03% in dry sausage, dried products, fresh sausage, and other fresh products on the basis of the ***fat content of the product at the time of formulation.*** They ***cannot*** be used in combination with other antioxidants. In section 381.147(f)(4) of the MPI Regulations, tocopherols are limited to 0.03% in various poultry products on the basis of the ***fat content of the product*** at the time of formulation. They ***can*** be used with any other approved antioxidant, but their limit is reduced to 0.02%. The establishment's ***target fat content*** for the product at the time of formulation is used for this calculation.

Note: *When antioxidants are part of a mixture, it is not necessary to calculate for each one. One calculation will be sufficient if the following rules are followed:*

(1) If no individual antioxidant or synergist is 50% or more of the total antioxidants in the mix, calculate for the total of all antioxidants using the .02% limit (.006% for dry sausage).

(2) If one individual antioxidant or synergist is 50% or more of the total antioxidants in the mix, calculate for that individual antioxidant or synergist using the .01% limit (.003% for dry sausage).

ANTIOXIDANTS INDIVIDUALLY ADDED TO MEAT AND POULTRY PRODUCTS

Procedure Table

The procedure below explains how to determine the maximum amount of an ***individual*** antioxidant allowed in products that have antioxidant restrictions based on the target fat content (fresh sausage, meatballs, etc.).

STEP	PROCEDURE	EXAMPLE
1	Determine the amount of product to which the antioxidant will be added and the target fat content of the product. *Note: If a fat target is not given by the establishment or the fat percentage cannot be computed from the meat or poultry ingredients used in the product's formulation (see pages 92 and 93), use the official fat analysis result of the product that had the lowest percent fat content as the target.*	Pork Sausage Pork trimmings 525 lb Water 16 lb Spice mixture (contains 0.40 oz BHA) 9 lb Total batch weight 550 lb Sausage is formulated to contain 40% fat.
2	Determine the amount of fat in the product at the time of formulation by multiplying the batch weight by the fat target percentage.	550 lb × .40 (40%) = 220 lb of fat in the product formulation.

3	To determine the maximum amount of antioxidant allowed, multiply the amount of fat by the antioxidant limit.	220 lb of fat × .0001 (.01%) 0.022 lb maximum BHA allowed
4	Convert the pounds of antioxidant to ounces by multiplying the answer in Step 3 by 16 (16 oz/lb).	0.022 lb maximum BHA allowed × 16 0.352 oz maximum BHA allowed Because the establishment used 0.40 oz of BHA, this formula ***is not*** in compliance.

Comment

To determine the ***maximum*** amount of an ***individual*** antioxidant allowed in products that have antioxidant restrictions based on the ***total weight of the product,*** multiply the batch weight by the antioxidant limit.

ANTIOXIDANTS ADDED TO MEAT AND POULTRY PRODUCTS AS A MIXTURE

Procedure Table

The procedure below explains how to determine the maximum amount of an ***antioxidant mix*** allowed in products that have antioxidant restrictions based on the total weight of the product (animal fats, dry sausage, dried meats, etc.). The product used for the example in the procedure table is rendered fat. Other products, such as dry sausage, will have different antioxidant allowances in Step 4.

STEP	PROCEDURE	EXAMPLE
1	Determine the amount of product to which the antioxidant is to be added.	1000 lb of lard
2	Determine the total content of the antioxidant/ synergist mixture and the percentage of each ingredient. Ingredients and their percentages are usually listed on the label of the antioxidant container.	BHA 25% BHT 8% Glycine 7% Propyl Gallate 7% Citric Acid 10% Carrier 43%

3	Determine what percentage of this mixture is made up of antioxidants.	BHA 25% BHT 8% Glycine 7% Propyl Gallate 7% 47%
4	CASE 1 If any one of the antioxidants or synergists makes up 50% or more of the antioxidant total, multiply the product weight by .0001 (.01%) to determine the amount of antioxidant allowed. CASE 2 If no single antioxidant or synergist makes up 50% of the antioxidant total, multiply the product weight by .0002 (.02%) to determine the amount of antioxidant allowed.	CASE 1 BHA (25%) makes up more than half of the antioxidant total (47% ÷ 2 = 23.5%). 1000 total weight × .0001 = 0.1 lb of antioxidant allowed CASE 2 *(different antioxidant mixture)* BHA 20% BHT 10% Glycine 10% Propyl Gallate 8% 48% No single antioxidant makes up half of the antioxidant total (48% ÷ 2 = 24%). 1000 total weight × .0002 = 0.2 lb of antioxidant allowed

5	CASE 1 Divide the amount of antioxidant allowed by the percent of the major antioxidant to determine the amount of antioxidant mixture that can be used. CASE 2 Divide the amount of antioxidant allowed by the percent of total antioxidants to determine the amount of antioxidant mixture that can be used.	CASE 1 0.1 lb ÷ 0.25 (25% BHA) = 0.4 lb (6.4 oz) maximum antioxidant mix allowed CASE 2 0.2 lb ÷ 0.48 (48% total antioxidants) = 0.4166 lb (6.66 oz) maximum antioxidant mix allowed

Comments

! To determine the ***maximum*** amount of an ***antioxidant mixture*** allowed in products that have antioxidant restrictions based on the ***weight of the fat content,*** determine the amount of fat in the formulation (see Steps 1 and 2 of the first procedure table), then follow Steps 2 through 5 of the second procedure table.

! An antioxidant (BHA, BHT, TBHQ, etc.) can never be added to a product in an amount greater than its individual limit (.01%, .003%, etc.) even when it is used in combination with other antioxidants, i.e., in a mixture. This is why the calculation for an antioxidant mixture is based on the .01% limit anytime an individual antioxidant makes up 50% or more of the total antioxidants in the mixture.

! A mixture of antioxidants prepared for a batch of fresh sausage containing 50% fat cannot be used in a fresh sausage batch of the same size containing 35% fat. The amount of antioxidants would have to be reduced to correspond with the reduced amount of fat.

Chapter 9

MAXIMUM AND MINIMUM MEAT OR POULTRY COMPONENT CALCULATIONS

HOW TO DETERMINE THE MAXIMUM AMOUNT OF BEEF CHEEK MEAT ALLOWED IN GROUND BEEF, HAMBURGER, AND FABRICATED STEAKS

Introduction

When beef cheek meat (trimmed beef cheeks) is used in the preparation of ground beef, hamburger, or fabricated steaks, the amount of cheek meat shall be limited to 25% [MPI Regulations, section 319.15(a)]. If the cheek meat exceeds natural proportions, its presence shall be declared on the label, either in the ingredients statement, or contiguous to the name of the product. Natural proportions is considered to be 2% or two trimmed cheeks per carcass. If the cheek meat is added in excess of 25%, cheek meat must appear in the product name, e.g., "Ground Beef and Beef Cheek Meat" (same size lettering). Heart and tongue meat are not acceptable ingredients in ground beef or hamburger.

Procedure Table

The procedure table below should be used to determine whether or not an establishment's formulation for ground beef, hamburger, or fabricated steaks that contains beef cheek meat is in compliance.

STEP	PROCEDURE	EXAMPLE
1	Check the formula to determine the weight of the beef cheek meat and other meat ingredients.	Ground Beef 225 lb beef trimmings 90 lb beef cheek meat 315 lb total ingredients
2	Since beef cheek meat ***cannot*** exceed 25% of the ingredients, you know that the other ingredients must constitute at least 75% of the formula. To determine what 100% of the formula would be if the maximum amount of beef cheek meat were to be used, divide by 75% (0.75).	225 lb = 75% 225 lb ÷ 0.75 = 300 lb

3	Subtract the weight of the other meat ingredients from that of the total ingredients to find the maximum amount of beef cheek meat allowed.	300 lb 100% – 225 lb – 75% 75 lb 25% maximum amount of cheek meat
	Note: Since the establishment had planned to use 90 lb of beef cheek meat, this formula would ***not*** be in compliance with beef cheek meat restrictions.	

Comment

This calculation is sometimes performed in a slightly different manner. The establishment may have a certain amount of beef cheek meat on hand and wish to use it up by adding beef to it. In this case your known amount, the weight of the beef cheek meat, is 25% of the formula ***at most.*** You can divide the weight of the beef cheek meat by 25% (0.25) to get 100% of the formula and then subtract the weight of the beef cheek meat from the weight of the total ingredients to find the ***minimum*** amount of beef that must be added.

ADDING SHANK MEAT TO CHOPPED HAM PRODUCTS

Introduction

The MPI Regulation section 319.105(b), Policy Memo (PM) 041B, and FSIS Directive 7124.1, state that the establishment may add ham shank meat to "chopped ham", "pressed ham", and "spiced ham" in the amount of 25% of that shank meat "normally present" in a ham. The amount of shank meat normally present has been set at 12% of the weight of the ham. An additional allowance of 25% would equal 3% (25 × .12) of the whole ham ingredient. Hence, a total of 15% shank meat is permitted in chopped ham products, which is 3% above the normal proportion of shank meat found in a whole ham.

Procedure Table

By using the procedure table below, one can determine if the amount of shank meat added to chopped ham product formulation complies with the regulation.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the whole ham ingredient(s) from the label transmittal form or establishment formulation records.	Chopped Ham Formula Boneless hams (shanks attached) 275 lb Boneless shankless hams 275 lb Boneless ham shank meat 125 lb

2	The first component of the formula has shanks attached. Since 12% shank meat is "normally present," only 3% shank meat would be allowed above the total weight of this component (15% permitted minus 12% present equals 3%). Therefore, the 275 lb of meat w/shanks represents 97% of the total weight. To find 100% of the weight, divide 275 lb by 0.97.	275 ÷ .97 (97%) = 283.50 lb (100%)
3	Subtract the amount of ham w/shank (97%) from the ham w/shank meat and added shank meat to determine the additional 3% shank meat allowed.	283.50 lb (100%) – 275.00 lb (97%) 8.50 lb (3%)-- maximum amount of shank meat that can be added
4	The second component of the formula contains no shank meat. The plant may add 12% shank meat normally present plus an additional 3% of the whole ham ingredient of the second component for a total 15% . The 275 lb of meat here represents 85% (100 – 15) of the total weight of this component. To find 100% of the weight, divide 275 lb by 0.85.	275 lb ÷ 0.85 (85%) = 323.52 lb of ham and shank meat
5	The amount of shank meat allowed would be 100% of the weight (with shanks) minus 85% of the weight (without shanks).	323.52 lb (100%) – 275.00 lb (85%) 48.52 lb (15%)--shank meat allowed to be added to 275 lb of ham (without shanks)
6	Thus the total amount of boneless shank meat that can be added is the sum of the answers in Steps 3 and 5. In this case, the amount the establishment planned to use (the third component of the formula) is far in excess of what regulations allow.	48.52 lb [added to ham (no shanks)] + 8.50 lb [added to ham (with shanks)] 57.02 lb--shank meat allowed to be added to the formula

HOW TO DETERMINE THE MAXIMUM AMOUNT OF POULTRY ALLOWED IN COOKED SAUSAGE PRODUCTS

Introduction

Cooked sausage products identified in section 319.180 of the MPI Regulations may contain poultry products which, individually or in combination, are not in excess of 15 percent of the ***total ingredients, excluding water and ice.***

The term "poultry products" includes:

- Poultry meat--MPI Regulations section 319.180(g)

  Deboned chicken or turkey meat ***without*** skin or added fat

- Chicken or turkey--MPI Regulations section 381.118

  Includes meat and edible parts such as skin and fat when not in excess of natural proportions

- Poultry byproducts--MPI Regulations section 381.1(c)

  Skin, fat, gizzard, heart, and liver

Procedure Table

The procedure below explains how to determine the maximum amount of poultry allowed in a cooked sausage product.

STEP	PROCEDURE	EXAMPLE
1	Determine the total batch weight of the establishment's formulation (from label transmittal form or formulation records) and subtract the water content.	663 lb wieners (see page 13) - 70 lb water/ice 593 lb
2	Subtract the weight of the poultry ingredients in the formula. Since poultry ingredients may make up to a maximum of 15% of the batch weight (excluding water), the answer in Step 2 must represent a minimum of 85% of the formula (excluding water).	593 lb (100%) - 40 lb chicken (15%) 553 lb 85%

3	To find the weight of 100% of the formula if the maximum amount of poultry is used, divide your answer by 85% (0.85).	553 ÷ 0.85 = 650.58 lb
4	Subtract your answer in Step 2 from that in Step 3 to find the maximum amount of poultry that could be used in this formulation.	650.58 lb (100%) - 553.00 lb (85%) 97.58 lb 15% maximum weight of poultry allowed
	Note: Since the establishment planned to use only 40 lb of chicken, this formula ***is*** in compliance with poultry restrictions.	

MEAT REQUIREMENTS IN CORNED BEEF HASH PRODUCTS

Introduction

MPI Regulation 319.303 is the standard by which corned beef hash is to be produced. This product is prepared with beef, potatoes, curing agents, seasonings, and other ingredients.

Either fresh beef, cured beef, canned corned beef, or a mixture of these ingredients may be used. There are two major meat requirements:

- The finished product ***must contain not less*** than 35% cooked beef.
- The weight of the cooked beef used in this calculation ***cannot exceed*** 70% of the weight of the uncooked fresh meat.

Procedure Table

The procedure table below will enable you to determine how much cooked meat must be in the finished product and the correct amount of uncooked fresh meat that should be used.

STEP	PROCEDURE	EXAMPLE
1	Find out how much cooked meat must be in the finished product by multiplying the batch weight by 35% (0.35).	500 lb batch × 0.35 175 lb cooked meat necessary

2	Now find out the ***minimum*** amount of fresh uncooked meat that must be used. The cooked meat weight can be no more than 70% of the uncooked fresh meat. So divide the weight of the cooked meat by 70% (0.70) to find the weight of the fresh uncooked meat.	175 lb cooked meat ÷ 0.70 = 250 lb of fresh meat minimum

Comment

In the example above, if cooked meat were to be used at the time of batching, you would know that 175 lb had to be added to the batch. Your only problem would be to make sure that the cooked meat was obtained from at least 250 lb of fresh meat.

If the establishment were to formulate the batch using fresh uncooked beef, you'd know that at ***least*** 250 lb would need to be added to get the proper percentage of cooked meat.

MEAT REQUIREMENTS IN SPAGHETTI AND MEAT BALLS WITH TOMATO SAUCE

Introduction

Section 319.306 of the MPI Regulations requires that a container labeled "Spaghetti and Meat Balls with Tomato Sauce" contain not less than 12 percent meat computed on the weight of fresh meat.

Procedure Table

The procedure table below will help you to determine if a formula meets this requirement.

STEP	PROCEDURE	EXAMPLE
1	Using the 12% requirement and the size of the container, determine how much meat is required per container by multiplying the container's net weight or contents by 0.12 (12%).	15.5 oz can × 0.12 (12%) 1.86 oz (meat required per can)
2	Find what percent of the meat ball formula is meat by dividing the weight of the meat by the weight of the meat ball formula.	100 lb meat 12 lb mix (salt, flour, spices) 3 lb water 115 lb meat ball formula weight 100 ÷ 115 = 87% meat in the batch

3	To find the required weight of the meat balls in each container, divide the weight of the meat required per container by the percentage of meat in the formula.	1.86 oz ÷ 0.87 (87%) = 2.137 oz of meat balls per container This product ***is*** in compliance if the weight of the meat balls in the containers is 2.137 oz or more.

HOW TO CALCULATE THE FRESH MEAT REQUIRED

Introduction

Several meat food products and poultry food products (chilies, stews, pies, soups, loaves, etc.) must contain a minimum amount of fresh meat or poultry and others require a minimum amount of cooked meat or poultry. Cooked meat or poultry may be substituted for fresh meat or poultry when fresh meat or poultry is not available.

Calculation Formula

Batch weight × % fresh meat or poultry required by standard = lb fresh meat or poultry required

Procedure Table

Use the procedure table below whenever it is necessary to determine or verify the weight of ***fresh*** meat or poultry required in a product.

STEP	PROCEDURE
1	Locate the product standard, on the approved label transmittal form, in the MPI regulations, or in the Standards and Labeling Policy Book. Note what percentage of fresh meat or poultry the product requires.
2	Determine the batch weight of the product from establishment formulation records.
3	Calculate the required weight of fresh meat or poultry in each batch by multiplying the batch weight by the percentage of fresh meat or poultry required.

Examples

! Product standard = 25% fresh meat
Batch weight = 700 lb

700 lb × 0.25 = 175 lb fresh meat required

- Product standard = 35% fresh poultry meat
  Batch size = 500 lb

  500 lb × 0.35 = 175 lb fresh poultry meat required

Comments

- Fresh meat or poultry must always be of the kind specified (beef, pork, mutton, chicken, turkey, etc.) in the product standard.

- Some establishments include a small percentage of meat or poultry in slurries or gravies. Such meat or poultry may be considered as a portion of the product's meat or poultry component.

SUBSTITUTING COOKED MEAT FOR FRESH MEAT

Introduction

Cooked meat may be used in meat food products although the product standard is stated in terms of fresh meat. The amount of cooked meat that is equivalent to the fresh meat required by a product standard should be determined by inspectional control. Chemical analysis can be used to supplement this control, but cannot be substituted for it.

Decision Table

	IF. . .	THEN. . .
	The required amount of fresh meat has been weighed and cooked at the processing plant AND you can verify that all the meat components were added to the batch formulation	accept the cooked meat as a replacement for the fresh meat required.
	The meat is ***not*** cooked at the plant OR you cannot verify the amount of fresh meat represented by the cooked meat	refer to the procedure table on the next page.

Calculation Formula

Batch weight × % fresh meat by standard = lb fresh meat required

lb fresh meat required × % fresh meat equivalency = lb cooked meat required

Procedure Table

The procedure table below explains how to determine the cooked meat equivalent of fresh meat.

<table>
<tr><th>STEP</th><th>PROCEDURE</th></tr>
<tr><td>1</td><td>Obtain the cooked meat sample laboratory analysis results from the establishment.</td></tr>
<tr><td>2</td><td>Compare the percentage of protein in the cooked meat with Table 2 of FSIS Directive 7124.1 and then find the range that it falls into in the first column.

Table 2 - Cooked Meat Equivalency Table
<table>
<tr><th>Laboratory results
Cooked meat protein
(Percent)</th><th>Fresh meat equivalency
of cooked meat
(Percent)</th></tr>
<tr><td>23.9 - under</td><td>100</td></tr>
<tr><td>24 - 28.9</td><td>75</td></tr>
<tr><td>29 - 31.9</td><td>62.5</td></tr>
<tr><td>32 - 35.9</td><td>56.25</td></tr>
<tr><td>36 - over</td><td>50</td></tr>
</table></td></tr>
<tr><td>3</td><td>Find the corresponding fresh meat equivalency percentage in the second column of Table 2.</td></tr>
<tr><td>4</td><td>Calculate the amount of cooked meat needed to substitute for fresh meat by multiplying this percentage by the amount of fresh meat required.</td></tr>
</table>

Example One

The product standard calls for 35% fresh meat. The batch weight is 650 lb. The amount of fresh meat required is 227.5 lb (650 lb × 0.35). The establishment wants to substitute cooked meat.

The protein percentage of the cooked meat as shown by the laboratory analysis is 26.2%. This puts it in the 24-28.9% range (column 1 of Table 2 above), which means that the weight of the cooked meat required as a substitute is 75% (column 2) of the fresh meat weight.

Thus 170.63 lb (227.5 lb × 0.75) of cooked meat will be required to substitute for 227.5 lb of fresh meat.

Example Two

The product standard calls for 50% fresh meat. The batch weight is 1000 lb. The amount of fresh meat required is 500 lb (1000 lb × 0.50). The establishment wants to substitute cooked meat. Determine cooked meat equivalence as follows.

The protein percentage of the cooked meat as shown by laboratory analysis is 34.1%. This puts it in the 32-35.9% range, which means that the weight of the cooked meat required (as a substitute) is 56.25% (column 2) of the fresh meat weight.

Thus 281.25 lb or 281 lb 4 oz (500 lb × 0.5625) of cooked meat will be required to substitute for 500 lb of fresh meat.

Comments

- To verify the validity of the establishment's cooked meat sample laboratory analysis, the inspector will send samples to the FSIS contract laboratory as often as deemed necessary.

- The Regulations state that fresh beef, canned corned beef, or cured beef may be used in preparing "corned beef hash." Therefore, inspection personnel must note the source of meat and other protein components on the laboratory forms.

HOW TO CALCULATE THE REQUIRED AMOUNT OF MEAT OR POULTRY ROLL TO USE

Introduction

Cooked meat or poultry rolls may be used in amounts necessary for cooked meat and poultry products to comply with product standards (FSIS Directive 7124.1).

Calculation Formulae

- The formula for calculating the amount of meat or poultry "roll" to use in a product to comply with a cooked meat or poultry requirement is:

  $$\frac{(PR)\,(CMR)\,(PY)}{RM} =$$ the % of meat or poultry that must be used in the product to comply with the cooked meat requirement

- The formula for calculating the amount of meat or poultry roll required in the batch is:

  Batch weight × % of meat/poultry roll required = lb meat/poultry roll required in the batch

Symbols

- PR = Protein Ratio
- CMR = Cooked Meat Requirements
- PY = Processing Yield (Rolls)
- RM = Raw Meat (percent in roll)

Protein Ratios

Cooked to Raw

Chicken	: 1.39
Turkey	: 1.31
Pork or Beef	: 1.44

Example One

Product - Sliced Beef and Gravy
Batch Size = 540 lb
Percent Cooked Meat Requirement = 50
Percent Processing Yield (meat roll) = 80
Percent Raw Meat in Roll (meat roll) = 85

Formula $\frac{(PR)\ (CMR)\ (PY)}{RM}$

$\frac{(1.44)\ (50)\ (80)}{85} = 67.76$ = the percent of meat roll that must be used in this product to comply with the 50 percent cooked meat requirement

To find the amount of meat roll required in the batch:

540 lb × .6776 = 365.9 lb (or 365 lb 14.4 oz) cooked meat roll required in the 540 lb batch.

Example Two

Product - Sliced Turkey and Gravy
Batch Size = 750 lb
Cooked Turkey Meat Requirement = 35 percent
Processing Yield of Turkey Roll = 85 percent
Raw Meat in Roll = 90 percent

Formula $$\frac{(PR)\ (CMR)\ (PY)}{RM}$$

$$\frac{(1.31)\ (35)\ (85)}{90} = 43.3 =$$ percent of turkey roll that must be used in this product to comply with the 35 percent cooked turkey meat requirement

To find the amount of turkey roll required in the 750 lb batch:

750 lb × .433 = 324.75 lbs (or 324 lb 12 oz) cooked turkey roll required in the 750 lb batch.

HOW TO DETERMINE THE MINIMUM MEAT PFF PERCENTAGE

Introduction

Protein Fat-Free (PFF) means the meat protein content expressed as a percent of the nonfat portion of the finished product. This definition allows the control of added ingredients by control of the meat protein in the nonfat portion of the cured pork product because anything added to the product dilutes the natural protein content. The PFF procedure reflects the presence of added ingredients, including water, and relates labeling claims to the percentage of meat protein in the product on a fat-free basis.

All data for monitoring the PFF compliance system will be on a computer that will provide assistance to the inspector. The computer will generate sample request forms, perform calculations, keep track of results, generate mathematical analyses of the process and compliance trends, and allow predictions of the potential for noncompliance. Nevertheless, there are occasions when the inspector must calculate the minimum PFF value. If the establishment is using an accredited laboratory to perform sample analyses, the inspector must calculate the minimum PFF value from the laboratory results. Furthermore, any time an inspector submits an "inspector-generated sample" because he or she has a strong suspicion that the product is adulterated or misbranded, he or she must calculate the minimum PFF value upon receiving the laboratory results.

Calculation Formula

PFF is a figure derived from laboratory analyses for protein and fat. The following formula is used to determine the PFF value of cured pork products from the laboratory results that are received:

$$\frac{\text{Percent Meat Protein by Analysis}}{100 - \text{Percent Fat by Analysis}} \times 100 = \text{PFF}$$

Example

Meat Protein = 18.60
Fat = 10.10

$$\frac{18.60}{100 - 10.1} = .20689 \times 100 = 20.689 \text{ or } 20.7$$

(PFF Percentage is rounded to the nearest thousandths, then hundredths, and then tenths)

Note: *If you need additional information on the PFF compliance system, refer to the PFF Guide.*

PROTEIN FAT FREE ADJUSTED FOR USE

Introduction

Protein Fat Free (PFF)-controlled cured pork products with qualifying statements, e.g., "Ham-Water Added", may be used in place of PFF-controlled cured pork products without qualifying statements, e.g., "Ham", to meet the minimum meat requirements of various products. However, the amounts of the PFF-controlled pork products with qualifying statements will need to be increased. For example, if a standard of identity requires a certain amount of ham, and a processor wants to use "Ham-Water Added", a greater amount of the "Ham-Water Added" will be needed to meet the standard. The magnitude of the amount is directly related to the relationship between the respective PFF values.

Calculation Formula

$$\frac{\text{\% cured pork required by standard} \times \text{its PFF value}}{\text{substituted cured pork product's PFF value}} \times 100 = \text{Required \% of substituted cured pork product}$$

Procedure Table

The procedure table below will help you determine the percentage of cured pork required in a standardized product when a processor substitutes a PFF-controlled cured pork product with a qualifying statement for one without a qualifying statement.

STEP	PROCEDURE	EXAMPLE
1	Examine the Standards and Labeling Policy Book or policy memos to determine the percent and type of PFF-controlled cured pork product needed in the formula.	Ham salad requires 35% cooked ham.
2	Identify what PFF-controlled cured pork product the processor will use in place of the ham.	"Ham-Water Added" will be used in the formula.
3	Identify the minimum PFF percentage for the cured pork product identified in the product's standard and for the cured pork product used to formulate the product from the Table in section 319.104 of the regulations.	The minimum PFF percentage (value) for "ham" is 20.5 and for "ham-water added" is 17.0.
4	Multiply the percentage of ham required in the product by the PFF value of ham. Divide this result by the PFF value of the cured pork product being used to formulate the product.	$\frac{0.35\ (35\%) \times 20.5}{17.0} = 0.4220$
5	Convert the result from step 4 to a percentage by multiplying by 100.	0.4220 × 100 = 42.2% "Ham-Water Added" needed in the formula

Comment

To determine the percentage of "Ham with Natural Juices" that is required to formulate ham salad, insert the PFF value for "Ham with Natural Juices" (18.5) in place of 17.0 in the above procedure table. Ham salad would need to be formulated with 38.8% "Ham with Natural Juices".

Chapter 10

PRODUCTS LABELED-- "X% WATER" OR "X% OF WEIGHT IS ADDED INGREDIENTS"

INTRODUCTION

Cooked cured beef products [covered under the MPI Regulations, sections 319.100-102 and policy memo (PM) 84A], turkey ham products (covered under section 381.171 of the MPI Regulations and PM 57A), pork products (not covered under the PFF regulations, e.g., snouts, hocks, feet, etc.--see PM 84A), and other ***cooked uncured meat products*** that weigh more than the green weight of the meat article or turkey thigh meat prior to curing and cooking or cooking must be descriptively labeled to indicate the presence and amount of added ingredients (solution) as part of the product name. "Cooked Corned Beef and X% Water", "Turkey Ham and Water Product-- X% of Weight is Added Ingredients", and "After Cooking, Contains X% of a Seasoning Solution of ...." are examples of acceptable product names. The ***percent*** of added ingredients in the ***finished product*** is inserted as the "X" value.

The ***percent*** of added ingredients in the ***finished product*** is inserted as the "X" value for ***both cooked and uncooked cured pork products*** listed in sections 319.104 and 319.105 of the MPI regulations that have the presence and amount of added ingredients declared as part of the product name, e.g., "Ham and Water Product-- X% of Weight is Added Ingredients".

Uncooked cured beef products (covered under the MPI Regulations, sections 319.100, 102, and 103) and pork products not covered under the PFF regulations (PM 66C) may contain up to 10% added ingredients (solution) without a label declaration. If more than 10% added ingredients are added, the presence and amount of the added ingredients must be declared as part of the product name. If more than 20% added ingredients are added to beef brisket (MPI Regulations, section 319.102), the presence and amount of the ingredients must be declared as part of the product name. "Cured Pork and X% Added Water" and "Corned Beef Brisket and Water Product-- X% of Weight is Added Ingredients" are examples of acceptable names. The ***percent*** of added ingredients or % gain ***above the green weight*** of the product is inserted as the "X" value.

Inspection personnel are responsible for monitoring the percent of added ingredients inserted into the "X" value of products labeled "X% Water", "X% of Weight is Added Ingredients", etc.

UNCOOKED MEAT PRODUCTS CONTAINING ADDED INGREDIENTS (SOLUTIONS)

Calculation Formula

Use the following formula to verify that an uncooked (cured or uncured) beef product or uncooked (cured or uncured) pork product not PFF-controlled complies with the label percentage declaration of "Weight is Added Ingredients", etc.

$$\frac{\text{(pumped, massaged, or treated) weight - green weight}}{\text{green weight}} \times 100 = \%\ \text{added ingredients}$$

Note: Pumped weight, massaged weight or treated weight could be inserted into the above formula, depending upon the processing procedures performed at the establishment, e.g., ***treated weight*** is used when the product is dipped or submerged in the solution; ***pumped weight*** is used when the solution is injected into the product.

Procedure Table (uncooked meat product)

The procedure table below will enable you to determine the percentage of added ingredients in an uncooked (cured or uncured) meat product.

STEP	PROCEDURE	EXAMPLE
1	Determine the green weight of a given number of pieces of fresh uncured product or an amount of fresh uncured product that will represent the lot.	Corned Beef and Water Product--25% of Weight is Added Water, Salt, Sodium Phosphate, and Sodium Nitrite. A vat of fresh uncured beef shoulder clods weighs (less the tare) 127.8 lb.

2	Determine the weight of the ***same*** pieces or vat of meat after pumping, massaging, or immersing. If a drain time is listed in the establishment's approved procedure, allow the pumped/treated product to drain for the specified time period and then weigh. If no drain is listed, take the weight directly after pumping, etc. ***Note:*** *If the product is trimmed after pumping, massaging, or immersing, the weight of the trimmings must be added back to the pumped, massaged, or immersed weight.*	After ***pumping*** the same vat of beef shoulder clods weigh 159.6 lb.
3	Subtract the green weight of the product from the pumped product weight.	159.6 lb – 127.8 lb = 31.8 lb
4	Divide this weight by the green weight of the product.	31.8 lb ÷ 127.8 lb = 0.2488
5	Convert the decimal answer into the percent of added ingredients by multiplying by 100.	0.2488 × 100 = 24.88% is the amount of added ingredients. Since 25% added ingredients is claimed, this product ***is*** in compliance.

COOKED MEAT AND POULTRY PRODUCTS, AND SPECIFIC COOKED AND UNCOOKED PORK PRODUCTS CONTAINING ADDED INGREDIENTS (SOLUTIONS)

Calculation Formula

Use the following formula to verify that a cooked (cured or uncured) beef product, cooked cured pork product not PFF-controlled, cooked turkey ham product, or cooked or uncooked cured pork product listed in sections 319.104 and 319.105 of the regulations complies with the label percentage declaration of "Weight is Added Ingredients", etc.

$$\frac{\text{finished weight - green weight}}{\text{finished weight}} \times 100 = \text{\% added ingredients}$$

Note: For ***uncooked*** cured pork products listed in sections 319.104 and 319.105 of the regulations, pumped weight, massaged weight, or treated weight will be substituted for finished weight in the above formula, depending upon the processing procedures performed at the establishment**.**

Procedure Table

The procedure table below will enable you to determine the percentage of added ingredients in the finished product.

STEP	PROCEDURE	EXAMPLE
1	Determine the green weight of a given number of pieces of fresh (unpumped or untreated) meat or turkey (turkey ham product only) or an amount of fresh (unpumped or untreated) meat or turkey product that will represent the lot.	Cooked Corned Beef Brisket and Water Product--10% of Weight is Added Water, Salt, Sodium Phosphate, and Sodium Nitrite. A vat of fresh uncured beef briskets weighs (less the tare) 161.4 lb.
2	Determine the weight of the ***same*** product after pumping/treating or chilling. You will need to maintain control of the meat or poultry through pumping, massaging, or immersing, and the subsequent cooking and chilling processes.	After ***chilling***, the ***same*** beef briskets weigh 178.7 lb. This is the finished product weight.
3	Subtract the green weight from the finished product weight.	178.7 lb – 161.4 lb = 17.3 lb
4	Divide this weight by the finished product weight.	17.3 lb ÷ 178.7 lb = 0.0968
5	Convert the decimal answer into the percent of added ingredients by multiplying by 100.	0.0968 × 100 = 9.68% is the amount of added ingredients. Since 10% added ingredients is claimed, this product ***is*** in compliance.

Chapter 11

PUMP/PICK-UP/GAIN CALCULATIONS

INTRODUCTION

Water-based and/or oil based solutions (curing, tenderizing, marinating, basting, etc.) can be added to various raw meat and poultry cuts or products. These solutions are added by pumping (injecting), tumbling, massaging, dipping, or immersing to impart favorable quality attributes and sensory characteristics to the finished product. Establishments ***must*** develop written processing procedures for PFF-controlled ***cured*** pork products, ***cured*** beef products, ***cured*** poultry products, ***cured*** beef and pork--"X% Added Ingredient" products, pickle-***cured*** pork bellies, etc., that at a minimum list the ingredients (names and weights) used to formulate the pickle solution and the ***targeted*** percent pump/pick-up.

Inspection personnel must perform pump, pick-up, or gain tests to verify that the amount of solution added to the product is in accordance with the regulations, approved procedures, or approved labels. ***Percent pump, percent pick-up, and percent gain*** are terms that represent the amount of weight gained (above the green weight---- expressed as a percent) by a meat or poultry cut or product when treated with a solution. Which term is used usually depends on the method of applying the solution, e.g., ***pick-up*** is used when the meat or poultry is submerged in the solution and ***pump*** is used when the solution is injected into the meat or poultry. ***Percent gain*** is a general term and is often used in place of percent pump or percent pick-up.

Curing solutions

There are a number of meat products that have specific regulatory limits for the amount of water that can be gained or picked-up from a curing solution. For example:

- **!** The application of curing solution to beef brisket shall not result in an increase (gain) in the weight of the finished cured product of more than 20% over the weight of the fresh uncured brisket--MPI Regulations, section 319.101. In other words, the green weight of the product cannot be increased by more than 20%. Refer to Chapter 10, if the establishment is producing uncooked beef briskets that exceed the 20% limit.

- The application of curing solution to beef cuts (except beef briskets) or beef tongue shall not result in an increase (gain) in the weight of the finished cured product of more than 10% over the weight of the fresh uncured beef cut or tongue--MPI Regulations, sections 319.102 and 319.103. In other words, the green weight of the product cannot be increased by more than 10%. Refer to Chapter 10, if the establishment is producing uncooked beef cuts or beef tongues that exceed the 10% limit.

- The application of curing solution to ***dry salt cured*** pork bellies/jowls and pork products not covered by the PFF regulations shall not result in an increase (gain) in the weight of the finished cured product of more than 10% over the weight of the fresh uncured pork belly/jowl or pork article. In other words, the green weight of the bellies/jowls or pork article cannot be increased by more than 10%.

Tenderizing (proteolytic enzyme) solutions

A solution consisting of water and an approved proteolytic enzyme(s) applied to or injected into raw meat and poultry cuts shall not result in a gain (pump or pick-up) of more than 3% above the green weight of the cut or product--MPI Regulations, sections 318.7, 381.147, and PM 66C.

Marinating/basting solutions

- Marinating or basting solutions added to raw meat cuts shall not result in a gain (pump or pick-up) of more than 10% above the green weight of the cut or product. If a product is treated with an enzyme solution and a flavoring solution, separately or in one step, the combined tenderization/marination solutions are limited to 10%--PM 66C.

- Marinating or basting solutions added to raw bone-in poultry and boneless poultry cuts shall not result in a gain (pump or pick-up) of more than 3% and 8% above the green weight of the cut or product, respectively--MPI Regulations, section 381.169, PM 42 and 44A.

Note: A qualifying statement that includes the percentage of solution contained in the product must be contiguous to the product name, e.g., "Marinated with Up to 8% of a Solution of Water, Salt, and Sugar."

Miscellaneous Solutions

Water-based and/or oil-based solutions may be added to raw bone-in or boneless meat and poultry cuts at various levels unless such use is forbidden or otherwise restricted by policy or regulation. The product name must be qualified with a statement indicating that the addition of solution has taken place, e.g., "Injected with Up to 12% of a Flavoring Solution." The terms "marinated", "basted", and "for flavoring" cannot be used on the label if the level of solution added is more than needed to marinate, baste, flavor, etc., (see requirements above)--PM 42, 44A and 66C.

HOW TO DETERMINE PERCENT GAIN

Calculation Formula

$$\frac{\text{(pumped, treated, or massaged) weight - green weight}}{\text{green weight}} \times 100 = \%\ \text{gain}$$

Note: Pumped weight, treated weight, or massaged weight can be in inserted into the above formula depending upon the method in which the solution is applied, e.g., ***treated weight*** is used when the product is dipped or submerged in the solution; ***pumped weight*** is used when the solution is injected into the cut.

Procedure Table

The following procedure allows you to compare a product's green weight with its pumped, treated, or massaged weight to determine the percent gain.

STEP	PROCEDURE	EXAMPLE
1	Determine the green weight of a given number of pieces of fresh (unpumped, untreated, etc.) meat or poultry or an amount of fresh (unpumped, untreated, etc.) meat or poultry product that will represent the lot.	Fifteen boneless hams to be pickle-cured weigh 227.6 lb.
2	If a drain time is listed in the establishment's approved procedure, allow the pumped/treated product to drain for the specified time period and then weigh. If no drain time is listed, take the weight directly after pumping.	After ***pumping***, the ***same*** fifteen boneless hams weigh 271.1 lb.
3	Subtract the green weight from the pumped or treated weight to obtain the pounds gained.	271.1 lb - 227.6 lb 43.5 lb gained
4	Divide the pounds gained by the green weight.	43.5 lb ÷ 227.6 lb = 0.1911
5	Convert the decimal answer into the percentage of gain by multiplying by 100.	0.1911 × 100 = 19.11% gain In this case 19.11% could also be referred to as the ***effective*** percent pump (if product is drained) or ***actual*** percent pump (if product is not drained). For an explanation of effective or actual percent pump, refer to the Glossary.

Comments

- ! When performing gain tests to ensure ***added solution*** compliance, the inspection program employee should use the ***same*** unpumped or untreated and pumped or treated pieces of meat or poultry to determine the % gain. If the effective or actual % pump/pick-up is greater than the targeted % pump/pick-up, the inspection program employee will retain the product represented by the gain test sample until it is drained to the targeted % pump/pick-up.

- ! The inspection program employee, under certain circumstances, e.g., the scale and pumping or injecting apparatus are not in the same area or room, ***may*** select and weigh pumped or treated pieces of meat or poultry before selecting fresh unpumped or untreated pieces ***provided*** that the pieces have been lotted into 2-to-3 lb weight ranges.

  - ▸ For PFF-controlled cured pork products, heat processed pickle-cured pork bellies/jowls, cooked cured beef products, etc., FSIS will permit an ***allowance of up to plus or minus 20%*** of the ***targeted % pump/pick-up*** before action is required because different pieces of meat or poultry were used to calculate the effective or actual % pump/pick-up. In addition, FSIS has finished product regulatory requirements and process control procedures in place for these products, e.g., Absolute Minimum PFF value/PFF value cusum charts, bacon yield difference charts, and 100% maximum yield or approved label declaration. For example, if the boneless hams in the Procedure Table on page 78 were grouped into a 2-to-3 lb weight range and had a 16% targeted pump, they would still be considered in compliance for ***added solution*** because the effective or actual % pump (19.11%) is less than the adjusted targeted % pump [16.0 × .20 (20%) = 3.2 + 16.0 = 19.2%]. However, if a consistent pattern of overpumping or underpumping (indicates lack of process control) is identified, then the inspection program employee shall request that establishment management submit a ***new procedure*** to reflect the effective or actual pumping percentage. Whenever the effective or actual % pump ***is more than 20% above*** the targeted % pump/pick-up on the procedure chart, the inspection program employee will retain the product until it is drained to the ***targeted*** % pump.

  - ▸ For ***"raw"*** cured beef products, cured pork products not covered by the PFF regulations, cured pork bellies/jowls, and other meat or poultry products that contain added solutions, FSIS will permit an ***allowance of up to plus or minus 20%*** of the ***targeted % pump/pick-up "provided"*** that the 20% allowance ***does not*** violate the maximum amount of solution allowed in the product, i.e., the standard of identity for the product. Products with an effective or actual % pump/pick-up within the 20% allowance but violate the added solution standard for the product will be retained until they are drained to the percentage required in the standard of identity. For example, if dry salt cured jowls that were targeted to have a 10% pump had an 11.5 % effective pump, they would be out of compliance for ***added solution*** even though they were within the 20% allowance 10.0 × .20 (20%) = 2.0 + 10.0 = 12%] because the standard (10% maximum added solution) for the product was exceeded. The jowls must be retained until they drain to 10% or less added solution.

Whenever the effective or actual % pump ***is more than 20% above*** the targeted % pump/pick-up without violating the product standard, the inspection program employee will retain the product until it is drained to the target % pump. For example, if beef briskets that were targeted to have a 15% pump had a 19% effective pump, they would be considered out of compliance with the establishment's procedure for the addition of solution and would be retained until they drained to 15% or less added solution. If a consistent pattern of overpumping or underpumping (indicates lack of process control) is identified, then the inspection program employee shall request that establishment management submit a ***new procedure*** to reflect the effective or actual pumping percentage.

HOW TO DETERMINE THE MAXIMUM PERCENT PUMP

Introduction

To verify that the level of ingoing restricted ingredients (curing agents, cure accelerators, phosphates, etc.) in a pickle formula are in compliance, one can determine the maximum % pump for each restricted ingredient and compare it to the targeted % pump. The listed target % pump ***shall never be greater than*** the maximum % pump allowed for any restricted ingredient in the solution. To verify restricted ingredient compliance at the time of pumping, the effective or actual % pump must be compared to the maximum % pump allowed for the pickle solution.

Calculation Formula

$$\frac{\text{lb restricted ingredient} \times \text{\% pump} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

Procedure Table

The following procedure table may be used for determining the maximum percent pump allowed for each restricted ingredient in a pickle or curing solution.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the total weight of the pickle solution, and the percent pump from the label transmittal form or the establishment's approved procedure record/chart. *If any two of these quantities are known, the third can be calculated by substituting the known values into the formula.*	Pickle Formula Water 1310.00 lb Salt 132.00 lb Dextrose 18.00 lb Phosphate 35.00 lb Sodium Erythorbate 3.25 lb Sodium Nitrite 1.75 lb Total 1500.00 lb Beef briskets are pumped with 16% solution.
2	Substitute the weight of the nitrite, the weight of the pickle solution, and the ppm limit for nitrite (200 ppm) into the formula and solve for ***n***, the maximum percent pump. *For further explanation of this formula, refer to the Appendix, Solving Equations that Have an Unknown Value, pages 115 to 123.*	We have 1.75 lb of nitrite in 1500 lb of solution that is to be pumped into beef briskets at a targeted level of 16%. However, what would be the maximum % pump allowed in the event the establishment exceeded the target % pump? $200 = \frac{1.75 \times n \times 1{,}000{,}000}{1500}$ $n = \frac{200 \times 1500}{1.75 \times 1{,}000{,}000} = 0.1714$
3	Convert the decimal answer into the percentage of gain by multiplying by 100.	0.1714 × 100 = 17.14 % is the maximum pump % level for nitrite.

Comments

! If you substituted the weights and maximum permitted levels (in ppm) of phosphate and sodium erythorbate into the Procedure Table above, you would obtain a maximum % pump of 21.42% for phosphate and 25.24% for sodium erythorbate. Although three different maximum % pump levels exist for this pickle solution, 17.14 % would be the maximum % pump level allowed for this solution because the ingoing nitrite limit would be exceeded at any % pump greater than 17.14%.

! As stated before, restricted ingredient compliance ***must be*** monitored at the time of pumping. Monitoring at this point helps assure that the pumping machine is in proper adjustment, draining procedures are followed, etc. This can be done by determining the effective or actual % pump (refer to "How to Determine Percent Gain" of this chapter) and comparing it with the maximum % pump for the pickle solution. For example, if the boneless hams on page 78 were pumped with the pickle solution in Step 1 of the Procedure Table on page 81, they would be out of compliance for ingoing nitrite because the effective or actual % pump (19.11%) is greater than the maximum % pump (17.14%) for the pickle solution.

When verifying the level of ***ingoing restricted ingredients*** at the time of pumping, the inspection program employee should use the ***same*** unpumped and pumped pieces of meat or poultry to determine the effective or actual percent pump. The inspection program employee, under certain circumstances, e.g., the scale and pumping or injecting apparatus are not in the same area or room, may select and weigh pumped pieces of meat or poultry before selecting fresh unpumped pieces provided that the pieces have been lotted into 2-to-3 lb weight ranges. In this case, FSIS will permit an ***allowance of up to plus or minus 20%*** of the ***maximum % pump*** before action is required because different pieces of meat or poultry were used to calculate the effective or actual % pump. For instance, if the boneless hams in the Procedure Table on page 78 were grouped into a 2-to-3 lb weight range and pumped with the pickle solution in Step 1 of the Procedure Table on page 81, they would still be in compliance for ***ingoing nitrite*** because the effective or actual % pump (19.11%) is less than the adjusted maximum % pump [17.14 × .20 (20%) = 3.42 + 17.14 = 20.56%]. However, if a consistent pattern of underpumping or overpumping (indicates lack of process control) is identified, then the inspection program employee shall request that establishment management submit a ***new procedure*** to reflect the new pickle formula and/or the effective or actual pumping percentage. Whenever the effective or actual % pump ***is more than 20% above*** the maximum % pump, the inspection program employee will retain the product until it is drained to the ***targeted %*** pump.

! Each restricted ingredient's compliance at the time of pumping could also be verified by inserting its weight, ***the effective or actual % pump,*** and the weight of the pickle solution into the formula in Step 2 of the Procedure Table on the previous page and solving for ppm.

HOW TO DETERMINE THE MAXIMUM AMOUNT OF GAIN

Introduction

Meat or poultry cuts dipped or submerged into, or injected with, tenderizing, marinating, and/or flavoring solutions ***must not*** gain more than the percentage (3%, 8%, 10%, etc.) allowed by regulation or on the approved label over the untreated product weight (green weight).

Procedure Table

The procedure table below will assist you in determining the maximum amount of gain.

STEP	PROCEDURE	EXAMPLE
1	Multiply the green weight of the meat or poultry to be pumped/treated by the allowed amount of gain -- 3% (.03), 10% (.10), 15% (.15).	Ten 16-oz T-Bone steaks-- "Tenderized with Papain" 160 oz meat (10 × 16 oz = 160 oz) × .03 (3%) 4.8 oz gain permitted
2	Add the untreated (green) weight and the permitted gain to get the total maximum weight of the treated product.	160.0 oz + 4.8 oz 164.8 oz or (10.3 lb) would be the maximum amount the ten steaks could weigh after being treated.

HOW TO DETERMINE THE GREEN WEIGHT WHEN THE PUMPED/TREATED WEIGHT AND PERCENT GAIN ARE KNOWN

Introduction

When corned (cured) beef products and cured pork products (not covered by PFF regulations) are cooked, the weight of the finished product ***shall not*** exceed the weight of the fresh uncured beef or pork cut, unless the presence and amount of added ingredients is indicated on the label . Inspection personnel will verify that the cooked weight does not exceed the green weight for those products that do not carry a qualifying statement in or contiguous to the product name.

Some establishments are pickle curing bone-in meat cuts, subsequently boning them, and using the boned materials (e.g., whole muscle, trimmings, and fat) in various products. Anytime a portion of muscle is removed from a pumped or treated bone-in meat cut and used in a cooked or uncooked meat product with the presence and amount of added ingredients indicated on the label, inspection personnel will need to calculate the green weight of the muscle that has been removed in order to verify the label claim. Once the green weight has been determined, one can insert it into one of the formulae in Chapter 10 to verify the compliance of the percentage ("X" value) in the qualifying statement.

When cured pork or beef trimmings are ingredients in sausage formulations that also contain ingredients that are limited on the basis of projected finished weight such as corn syrup and various binders and extenders, the pork or beef trimmings' green weight must be calculated so that the amount of water from the curing solution can be removed when determining the sausage's projected finished weight (refer to pages 100-102).

Calculation Formula

$$\frac{\text{(pumped, massaged, or treated) weight}}{\%\text{ gain} + 100\%} = \text{green weight}$$

Note: Pumped weight, treated weight, or massaged weight can be in inserted into this formula depending upon the method in which the solution is applied. Likewise, % pump or % pick-up could be inserted for % gain.

Procedure Table

The following procedure allows you to find a product's green weight when the pumped weight and percent gain are known.

In this example, the pumped weight is 220 lb and the percent gain is 10%.

STEP	PROCEDURE	EXAMPLE
1	The pumped or treated weight represents 100% of the green weight plus the percent gain. So, to find the percentage represented by the pumped or treated weight, simply add the percent gain to 100%.	10% (percent gain) + 100% (green weight) is 110% (pumped weight).
2	Convert the pumped or treated weight percentage to a decimal.	1.10 (110% ÷ 100)
3	Divide the pumped or treated weight by this decimal to determine the green weight.	220 lb (pumped weight) ÷ 1.10 = 200 lb (green weight) and 20 lb (solution)

Chapter 12

SHRINKAGE CALCULATIONS

INTRODUCTION

Inspection personnel are responsible for monitoring the shrinkage of various meat and poultry products. For example:

- Barbecued meat must shrink a minimum of 30%-- MPI Regulations, section 319.80.
- Cooked bacon bits or crumbles must shrink a minimum of 60%--Standards and Labeling Policy Book.
- Dry-cured hams and pork shoulders must shrink a minimum of 18%--MPI Regulations, section 319.106.
- Product shrink, cook shrink, and/or chill shrink that are part of quality control programs or systems must remain within established shrinkage limits.
- Cook and/or chill shrinks for pickle cured pork products must be in accordance with the establishment's approved processing procedure(s).

HOW TO DETERMINE A PRODUCT'S REQUIRED SHRINK

Calculation formula

Use the following formula to verify the percent shrink compliance of dry cured hams and pork shoulders, bacon bits, barbecued meat, etc.

$$\frac{\text{green weight meat or poultry} - \text{finished weight}}{\text{green weight meat or poultry}} \times 100 = \text{\% shrink}$$

Note: Bacon bits are usually produced from bacon ends and pieces. Although the bacon ends and pieces contain curing ingredients and have been smoked, the use of green weight, which is actually the uncooked weight, in the formula would still be applicable because the weight of the cured bellies must not exceed the green (uncured) weight of the pork bellies.

Procedure Table

The following procedure table should be used when you want to find a product's percent shrink.

STEP	PROCEDURE	EXAMPLE
1	Determine the green weight of the meat or poultry.	Dry-Cured Pork Shoulders Pork shoulders 500 lb
2	Determine the weight of the product after processing (cooking, drying, etc).	After the specified curing period, the pork shoulders weigh 395 lb.
3	Subtract the weight of the product after processing (finished weight) from the green weight of the meat or poultry to find the amount the product shrunk.	500 lb - 395 lb 105 lb
4	Divide the number of pounds the product has shrunk by the green weight of the meat or poultry.	105 lb ÷ 500 lb = 0.21
5	Convert the decimal answer into the percentage of shrink by multiplying by 100.	0.21 × 100 = 21% shrink (in compliance)

HOW TO DETERMINE COOK AND CHILL SHRINKS

Calculation Formula

Use the following formula to determine the percent cook shrink or chill shrink of cooked sausages, bacon, PFF-controlled cured pork products, etc.

$$\frac{\text{weight in (smokehouse/oven/cooler) - weight out (smokehouse/oven/cooler)}}{\text{weight in (smokehouse/oven/cooler)}} \times 100 = \%\ \text{shrink}$$

Procedure Table

The following procedure should be used when you want to determine the percentage of cook or chill shrink.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the product (less tare) going into the smokehouse, oven, cooler, etc.	1000 lb of Franks

2	Determine the weight of the product (less tare) coming out of the smokehouse, oven, cooler, etc.	927 lb of franks after cooking and smoking
3	Subtract the weight coming out from the weight going in to find the amount of product shrink.	1000 lb – 927 lb 73 lb
4	Divide the number of pounds shrunk by the product weight going into the smokehouse, oven, cooler, etc.	73 lb ÷ 1000 lb = 0.073
5	Convert this decimal answer into the percentage of shrink by multiplying by 100.	0.073 × 100 = 7.3% shrink

COMMENTS

- Shrink calculations should be conducted on entire lots of product. However, in many instances it is not feasible to perform shrink tests with the entire weight of the lot (inspection personnel time constraints, extremely large lot size, etc.). Therefore, weighing a large enough portion (sample) to represent the lot would be acceptable.
- Shrink limitations and yield limitations are interrelated. For instance, barbecued meat must shrink at least 30%. The same requirement is expressed in MPI Regulations, section 319.80, as "the weight of the barbecued meat shall not exceed 70% of the weight of the fresh uncooked meat", which means "the barbecued meat shall not have a yield greater than 70%".

Chapter 13

YIELD CALCULATIONS

INTRODUCTION

Inspection personnel are responsible for monitoring the yields of various meat and poultry products. Yield determinations preclude, among other things, economic fraud from the use of added ingredient solutions, specifically excess added water. Examples of products with yield limitations:

- Brown-and-serve sausage formulated with no more than 8.8% or 10% added water must have a yield no greater than 85% and 80%, respectively--Standards and Labeling Policy Book.

- Cooked bacon bits or crumbles must have a yield no greater than 40% --Standards and Labeling Policy Book.

- The weight of pork bellies cured by pumping, immersing, massaging, or tumbling that are ready for slicing and labeling as "bacon" shall not exceed the weight of the fresh uncured pork bellies. In other words, the cured pork bellies must have a yield no greater than 100%--MPI Regulations, section 319.107.

- Various products that have a yield standard established as part of an establishment's approved quality control program or system.

HOW TO DETERMINE A PRODUCT'S YIELD

Calculation formulae

- The following formula can be used to determine percent yield for a product prepared from a whole piece of meat or poultry (pumped hams or pork bellies, steaks or breasts pumped with, or immersed in ingredient solutions, etc.).

$$\frac{\text{finished weight}}{\text{green weight meat or poultry}} \times 100 = \%\ \text{yield}$$

Note: Pumped weight, cooked weight, dried weight, treated weight, etc., could be substituted for finished weight in the above formula, depending upon the processing procedures performed at the establishment and/or the form in which the products are packaged and labeled for sale.

► **Procedure Table**

By using the following procedure table, you can determine the percent yield for a product prepared from a whole piece of meat or poultry.

STEP	PROCEDURE	EXAMPLE
1	Determine the green weight of the meat or poultry.	Fifty skinned and trimmed pork bellies (10- to-12 lb weight range) weigh 551.90 lb.
2	Determine the weight of the product after processing (cooking, drying, etc.).	Fifty processed pork bellies (10- to-12 lb weight range) ready for slicing weigh 546.40 lb.
3	Divide the weight of the product after processing (finished weight) by the green weight of the meat or poultry.	546.40 lb ÷ 551.90 lb = 0.9900
4	Convert this decimal answer into the percent yield by multiplying by 100.	0.9900 × 100 = 99% yield

! The following formula can be used to determine percent yield for a cooked comminuted product, such as brown-and-serve sausage.

$$\frac{\text{cooked weight}}{\text{uncooked weight}} \times 100 = \%\ \text{yield}$$

Note: Formulated weight or batch weight could be substituted for uncooked weight in the above formula.

► **Procedure Table**

By using the following procedure table, you can determine the percent yield for a cooked comminuted product.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of enough product to represent the lot before cooking (uncooked weight).	Ten brown-and-serve pork sausage patties (3 to 4 ounce range) weigh 35.7 oz.

2	Determine the weight of the same amount of product after cooking (cooked weight).	After cooking, ten brown-and-serve sausage patties (3 to 4 ounce range) weigh 28.6 oz.
3	Divide the weight of the product after cooking by the weight of the product before cooking.	28.6 oz ÷ 35.7 oz = 0.8011
4	Convert this decimal answer into the percent yield by multiplying by 100.	0.8011 × 100 = 80.1% yield

COMMENT

Yield limitations and pump/pick-up limitations are interrelated. For instance, corned beef brisket can be pumped with a curing solution up to 20% . The same requirement is expressed in MPI Regulations, section 319.101, as "the application of curing solution to beef brisket shall not result in an increase in the weight of the finished cured product of more than 20% over the weight of the fresh uncured brisket". In other words, the finished cured product shall not have a yield greater than 100% + 20% or 120%.

Chapter 14

MISCELLANEOUS CALCULATIONS

HOW TO DETERMINE THE PERCENT OF AN INGREDIENT IN A FORMULA

Calculation Formula

$$\frac{\text{ingredient weight in the formula}}{\text{total formula or batch weight}} \times 100 = \%\text{ of ingredient}$$

Procedure Table

The procedure table below will assist you in determining the percentage of any formula ingredient (pickle solution ingredient, cure mix ingredient, or product ingredient) when the ingredient weights are known.

STEP	PROCEDURE	EXAMPLE
1	Total the weights of all items in the mix, formula, batch, solution, etc.	Pickle Formula Water 740.00 lb ISP 110.00 lb Salt 105.00 lb Sugar 41.00 lb Sodium Ascorbate 2.96 lb Sodium Nitrite 1.04 lb Total 1000.00 lb
2	Take the weight of the ingredient, for which you want to determine the percentage, and divide it by the total weight.	ISP: 110 lb 110 lb ÷ 1000 lb = 0.11
3	Convert your decimal answer to a percentage by multiplying by 100 (i.e., move the decimal point 2 places to the right).	0.11 × 100 = 11% ISP makes up 11% of this pickle formula by weight.

HOW TO DETERMINE THE FAT CONTENT OF A COMMINUTED PRODUCT FORMULA

Introduction

To monitor the compliance of a restricted ingredient that has a regulatory limit based on the fat content of the product, e.g., an antioxidant, inspection personnel must be able to calculate the amount of fat in the product. A product's laboratory fat analysis history or the establishment's target fat content for the product is used as the basis for determining the maximum level of antioxidants allowed in the product. If a product has less fat in it than its targeted fat content, but the antioxidant level is based on the targeted fat content, then the product is out of compliance for antioxidants. Therefore, inspection must verify that the amount of fat in the product at the time of formulation is equal to or more than the establishment's target fat content, but not more than the amount of fat allowed in the product.

The inspector's fat content verification can also be used as an ***indicator*** of the establishment's compliance or noncompliance with the standard (requirement) for the amount of fat allowed in the product. A fat standard noncompliance at the time of formulation should be confirmed through laboratory analysis. Regulatory action for fat content noncompliance ***must*** be based on the laboratory result.

Procedure Table

When the percentage of fat for each meat, poultry, meat byproduct, or poultry byproduct in a formula is known, the procedure table below can be used to determine the percentage of fat in the total formula.

STEP	PROCEDURE	EXAMPLE
1	From establishment formulation records, determine the batch weight, % fat content of each meat, meat byproduct, poultry, or poultry byproduct item, and the targeted fat % in the finished product.	Breakfast Sausage Cow meat (40% fat) 140.0 lb Beef plates (50% fat) 125.0 lb Pork trimmings (70% fat) 125.0 lb Beef hearts (25% fat) 20.0 lb Water 12.0 lb Salt 4.0 lb Dextrose 1.0 lb Flavorings 31.7 oz BHA 0.3 oz Total batch weight 429.0 lb 48% target fat level in the finished product

2	Determine the amount of fat (in pounds) permitted in the total formula.	429 lb batch weight × 0. 48 (48% fat) 205.92 lb of fat permitted
3	Determine the weight of the fat in each meat, poultry, meat byproduct, or poultry byproduct item in the formula by multiplying the total weight of each ingredient by the decimal equivalent of its fat percentage.	Cow meat 140 lb (40%) Fat × 0.40 56 lb fat
		Beef plates 125 lb (50%) Fat × 0.50 62.5 lb fat
		Pork trimmings 125 lb (70%) Fat × 0.70 87.5 lb fat
		Beef hearts (cap off) 20 lb (25%) Fat × 0.25 5 lb fat
4	Total the weight of the fat.	56.0 lb 62.5 lb 87.5 lb + 5.0 lb 211.0 lb total fat added
5	Divide the weight of the fat added by the batch weight.	211 lb ÷ 429 lb = 0.4918
6	To determine the percentage of fat in the formula convert your decimal answer to a percentage by multiplying by 100 (i.e., move the decimal point 2 places to the right).	0.4918 × 100 = 49.18% fat (as formulated) in the finished breakfast sausage

USING THE PEARSON SQUARE METHOD TO VERIFY A PRODUCT'S FAT CONTENT AT THE TIME OF FORMULATION

Introduction

Ground beef, hamburger, and several fresh meat sausages have regulatory limits on the amount of fat that can be present in the finished product. By using the Pearson Square method, you can determine the proper amounts of raw material containing fat that must be used in a formulation. The following procedure table illustrates this method when there are two lots of raw material with different fat contents.

Procedure Table

STEP	PROCEDURE	EXAMPLE
1	From establishment formulation records, determine the batch weight, % fat content of each meat, meat byproduct, poultry, or poultry byproduct item, and the targeted fat % in the finished product.	Pork Sausage Special pork trimmings (40% fat) 130.0 lb Regular pork trimmings (60% fat) 280.0 lb Water 12.0 lb Salt 4.0 lb Sugar 1.0 lb Flavorings 31.7 oz BHA 0.3 oz Total batch weight 429.0 lb 45% target fat level in the finished product
2	Determine the amount of fat (in pounds) permitted in the total formula.	429 lb batch weight × 0. 45 (45% fat) 193.05 lb of fat permitted
3	Determine the weight of the meat block.	Special pork trimmings 130 lb Regular pork trimmings + 280 lb Meat block 410 lb
4	Determine the fat percentage in the meat portion that will produce a finished product with a 45% fat content after all the other ingredients are added to the formula by dividing the permitted pounds of fat in the product by the weight of the meat block, and then multiply the result by 100.	(193.05 lb ÷ 410 lb) × 100 = 47.08% or 47% fat level needed in the meat portion of the formula.
5	Set up the Pearson Square by placing the needed fat percentage in the meat portion (in this case 47%) at the center of the "square" and draw two diagonal lines through it.	47

6	On the left corners, enter the fat percentages of the two lots to be used in the formula.	40 47 60
7	Subtract the lesser amount from the greater amount along each diagonal line and enter the answers on the right corners on the same line.	40 13 47 60 7
8	By reading across, you can now tell how many parts of each lot must be used. In this case, the formula will contain 13 parts of the 40% fat trimmings to 7 parts of the 60% fat pork trimmings.	40-------------------- 13 47 60------------------- 7
9	To determine how many pounds of each lot will be required, first add the total number of parts. In this case, 13 + 7 = 20	40-------------------- 13 47 60------------------- 7 20
10	Divide the meat block weight by the total number of parts. This will give the number of pounds per part.	410 lb ÷ 20 parts = 20.5 lb per part
11	Now simply multiply the number of parts of each lot called for by the pounds per part.	20.5 lb × 13 parts = 266.5 lb 20.5 lb × 7 parts = 143.5 lb This formula requires 266.5 lb of the 40% fat pork trimmings and 143.5 lb of the 60% fat pork trimmings. Since this batch of pork sausage is not formulated with the proper amounts of raw material, the fat content ***may*** violate the fat limitation given in the product standard. In fact, this pork sausage is formulated with a 51.2% fat content.

Note: *The Pearson Square method cannot be used if the establishment has not provided the fat content of each raw meat or meat byproduct used in the product formula.*

HOW TO DETERMINE BRINE CONCENTRATION

Introduction

MPI Regulations [section 318.10(c)(3)(iv)] identify two curing methods that an establishment may use to destroy trichinae in hams. When either method is used, the concentration of the brine remaining in the hams at the end of the drying period must be 6 percent or more. The establishment must establish and maintain compliance by taking samples, having them analyzed for salt and water content by an accredited laboratory, and performing brine calculations. Brine extracts are taken from the biceps femoris muscle and analyzed for salt content.

Cured meat or poultry products such as boneless pork shoulders, pork loins, hams, meat loaves, luncheon meats, poultry loaves, etc., formulated without cereal or starch may be packaged in a hermetically sealed container, heated, and labeled "Perishable, Keep Under Refrigeration", provided the finished product has a brine concentration of not less than 3.5%. Meat loaves, nonspecific loaves, and similar cured products formulated with cereal, starch, or other extenders must have a brine concentration not less than 6 %.

Calculation Formula

When the data from a laboratory sample analysis is available, the formula below may be used to determine the brine concentration.

$$\frac{\text{Total Salt}}{\text{Total Salt and Total Water}} = \text{\% Brine Concentration}$$

Example

The laboratory sample results indicate that the total salt in a canned mortadella formulated with extenders is 4.1% and the total water 62%.

$$\text{\% Brine Concentration} = \frac{0.041}{0.041 + 0.62}$$

$$= \frac{0.041}{0.661}$$

$$= 6.2 \text{ \% Brine Concentration}$$

HOW TO DETERMINE THE COMPLIANCE OF BREADED PRODUCT

Introduction

In a battering and breading operation, the meat and poultry product may be dusted with a flour mix, battered, breaded, and further processed. Battering and breading may be done in one operation or separately. The automated battering and breading operation is a timed process that allows excess batter to drip from the product. The amount of batter and breading on the finished breaded product is dependent upon the type of product (chicken breast, corn dog, fritter, etc.) and the consistency and formulation of the batter. After the establishment batters and breads the product, the breaded product may be frozen in a raw, blanched and raw, or blanched and cooked state; cooked or blanched and cooked; or sold refrigerated in a raw, prebrowned raw, or cooked form to consumers.

To assure compliance with the regulations, inspection personnel monitor the process by sampling raw and battered and breaded product. Compliance of product with batter and breading limits is determined by weighing the finished product before freezing; blanching and freezing; blanching and cooking; or blanching, cooking, and freezing. ***The weight of batter and breading used as a coating for breaded product must not exceed 30% of the weight of the finished breaded meat or poultry product.*** The meat portion of the product thus represents 70% of the finished product. The 30% breading limitation applies to the combination of the weights of the battering and the breading operation(s).

Although FSIS has a 30% breading limitation for products label as "breaded", fritters and corn dogs are permitted to have up to 65% batter and breading ***on*** the finished product. A fritter must contain at least 35% fresh meat or poultry. The frankfurter must comprise at least 35% of the corn dog.

A fritter is a product manufactured from meat or poultry whole muscle. If the product is formed by chopping or grinding, the name must be qualified to indicate the process such as "chopped and formed". Textured vegetable protein, soy derivatives, water, or other approved extenders can be included in a fritter formulation if the product is properly labeled. Proper labeling means that the name of the product must meet a definition or a standard of identity. These products are "patties" and must be labeled accordingly [e.g., "(Species) Patty Fritter"]. If a patty (***meat food product)*** is made into a fritter, the patty (***meat food)*** must comprise at least 35% of the fritter and the batter and breading cannot exceed 65% of the finished weight.

Calculation Formulae

! To determine the maximum amount of batter and breading allowed, use the following formula.

meat/poultry portion ÷ % finished product = finished (breaded) product

finished (breaded) product – meat/poultry portion = maximum amount breading

! To determine the percentage of breading use the following formula.

$$\frac{\text{breaded weight - unbreaded (green) weight}}{\text{breaded weight}} \times 100 = \text{\% breading}$$

Procedure Tables

The procedure tables below explain how to determine the maximum amount of batter and/or breading that can be added to raw meat or poultry products.

! If the product is uniform in size and weight:

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of a given number of pieces of product before they are breaded.	20 boneless chicken breasts = 80 oz
2	This weight ***must*** total at least 70% of the finished product weight of these pieces. Therefore, you can determine the finished (breaded) weight by dividing this weight by 70% (0.70).	80 oz ÷ 0.70 = 114.2 oz finished (breaded) weight
3	Subtract the weight of the unbreaded pieces from the finished (breaded) weight to determine the maximum amount of breading allowed.	114.2 oz – 80 oz = 34.2 oz of breading allowed We could also say that "to be in compliance, the 20 unbreaded chicken breasts cannot weigh more than 114.2 oz after breading".

! If the product is nonuniform in size and weight:

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of the total unbreaded amount of meat or poultry.	200 lb of veal

2	This weight ***must*** total at least 70% of the finished product weight. Therefore you can determine the finished (breaded) weight by dividing this weight by 70% (0.70).	200 lb ÷ 0.70 = 285.7 lb finished (breaded) weight
3	Subtract the weight of the unbreaded pieces from the finished (breaded) weight to determine the maximum amount of breading allowed.	285.7 lb – 200 lb = 85.7 lb of breading allowed To be in compliance, finished product weight cannot exceed 285.7 lb.

The procedure table below explains how to determine the percentage of breading.

STEP	PROCEDURE	EXAMPLE
1	Determine the weight of a given number of pieces of product before they are breaded.	20 chicken wings = 59.3 oz
2	Weigh the same pieces of product after breading.	After breading, the 20 chicken wings weigh 82.4 oz.
3	Subtract the unbreaded (green) weight from the breaded weight to obtain the amount of breading.	82.4 oz – 59.3 oz 23.1 oz breading
4	Divide the amount of breading by the breaded weight.	23.1 oz ÷ 82.4 oz = 0.2803
5	Convert this decimal answer into the percent breading by multiplying by 100.	0.2803 × 100 = 28.03% breading

Comments

! Mixtures for batter and breading may be prepared from individual ingredients or commercial mixtures (ready-mixed) may be purchased. Commercial mixtures are restricted to those on the label transmittal form. Ingredients used in mixtures formulated at the establishment are strictly limited to those listed in the formula.

! When unbreaded product is uniform in size (4 oz patties, 1 oz finger steaks, etc.) inspection personnel are not required to weigh the unbreaded pieces every time. To conduct a compliance test, select breaded pieces, weigh them, subtract the unbreaded weight (number of pieces times the product weight), and divide the difference by the breaded weight to determine the percent breading in the finished product.

HOW TO DETERMINE A PROJECTED OR CALCULATED FINISHED WEIGHT

Introduction

Calculations for the ingoing amount of binders and extenders, and any restricted flavorings are based on the finished weight of the product. These ingredients function by affecting the entire product, not just the meat or poultry portion. In addition, binders and extenders are potential economic adulterants, not potential health hazards like nitrite and nitrate. Therefore, ***projected finished weight is an acceptable basis for calculation.*** The projected finished weight (PFW) is the calculated weight a product is expected to have after it is processed. A PFW can be calculated for either raw or cooked products.

Procedure Tables

The procedure table below explains how to ***calculate*** the finished weight of a raw comminuted red meat product. By determining this projected or calculated finished weight, inspection personnel can estimate whether or not the amount of binders, extenders, phosphates, and/or flavorings in a formula are in compliance.

STEP	PROCEDURE	EXAMPLE
1	Select from the formula those binders, extenders, phosphates, and/or flavorings that you are checking for compliance.	Bologna Formula Beef 250 lb Pork 250 lb Water/Ice 70 lb Rework (has NFDM, CSS and disodium phosphate) 50 lb NFDM 18 lb Corn Syrup Solids 15 lb Salt 5 lb Flavorings 4 lb Disodium Phosphate 3 lb Sodium Nitrate 10.75 oz Sodium Erythorbate 4.00 oz Sodium Nitrite 1.25 oz Total batch 666 lb *Targeted added water--10%*
2	Deduct the weight of any rework in the formula already containing the binder, extender, phosphate, and/or flavoring of concern from the batch or formula weight.	666 lb - 50 lb rework 616 lb

3	This batch weight represents 100% of new product ingredients. From it, subtract the water/ice, and its targeted percent in the finished product.	616 lb 100% – 70 lb Water/Ice 10% target 546 lb 90%
4	From this weight and percentage, subtract the weight and the maximum percentage allowed of the ingredients for which you are checking compliance. ***Note:*** *When determining the projected finished weight, always subtract the weight of all the restricted ingredients that are based on finished product weight and the maximum percentage allowed of each ingredient.*	546 lb 90.0% – 18 lb NFDM 3.5% 528 lb 86.5% 528 lb 86.5% – 15 lb CSS 2.0% 513 lb 84.5% 513 lb 84.5% – 3 lb Phosphate 0.5% 510 lb 84%
5	To find the PFW, divide this weight by the percentage of the formula weight that it represents.	510 ÷ 0.84 = 607.14 lb PFW

The procedure table below explains how to ***calculate*** the finished weight of a cooked comminuted meat product. This procedure will also use the bologna formula on page 100 as an example, however, for this calculation the establishment has provided inspection with the bologna's ***expected*** smokehouse (cook) shrink (6%) and cooler (chill) shrink (2%).

STEP	PROCEDURE	EXAMPLE
1	Deduct the weight of any rework in the formula already containing the binder, extender phosphate and/or flavoring of concern from the batch or formula weight.	666 lb – 50 lb rework 616 lb
2	This new batch weight represents 100% of new product ingredients. Multiply this weight by the total expected percent shrink to determine the expected pounds of shrink.	616 lb × .08 (6% + 2%---Shrinks) 49.28 lb
3	Subtract the expected pounds of shrink from the weight of the new product ingredients or new batch weight to determine the PFW.	616.00 lb – 49.28 lb 566.72 lb PFW

Comments

- ! To determine the percentage of the binder, extender, phosphate, and/or flavoring in the finished product, divide the weight of the binder, extender, phosphate, and/or flavoring in the formula by the PFW and multiply by 100. To determine the maximum amount of the binder, extender, flavoring or phosphate that could be used in the formula, multiply the PFW by the percent limitation (e.g., 3.5%, 2%, or 0.5%). Refer to Chapters 5, 6 and 7.

- ! Subtracting the expected amount of shrinkage rather than the amount of added water from the sausage formulation provides a more accurate projected finished weight for determining compliance of binders/extenders and restricted flavorings which, by regulation, are based on finished weight of the product. Although most processors indicate the expected product shrink values on their cooked sausage formulation records,

  it is not required by regulation. Therefore, determining the PFW from the raw formulation may be necessary. Of course, inspection personnel could determine the ***actual*** percent cook and chill shrinks (see Chapter 12, pages 85-87) and insert them into the above calculation to determine the ***actual*** finished weight.

- ! Cooked sausage products identified in section 319.180 of the MPI regulations are limited to 30% total fat or to 40% combined fat plus added water. Inspection personnel will use the 10% added water limit for this calculation unless establishment management informs them that their sausage product formulation targets a higher percentage of added water (12%, 15%, etc.).

HOW TO DETERMINE THE PERCENT OF PROTEINACEOUS INGREDIENTS IN A COOKED SAUSAGE

Introduction

Meat and poultry ingredients have a moisture-to-protein ratio (MPR) of approximately 4 (moisture) to 1 (protein). This means that for each percent of meat or poultry protein, the amount of inherent water in the product will be four percent. The laboratory uses this MPR to calculate the amount of added water in those products that have a water limitation. When an analysis is run by the laboratory, it will determine the ***total protein*** in the product. In order for the laboratory to accurately calculate the amount of added water in cooked sausage products, the amount of protein that comes from proteinaceous additives (classified as Group 2 Protein contributing ingredients in section 318.22 of the MPI regulations) must be deducted from the total analytical protein to determine the amount of meat/poultry protein. Hence, it is imperative that inspection personnel determine and record the percent of proteinaceous ingredients in ***the finished or projected finished product*** on FSIS Form 10,600-1 when submitting a sample of cooked sausage, formulated with such ingredients, to the laboratory.

Types of Proteinaceous Ingredients (section 318.22 of the MPI regulations and FSIS Directive 7140.2)

- **Group 1 Protein-Contributing Ingredients**

These are ingredients of livestock or poultry origin, such as meat, meat byproducts, mechanically separated species, and poultry products, that are not processed by hydrolysis, extraction, concentrating, or drying.

- **Group 2 Protein-Contributing Ingredients**

These are ingredients from Group 1 Protein-Contributing Ingredients which have been processed by hydrolysis, extraction, concentrating, or drying , or ***any other ingredient*** which contributes ***protein,*** such as ingredients of dairy, plant or yeast origin. Examples include: hydrolyzed pork skins, hydrolyzed plant protein, nonfat dry milk, milk protein hydrolyzate, autolyzed yeast extract, and beef extract.

Procedure Table

The procedure table below can be used to determine the percentage of Group 2 Protein-Contributing Ingredients in cooked sausages on a ***per batch basis*** that must be indicated on FSIS Form 10,600-1 when submitting a sample to the laboratory for added water analysis.

STEP	PROCEDURE	EXAMPLE
1	Examine the label transmittal form, ingredients statement, or establishment formulation records to determine if Group 2 Protein-Contributing Ingredients were used in the sampled formulation of cooked sausage.	Bologna Formula Beef Trimmings 250.00 lb Pork Trimmings 150.00 lb Water 110.00 lb Chicken meat 65.00 lb ISP 11.00 lb Salt 7.00 lb Mustard Flour 3.75 lb Flavorings 2.00 lb Cure mix (6.25% nitrite w/ salt carrier) 1.00 lb Sodium Erythorbate 0.25 lb Total Batch Weight 600 lb *Added water target is 15%*

2	Determine the protein content (%) of each Group 2 Protein-Contributing Ingredient.	The label on the ISP container indicates that the ISP has 90% protein content. A signed letter from the mustard flour manufacturer states that the protein content is 32%.
3	Total the weight of all the Group 1 Protein-Contributing Ingredients.	Beef Trimmings 250 lb Pork Trimmings 150 lb Chicken Meat + 65 lb Total 465 lb
4	Total the weight of all the solid ingredients.	ISP 11.00 lb Salt 7.00 lb Mustard Flour 3.75 lb Flavorings 2.00 lb Cure mix 1.00 lb Sodium Erythorbate + 0.25 lb Total 25 lb
5	Total the weights in Steps 3 and 4 and divide by 100 minus the targeted percent of added water to determine the projected finished cooked sausage weight.	465 lb + 25 lb = 490 lb 490 lb ÷ .85 [85% (100% – 15%)] = 576.47 lb of finished cooked sausage
6	Multiply the weight of each Group 2 Protein-Contributing Ingredient used in the formula by its percentage of protein, and total the weights.	ISP 11 lb × .90 (90%) 9.9 lb of protein Mustard flour 3.75 lb × .32 (32%) 1.2 lb of protein 9.9 lb + 1.2 lb = 11.1 lb of total protein
7	Divide the total from Step 6 by the total from Step 5 and multiply by 100 to determine the percentage of protein from Group 2 Protein-Contributing Ingredients in the cooked sausage.	11.1 lb total protein / 576.47 lb of cooked sausage × 100 = 1.93%

Comments

- **!** Cooked sausage products identified in section 319.180 of the MPI regulations are limited to 30% total fat or a total fat of 40% combined fat and added water. Inspection personnel will use the 10% added water limit for this calculation unless establishment management informs them that their sausage product formulation targets a higher percentage of added water (12%, 15%, etc.).

- **!** Establishment management must provide inspection personnel with information stating the protein content (%) of each Group 2 Protein-Contributing Ingredient or ingredient mixture. The protein content may be obtained by laboratory analysis of each Group 2 Protein-Contributing Ingredient or ingredient mixture, certified letter from the manufacturer/supplier, or declaration on the label.

- **!** The percentage of Group 2 Protein-Contributing Ingredients in cooked sausages can also be determined on a ***yield basis.*** Inspection personnel must determine the average total pounds (yield) of finished cooked sausage of the last five production lots from yield information supplied by the establishment (refer to Chapter 13, pages 88-90). Suppose the average total pounds of finished bologna in the example above were 571 lb. To find the percentage of Group 2 Protein-Contributing Ingredients in the bologna, divide the total protein found in Step 6 (11.1 lb) by 571 lb and multiply by 100. In this case, 1.94% would be recorded on FSIS Form 10,600-1.

HOW TO DETERMINE IF A PRODUCT MEETS THE 70/30 LABELING PROVISION

Introduction

Section 317.2(f)(1)(v) of the MPI regulations states "when two meat ingredients comprise at least 70 percent of the meat and meat byproduct [meat block] ingredients of a formula and when neither of the two meat ingredients is less than 30 percent by weight of the total meat and meat byproducts (meat block) used, such meat ingredients may be interchanged in the formula without a change being made in the ingredients statement on labeling materials: *provided*, that the word "and" in lieu of a comma shall be shown between the declaration of such meat ingredients in the statement of ingredients."

For a product to bear a label in which two meat ingredients are connected by the word "and," two criteria must be met.

(1) The ***two*** meat ingredients must equal 70% or more of the ***total*** meat and meat byproduct ingredients.

(2) The lesser of the two meat ingredients must equal 30% or more of the ***total*** meat and meat by-product ingredients.

Note: When determining the 70/30 labeling provision, ***do not*** include poultry products in the meat and/or meat byproducts (meat block) portion of the formula.

Procedure Table

Use the procedure table below to determine if a product's label can have two meat ingredients connected by the word "and" in the ingredients statement.

STEP	PROCEDURE	EXAMPLE
1	Total the weights of the meats and meat byproducts in the formula.	Beef 70 lb Pork 53 lb Beef Tripe 20 lb Veal 15 lb Mutton 17 lb Total meat block 175 lb
2	Find what 70% of this weight is by multiplying the weight by 0.70.	175 lb × .70 122.5 lb
3	Total the weights of the two meats that are connected with the word "and" on the label. If their combined weight ***equals or exceeds*** the weight obtained in Step 2, the first criterion has been met.	Beef 70 lb Pork 53 lb Total 123 lb used 122.5 lb required First criterion has been met.
4	Now multiply the total weight of the meat and meat byproducts by 0.30 to determine what 30% of the total weight is.	175 lb × .30 52.5 lb
5	Compare the weight of the lesser of the two meat products to be connected with the word "and" with the weight obtained in Step 4. If the weight of the meat ***equals or exceeds*** the weight in Step 4, the second criterion has been met.	Pork -- 53 lb used 52.5 lb required Second criterion has been met. Hence, this product's ingredient statement can read "Beef and pork or Pork and beef....."

Comment

Remember that ***both criterion*** must be met before the two meat ingredients can be connected with the word "and" on the label. The order in which the two are listed is immaterial.

HOW TO DETERMINE THE VOLUME OF A CONTAINER

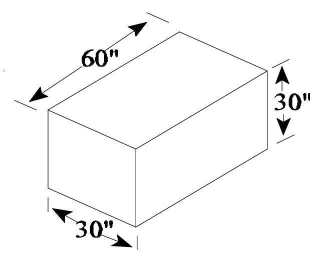
Introduction

The inspector will often need to determine the volume of various-shaped tanks and containers used by establishments. Pages 107 and 108 will demonstrate how to find the volume of four commonly encountered containers. Definitions for the symbols that appear in the various volume formulae can be found on page 114.

Square or Rectangular Tanks (Flat Bottom)

Formula: lwh = Volume

Example:



Length 60"; Width 30"; Height 30"

60" × 30" × 30" = 54,000 cu in

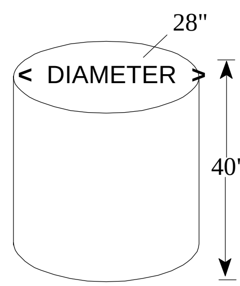
To convert answer into gallons.
(231 cubic inches per one gallon)

54,000 cu in ÷ 231 cu in/gal = 233.76 gal

Cylindrical Tanks (Flat Bottom)

Formula: $\pi r^2 h$

Use 3.14 as the numerical equivalent of π



Example:

r = 14"; h = 40"

3.14 × 196 × 40 = 24,617.60 cu in

To convert answer into gallons.
(231 cubic inches per one gallon)

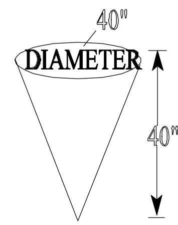
24,617.60 cu in ÷ 231 cu in/gal = 106.56 gal

Cone-Shaped Container

These are usually at the base of a cylindrical tank.

Formula: **a** πr^2 h = V

Use 3.14 as the numerical equivalent of π



Example:

r = 20"; h = 40":

a × 3.14 × 400 × 40 = 16,746.66 cu in

To convert answer into gallons.
(231 cubic inches per one gallon)

16,746.66 cu in ÷ 231 cu in/gal = 72.49 gal

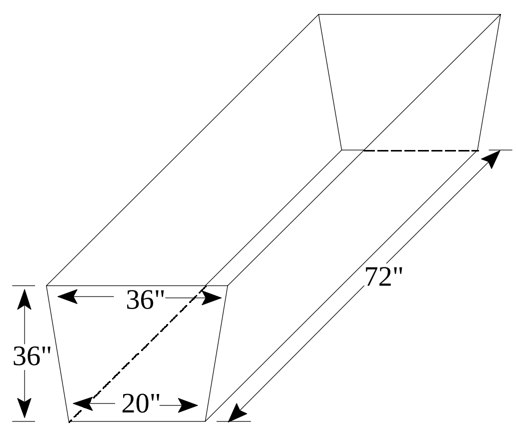
Trapezoid-Shaped Container

Formula: $l \times \frac{w + w^1}{2} \times h = V$

Example:

l = 72"; w = 36"; w^1 = 20"; h = 36"

$72 \times \frac{36 + 20}{2} \times 36 = 72{,}576$ cu in



To convert answer into gallons.
(231 cubic inches per one gallon)

72,576 cu in ÷ 231 cu in/gal = 314.18 gal

APPENDIX

CONVERTING UNITS OF MEASUREMENT

Introduction

To convert units from one measure, such as gallons of water, to another measure, such as pounds of water, you will need to multiply by a ***unity factor.*** A unity factor is an expression for the number one. Therefore, you are essentially multiplying by one and not changing the value of the expression when multiplying by a unity factor. Only the units in which that value is expressed are changed. The unity factor must be arranged so that the units you want to change from cancel out.

You will need to know certain equivalent units or conversion factors, such as 1 gallon of water = 8.33 lb, to set up unity factors. The unity factor is the fraction expressed as 1 gallon of water/ 8.33 lb or 8.33 lb/1 gallon of water. Both of these fractions are expressions of the value one. The units you want to convert out of, and the units you want to convert into, determine which unity factor you use.

Example

Express 20 gallons of water in pounds. First, you need to set up the unity factor so that gallons cancel out.

$$20 \text{ gallons} \times \frac{8.33 \text{ lb}}{1 \text{ gallon}} = 166.6 \text{ lb}$$

Using cross-product cancellation, the gallons cancel out and you are left with pounds as the unit of measurement. Once you have the desired units, you can arrive at the correct answer by performing the mathematics. In this example, 20 is multiplied by 8.33 lb to get an answer of 166.6 lb.

Conversion Factors

Weight

U.S. Customary Unit (Avoirdupois)	U.S. Equivalents	Metric Equivalents
One ounce	473.5 grains	28.35 grams
One pound	16 ounces; 7,000 grains	453.59 grams; 0.4536 kilograms

Volume or Capacity

U.S. Customary Unit	U.S. Equivalents	Metric Equivalents
Fluid ounce	1.804 cubic inches	29.573 milliliters
One pint	16 fluid ounces	0.473 liter
One quart	2 pints	0.946 liter
One gallon	4 quarts; 231 cubic inches	3.785 liters
One barrel	31 ½ gallons	------------
One cubic foot	1,728 cubic inches	0.028 cubic meter

Weight and Volume

Metric System	U.S. Equivalents	U.S. Customary Unit
One kilogram(Kg)	35.2 ounces	2.2 pounds
One gram	0.0022 pounds	0.035 ounce
One liter	1.06 quart	0.26 gallon

Temperature

To change from Fahrenheit (F) to Centigrade (C):

$$F = (9/5\ C) + 32$$

To change from Centigrade (C) to Fahrenheit (F):

$$C = 5/9\ (F - 32)$$

NOTE: For each 9^{o} increase or decrease on a Fahrenheit thermometer the Celsius thermometer will increase or decrease 5^{o}. Therefore, we have a 9 to 5 ratio or 9 ÷ 5 = 1.8 (factor). To use 9/5, multiply by 1.8. To use 5/9, divide by 1.8.

Decimals and Percentages

To convert percent to decimal, divide by 100.
To convert decimal to percent, multiply by 100.

Converting Pounds and Ounces

1. Pounds to ounces.

	Procedure	*Example*
a.	When pounds expression does not include a fraction.	3.4 pounds
	Multiply pounds by the conversion factor 16 (16 ounces = 1 lb).	3.4 × 16 = 54.4
	Answer is in ounces.	54.4 oz
b.	When fraction is included in pounds.	3 ¼ pounds
	Convert fraction portion to a decimal.	¼ = 1 ÷ 4 = .25
	Add whole number to the fraction.	3 + .25 = 3.25
	Multiply pounds and decimal portion by the conversion factor 16 (16 oz = 1 lb).	3.25 × 16 = 52
	Answer is in ounces.	52 ounces

2. Ounces to pounds.

Procedure	*Example*
Determine the number of ounces.	36 ounces
Divide the ounces by the conversion factor 16 (16 ounces = 1 lb).	36 ÷ 16 = 2.25
Answer is in pounds.	2.25 pounds

3. Portions of a pound to ounces.

Procedure	*Example*
Determine portion of a pound.	¾ pounds
Convert fraction to a decimal.	3 ÷ 4 = .75

Multiply decimal portion of a pound by the conversion factor 16 (16 oz = 1 lb).	$.75 \times 16 = 12$
Answer is in ounces.	12 ounces

4. Ounces to pounds and fractions of a pound

Procedure	*Example*
Determine the weight.	16 ¼ oz
Change fraction portion to a decimal.	$\frac{1}{4} = 1 \div 4$ $1 \div 4 = .25$
Add decimal portion of ounces to whole ounces.	$16 + .25 = 16.25$ oz
Divide total ounces by 16.	$16.25 \div 16 = 1.015$
Convert decimal portion to a fraction.	$.015 = \frac{15}{1000}$
Reduce fraction to lowest common denominator.	$\frac{15}{1000} = \frac{3}{200}$
Add fraction to total pounds.	$1 + \frac{3}{200} = 1\frac{3}{200}$
Answer in pounds and fraction of a pound.	$1\frac{3}{200}$ lb

5. Decimal equivalent of ounces in pounds.

Ounces	*Decimal equivalent pounds*
1	.0625
2	.125
3	.1875
4	.25
5	.3125
6	.375
7	.4375
8	.5
9	.5625
10	.625

11	.6875
12	.75
13	.8125
14	.875
15	.9375
16	1.0

Converting Metric Weights to U.S. Equivalents (Avoirdupois)

Most of the world outside the United States uses the Metric System and many companies in the U.S. are using scales that are calibrated in grams instead of ounces.

1. **Grams to Ounces.**

Procedure	*Example*
Determine the number of grams.	227 grams
Divide the grams by the conversion factor 28.35 (1 ounce = 28.35 grams).	227 ÷ 28.35 = 8.0
Answer is in ounces.	8.0 ounces

2. **Kilograms to pounds.**

Procedure	*Example*
Determine the number of kilograms.	40 kg
Multiply the kilograms by the conversion factor 2.2 (1 lb = 2.2 kg).	40 × 2.2 = 88
Answer is in pounds.	88 pounds

Converting Fahrenheit to Celsius or Celsius to Fahrenheit

1. Fahrenheit to Celsius.

Example:	*Procedure:*
$C = (F - 32^o) \div 1.8$	Formula
108^o Fahrenheit	! Determine Fahrenheit temperature in degrees.
$108^o F - 32^o = 76^o F$	! Subtract 32^o from 108^o F.
$C = 76 \div 1.8 = 42.2^o$	! Divide 76^o by 1.8.
$C = 42.2^o$	! Result is degrees Celsius equal to the known Fahrenheit degree temperature.

2. Celsius to Fahrenheit.

Example:	*Procedure:*
$F = C \times 1.8 + 32^o$	Formula
40^o Celsius	! Determine Celsius temperature in degrees.
$40^o C \times 1.8 = 72^o F$	! Multiply 40^o Celsius times 1.8.
$F = 72^o + 32^o = 104^o$	! Add 72^o and 32^o.
$F = 104^o$	! Result is degrees Fahrenheit equal to the known Celsius degree temperature.

SYMBOLS

π (Pi) = 3.14	l = Length
d = Diameter	w = Width
r = Radius	h = Height
r^2 = Radius squared ($r \times r$)	V = Volume

SOLVING EQUATIONS THAT HAVE AN UNKNOWN VALUE

Introduction

This section gives a very simplified explanation of how to solve the basic equations used to determine the amount of restricted ingredients permitted.

Methods

! Unknown Value is Part of the PPM Formula

To solve for an unknown value in the ppm equations shown in Chapter 3, pages 13-31 and Chapter 11, page 81, you need to first restructure them so that the unknown value (n) is on one side of the equation and all the known values are on the other side of the equation.

Generic Model

To algebraically isolate an unknown value to one side of the equation and have all of the known values on the other, you need to perform identical functions on both sides of the equation.

The following ppm formula will be used to illustrate the generic model.

$$\frac{\text{lb Restricted Ingredient (RI)} \times 1{,}000{,}000}{\text{lb meat block}} = \text{ppm}$$

If all the values in the equation are known except the pounds of RI, you need to isolate pounds of RI (which is n) on one side of the equation and solve for it.

$$\frac{n \times 1{,}000{,}000}{\text{lb meat block}} = \text{ppm}$$

In this instance, you'll want to move all your known values to the right side of the equation, leaving the n on the left side where it is the numerator. First, move "1,000,000" and "lb meat block" to the same side of the equation as ppm, by multiplying both sides of the equation by "lb meat block". This cancels "lb meat block" on the n side of the equation.

$$\text{lb meat block} \times \frac{n \times 1{,}000{,}000}{\text{lb meat block}} = \text{ppm} \times \text{lb meat block}$$

$$n \times 1{,}000{,}000 = \text{ppm} \times \text{lb meat block}$$

Next, to leave n by itself, divide both sides of the equation by "1,000,000". This cancels "1,000,000" on the n side of the equation.

$$\frac{n \times 1{,}000{,}000}{1{,}000{,}000} = \frac{\text{ppm} \times \text{lb meat block}}{1{,}000{,}000}$$

$$n = \frac{\text{lb meat block} \times \text{ppm}}{1{,}000{,}000}$$

Now you can solve for *n*. This same procedure is used to isolate *n* to one side of ***any*** equation.

Example

In the equation on page 14, the maximum amount of sodium nitrite is the unknown and is represented by the *n* in the equation:

$$\frac{n \times 1{,}000{,}000}{500 \text{ lb}} = 156 \text{ ppm}$$

In this instance, you'll want to move all your known values to the right side of the equation, leaving the *n* on the left where it is the numerator. First, multiply both sides of the equation by 500. This cancels 500 lb from the *n* side of the equation.

$$500 \times \frac{n \times 1{,}000{,}000}{500} = 156 \times 500$$

$$n \times 1{,}000{,}000 = 156 \times 500$$

Next, divide each side of the equation by 1,000,000. This cancels 1,000,000 on the *n* side of the equation.

$$\frac{n \times 1{,}000{,}000}{1{,}000{,}000} = \frac{500 \times 156}{1{,}000{,}000}$$

$$n = \frac{500 \times 156}{1{,}000{,}000}$$

$$n = \frac{78{,}000}{1{,}000{,}000}$$

$$n = .078$$

.078 lb is the maximum amount of nitrite allowed.

Example

In the equation on page 20, the pounds of pickle is the unknown value and is represented by *n* in the equation:

$$200 \text{ ppm} = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{n}$$

We need to put *n* on one side of the equation all by itself in order to find out its value. Which side? The side on which it will appear in the numerator. (Note that in the equation it is presently in the denominator.)

$$\begin{matrix} \text{Numerator} \rightarrow \\ \text{Denominator} \rightarrow \end{matrix} \quad \frac{200}{1} = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{n}$$

[You don't normally write the denominator when it's 1 - we just did here for illustration.]

To move *n* to the side where it will appear in the numerator, multiply both sides of the equation by $\frac{n}{1}$. This cancels the *n* on the side of the equation where it was.

$$\frac{n}{1} \times 200 = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{n} \times \frac{n}{1}$$

$$n \times 200 = 1.75 \times 0.25 \times 1{,}000{,}000$$

We're not through though, because it must be alone before you can solve for its value. We need to transfer the 200 from the left side of the equation (where it is in the numerator) to the right side of the equation (where it will appear in the denominator). Thus you must divide both sides of the equation by 200. This cancels 200 ppm on the *n* side of the equation.

$$\frac{n \times 200}{200} = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{200}$$

$$n = \frac{1.75 \times 0.25 \times 1{,}000{,}000}{200}$$

Now you can solve the equation for *n* and find the pounds of pickle that can be made.

$$n = \frac{437{,}500}{200}$$

$$n = 2187.5 \text{ lb}$$

A minimum of 2187.5 pounds of pickle can be made.

Example

In the equation on page 21, the unknown is the maximum amount of sodium nitrite:

$$200 \text{ ppm} = \frac{n \times 0.25 \times 1{,}000{,}000}{1500}$$

$$1500 \times 200 = \frac{n \times 0.25 \times 1{,}000{,}000}{1500} \times 1500$$

$$1500 \times 200 = n \times 0.25 \times 1{,}000{,}000$$

$$\frac{1500 \times 200}{0.25 \times 1{,}000{,}000} = \frac{n \times 0.25 \times 1{,}000{,}000}{0.25 \times 1{,}000{,}000}$$

$$\frac{200 \times 1500}{0.25 \times 1{,}000{,}000} = n$$

$$\frac{300{,}000}{250{,}000} = n$$

$$1.2 = n$$

1.2 pounds of sodium nitrite is permitted.

Example

In the equation on page 81, the unknown is the maximum percent pump:

$$200 \text{ ppm} = \frac{1.75 \times n \times 1{,}000{,}000}{1500}$$

$$1500 \times 200 = \frac{1.75 \times n \times 1{,}000{,}000}{1500} \times 1500$$

$$1500 \times 200 = 1.75 \times n \times 1{,}000{,}000$$

$$\frac{1500 \times 200}{1.75 \times 1{,}000{,}000} = \frac{1.75 \times n \times 1{,}000{,}000}{1.75 \times 1{,}000{,}000}$$

$$\frac{1500 \times 200}{1.75 \times 1{,}000{,}000} = n$$

$$\frac{300{,}000}{1{,}750{,}000} = n$$

$$0.1714 = n$$

Multiply .1714 by 100 to convert to a percent, and 17.14% is the maximum percent pump.

Practice solving similar equations by creating your own formulation problems. In a short time you should be solving such problems easily.

! Unknown Value is Part of a Ratio or Proportion

The projected finished weight (PFW) or calculated finished weight in Chapter 14, pages 100 and 101, is determined by applying the methods used for solving a ratio or proportion problem. Ratio or proportion problems are expressed as equations that contain an unknown value.

Generic Model

When it is known that the weight of certain ingredients makes up a certain percentage of a product, you can find the total weight (100%) of a product by using the following procedure.

- State the problem in the "if-then" form.

  When a problem is stated in the "if-then" form, it is easily converted to an equation.

  Example

  Here is a problem:

  85% of a product is 340 lb. What is the total weight of the product?

  Here is the same problem stated in the "if-then" form:

  If 340 lb is 85% of the product, then what would be the total weight (100%) of the product?

- Write the equation.

Let the letter *n* represent the word "what" in the above "if-then" problem statement and you have:

If 340 lb is 85% of the product, then *n* would be the total weight (100%) of the product.

The equation is simply : $\frac{340}{n} = \frac{.85\ (85\%)}{1.00\ (100\%)}$

- Cross multiply.

The first step in solving for *n* is to "cross multiply". "Cross multiply" means that you multiply the numerator of each side of the equation by the denominator of the other side.

Example: Cross multiplying the above equation you get: $\frac{340}{n} = \frac{.85}{1.00}$

$340 \times 1.00 = .85 \times n$

or $340 = .85n$

- Isolate *n* on one side of the equation.

To algebraically isolate an unknown value to one side of the equation and have all of the known values on the other, you need to perform identical functions on both sides of the equation. In this instance, you'll want to move all your known values to the left side of the equation, leaving the *n* on the right side. To leave *n* by itself, divide both sides of the equation by .85. This cancels .85 on the *n* side of the equation.

$$\frac{340}{.85} = \frac{.85n}{.85}$$

$$400 = n$$

If 340 lb is 85% of the product, then 400 lb would be the total weight (100%) of the product.

Example

Given the cooked sausage formula from page 100, determine whether or not the NFDM is in compliance with the regulations.

Bologna Formula

Beef	250 lb	
Pork	250 lb	
Water/Ice	70 lb	
Rework (has NFDM, CSS and disodium phosphate)	50 lb	
NFDM	18 lb	
Corn Syrup Solids	15 lb	
Salt	5 lb	
Flavorings	4 lb	
Disodium Phosphate	3 lb	
Sodium Nitrate		10.75 oz
Sodium Erythorbate		4.00 oz
Sodium Nitrite		1.25 oz
Total batch	666 lb	

Targeted added water--10%

To set this problem up as a ratio or proportion problem, subtract the "like product" rework (i.e., product with the same ingredients as in the new formula) from the batch weight.

	666 lb	formula weight
–	50 lb	rework
	616 lb	(100%)

Next, subtract the weight of the water or ice and other restricted ingredients (those with a limitation based on the PFW) that are assumed to have been added in their maximum amounts and percentages from the total weight of the new ingredients (100%).

	616 lb	New Ingredients	100.0%
–	70 lb	Water/ice	10.0%
	546 lb		90.0%
–	18 lb	NFDM	3.5%
	528 lb		86.5%
–	15 lb	CSS	2.0%
	513 lb		84.5%
–	3 lb	Phosphate	0.5%
	510 lb		84.0%

At this point, you know that 84% of the finished product is 510 lb. However, you do not know the projected finished weight or theoretical total weight of the compliant bologna product. To find the PFW, state the problem in the "if-then" form:

If 510 lb is 84% of the finished bologna product, then what would be the projected finished weight (100%) of the bologna product?

Let *n* represent the word "what" in the "if-then" problem statement:

If 510 lb is 84% of the finished bologna product, then *n* would be the projected finished weight (100%) of the bologna product.

Write the equation for the "if-then" problem statement.

$$\frac{510}{n} = \frac{84\%}{100\%}$$

Change the percentages to decimals and cross multiply.

$$510 = .84n$$

To solve for *n,* divide both sides of the equation by .84.

$$\frac{510}{.84} = \frac{.84n}{.84}$$

$$607.14 \text{ lb} = n \quad \text{(represents 100\% of the compliant product)}$$

To determine the maximum amount of NFDM allowed in the projected finished weight of the bologna, state the problem in the "if-then" form. You know that NFDM is limited to 3.5% in the finished product. Therefore:

If 607.14 lb represents 100% of the finished bologna product, then what would be the weight of 3.5%?

Let *n* represent the word "what" in the "if-then" problem statement:

If 607.14 lb represents 100% of the finished bologna product, then *n* would be the weight of 3.5%.

Write the equation for the "if-then" problem statement.

$$\frac{607.14}{n} = \frac{100\%}{3.5\%}$$

Change the percentages to decimals and cross multiply.

$$607.14 \times .035 = n \times 1$$

$$21.24 = n$$

The bologna product is in compliance because the maximum amount allowed is 21.24 lb and only 18 lb is being used.

ABBREVIATIONS AND GLOSSARY

ABBREVIATIONS

The following terms are used in their shortened form in this Handbook:

BHA	Butylated Hydroxyanisole
BHT	Butylated Hydroxytoluene
CS	Corn Syrup
CSS	Corn Syrup Solids
FMIA	Federal Meat Inspection Act
FSIS	Food Safety and Inspection Service
GDL	Glucono delta-lactone
GS	Glucose Syrup
ISP	Isolated Soy Protein
MPI	Meat and Poultry Inspection
MS	Malt Syrup
NFDM	Non-Fat Dry Milk
PFF	Protein Fat-Free
PFW	Projected Finished Weight
PM	Policy Memorandum
PPIA	Poultry Products Inspection Act
PPM	Parts Per Million
RI	Restricted Ingredient
SAPP	Sodium Acid Pyrophosphate
TBHQ	Tertiary Butylhydroquinone

GLOSSARY

Actual Percent Pump. The amount (pounds) of a water-based or oil-based solution (curing, tenderizing, marinating, etc.) pumped or injected into a piece of meat or poultry that is not held for a period of time and allowed to drain prior to being further processed. This is expressed as a percentage of the weight of the meat or poultry before it is pumped with the solution.

Additive. Anything added to a meat or poultry product other than meat, poultry, or meat and poultry byproducts.

Antioxidant. A substance that retards oxidation. Antioxidants are added to meat and poultry products to prevent oxidative rancidity of fats.

Binder. An additive used to improve the binding properties of lean meat or poultry or meat and/or poultry mixtures. Binders have strong affinity for water, therefore misuse of binders may cause the product to be adulterated with excess water.

Brine Solution. An amount of water that contains salt either alone or with other ingredients; often referred to as a pickle.

Comminuted. Ground meat, poultry, meat byproducts, or poultry byproducts; finely comminuted meat, poultry, meat byproducts or poultry byproducts are often referred to as emulsified.

Cover Pickle. A liquid brine, cure, or vinegar solution that covers submerged pieces of meat or poultry.

Cure. To add salt or salt brine and nitrite and/or nitrate, with or without sugar and other ingredients, to a meat or poultry product.

Cured, Comminuted Products. Products consisting of coarsely or finely ground meat and/or poultry and cure ingredients mixed together (bologna, turkey salami, pepperoni, pepper loaf, etc.).

Cured, Dry Products. Products that have dry or powdered cure ingredients directly applied to the surface of the meat or poultry (ham, pork shoulder, pork belly, etc.).

Cured, Pickled Products. Products that are pumped or massaged with, or immersed in, a pickle solution of cure ingredients (ham, corned beef, poultry breasts, etc.).

Dry Salt Cured Products. Products that have had a pickle solution of cure ingredients directly pumped into the muscle tissue (not through the circulatory system) before having the dry or powdered cure ingredients applied to the surface of the meat or poultry.

The meat and poultry may not be immersed in the pickle solution. To facilitate the penetration of salt, the meat or poultry may be momentarily moistened just before being covered with the dry curing ingredients.

Effective Percent Pump. The weight gained (expressed as a percent) by the meat or poultry after draining for a specified amount of time (up to a maximum of 30 minutes), and represents the amount of reactive solution that remains in the product.

Any reactive ingredients (nitrites, phosphates, enzymes, etc.) in the solution are thought to remain in solution during the 30 minutes after pumping, rather than reacting immediately with the meat or poultry protein. Therefore, using the effective percent pump in calculations more accurately reflects the ingoing amount of ingredients.

Extender. An additive that increases the weight and changes the texture of meat and poultry products, e.g., cereal, starches, etc.

Finished Weight, Finished Product Weight, or Weight of the End Product. All these terms refer to the weight of the product after processing.

The finished product (after processing) could be a cooked, ready-to-eat turkey breast or could be a raw, ready-to-cook corned beef brisket, depending up the processing procedures performed at the establishment and the form in which the products are packaged and labeled for sale.

Unlike the green weight, which is the weight of the meat and/or poultry only, the finished weight is the weight of the meat and/or poultry plus the weight of any ingredients added during processing, minus the ***actual*** shrink.

Formulated Weight, Weight of the Formulation, or Batch Weight. The total weight of all the ingredients of a product ***after*** it is formulated, including pumping and draining, if relevant.

For cured or uncured comminuted products, the formulated weight would be the weight of the meat and/or poultry plus the weight of all the ingoing ingredients.

For products that have been treated with a water-based or oil-based solution (curing, tenderizing, marinating, etc.), the formulated weight would be the weight of the meat and/or poultry plus the weight of the solution's ingredients at a specified percent pump or pick-up.

Product formulation may be found on the label approval transmittal form or in the establishment's formulation records. For uncooked products, formulated weight and finished weight may be identical.

Green Weight. The weight of the meat and/or poultry (ham, breast, belly, beef or pork trim for sausage, etc.) prior to processing (grinding, pumping, breading, cooking, drying, etc.). Nothing has been added or removed from the meat and/or poultry.

In section 319.107 of the regulations, the term ***fresh***, as in "... weight of the fresh uncured pork bellies ...", means the same as "***green weight***" because it is referring to bellies that are unprocessed.

Ingoing Amount. The amount of an ingredient added to a product when the product is being formulated. The green weight of the meat and/or poultry is an ingoing amount.

Meat. The part of the muscle of any cattle, sheep, swine, or goat that is skeletal or that is found in the tongue, in the diaphragm, in the heart, or in the esophagus with or without the accompanying and overlying fat, and the portions of bone, skin, sinew, nerve, and blood vessels which normally accompany the muscle tissue and which are not separated from it in the process of dressing. It ***does not*** include the muscle found in the lips, snouts, or ears.

Meat Block. A packing plant term that represents the total of the green weights of the meat and/or poultry and/or meat/poultry byproducts used in the formulation of a product.

Meat Byproduct. Any part capable of use as human food, other than meat, which has been derived from one or more cattle, sheep, swine, or goats.

Meat Food Product. Any article capable of use as human food which is made wholly or in part from any meat or other portion of the carcass of any cattle, sheep, swine , or goats, except such articles as organotherapeutic substances, meat juice, meat extract, and the like, which are only for medicinal purposes.

Overhauling. The process of transferring meat or poultry from one curing vat to another and then pouring the original curing solution over the meat or poultry when it is in the second vat. This process insures a more uniform cure by mixing the curing solution and exposing individual pieces to the curing solution at a different location in the curing vat.

Percent Gain. The weight gained by a meat or poultry cut or product resulting from the application of a water-based or oil-based solution. This is expressed as a percentage of the meat or poultry cut or product before the solution was applied.

Percent Pick-up. The amount (pounds) of a water-based or oil-based solution (curing, tenderizing, marinating, etc.) absorbed by an immersed piece of meat or poultry. This is expressed as a percentage of the weight of the meat and poultry before it is treated with the solution.

Percent Pump. The amount (pounds) of a water-based or oil-based solution (curing, tenderizing, marinating, etc.) pumped or injected into a piece of meat or poultry. This is expressed as a percentage of the weight of the meat or poultry before it is pumped with the solution.

Most pumped meat and poultry products are purposely held for a period of time, and allowed to drain prior to being further processed. When pumped products are drained, restricted ingredient calculations should be made using the effective pump rather than the actual pump. The drain time is not mandatory, so for products that are pumped, stuffed, and cooked in a continuous process, the actual percent pump should be used in calculations.

Phosphate. An additive used to increase the water-retaining capacity of meat and poultry tissue. Misuse of phosphate solutions may cause the product to be adulterated with excess water.

Pickle. Any brine, cure, vinegar or spice solution used to preserve or flavor food.

Poultry. Any domesticated bird (chicken, turkeys, ducks, geese, or guineas), whether live or dead.

Poultry Food Product. Any product capable of use as human food which is made in part from any poultry carcass or part.

Poultry Product. Any poultry carcass or part or any product which is made wholly or in part from any poultry carcass or part.

Projected Finished Weight (PFW) or Calculated Finished Weight. The calculated weight a product is ***expected*** to have after it is processed. Projected finished weight may be calculated for either raw or cooked products.

For a raw comminuted product ***with*** a water limitation, the PFW would be the formulated weight ***minus*** the weight of the water in the formula and its targeted percentage in the finished product, ***and minus*** the weight and percentage limitation of each restricted ingredient (with a limitation based on the PFW), divided by the percentage of the formula weight remaining after all the aforementioned deductions have been made.

For a raw comminuted product ***without*** a water limitation, the PFW would be the formulated weight ***minus*** the weight and percentage limitation of each restricted ingredient (with a limitation based on the PFW), divided by the percentage of the formula weight remaining after the aforementioned deductions have been made.

For a cooked comminuted product, the PFW would be the formulated weight, minus the ***expected*** shrink.

Protein Fat-Free (PFF). The meat protein content (inherent in the raw, unprocessed pork cut) expressed as a percentage of the nonfat portion of the finished weight.

Proteolytic. A term used to describe substances, usually enzymes, that attack or digest complex proteins, resulting in simpler proteins or amino acids.

Pump. To inject a solution (curing, tenderizing, etc.), either intramuscularly or intra-arterially into a cut of meat or poultry.

Restricted Ingredient. A product component that:

- Must be used in some required amount or percentage when the product is formulated or be in the finished product in some required amount or percentage; or
- May be added to a product when the product is formulated or be a component of the finished product in an amount no greater than a specified maximum amount or percentage; and/or
- In addition to quantitative limits, may be subject to certain use conditions.
- May be prohibited from use in certain products.

Rework. Any fully or partially processed product rerouted for reasons other than unwholesomeness or adulteration and intended for inclusion in cooked sausages, loaves, and similar products.

Shrinkage. The weight lost by a meat or poultry product during cooking, cooling, drying and storing.

Standard of Identity. The minimum requirements (cut, ingredients, processing, etc.) for meat or poultry food product to be identified or labeled with an established or acceptable name.

Synergist. A substance, that when used with another has a better effect than if each one was used alone.

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