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OREGON DEPARTMENT OF AGRICULTURE

Expert Article

SCALING PRODUCTION

A critical step in launching a new product is determining the final Product Formulation. A product formulation (or formula) is different than a recipe in a few ways. A recipe may change each time it is prepared, depending on taste or what ingredients are on-hand.

A formula, however, should remain largely unchanged from batch to batch to ensure predictable processing qualities and provide a consistent customer experience. A recipe is often prepared volumetrically using cups, milliliters, teaspoons, or tablespoons. In general, food formulations will be weightbased. So, how does one convert a recipe to a formulation? This is one of the key services provided by the FIC.

Converting a volumetric recipe to a weight-based food formulation requires a good quality scale. A lot of kitchen scales are readily available for a reasonable price, these are great for home cooking and baking.

Unfortunately, most of these scales are only precise enough to weigh down to the single gram (and only as small as 0.1 ounces when using Imperial measurements). For most formulations this is not precise enough.

Mike Adams

OSU Food Innovation Center

Mike Adams is a Food Scientist for the Product and Process Development program at the Oregon State University Food Innovation Center. The Food Innovation Center (FIC) has helped to establish the Pacific Northwest as a destination for Food Product Development, Innovative Food Trends, and Processing Techniques.

The FIC prefers to use scales that have a degree of precision at least down to the hundredth of a gram (0.01). For ingredients with particularly low usage, like enzymes and natural flavors, the FIC prefers to use scales that measure in thousandths (0.001) or even ten thousandths (0.0001) of a gram!

You pay for precision when purchasing a scale. Many scales that that are this precise cost thousands of dollars or more.

Additionally, high-precision scales need to be checked and calibrated each year to ensure they are measuring accurately. Fortunately, the FIC has plenty of these scales and the expertise to operate and maintain them.

Converting a recipe to a formulation is a service that the FIC has provided for over 20 years. Traditionally this process would involve the client scheduling time in the FIC kitchen, having the recipe(s) ready, bringing the necessary ingredients, and providing a rough outline of the typical preparation method.


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Remember to write everything down, sometimes mistakes lead to miracles. If you keep detailed notes you can capture the magic.

Time needed for this process depends on number and complexity of products. Any specialty equipment the FIC does not have would also need to be brought by the client.

As of 2020, this process has been performed by the FIC based on the recipe and instructions from clients without the client being present. Upon preparing the samples, the FIC submits them to the client for tasting and approval. Once the samples have been approved by the clients the FIC writes up the formulation (by batch weight and in weight percent), a processing outline and flowchart, and records of any important analytical measurements.

There are advantages and disadvantages to remote and in-person sessions. Having the client measuring out the ingredients can ensure a predictable end-product. For example, everyone measures out a cup of flour differently. The client knows how they measure flour to get the end-product they prefer. A scientist at the FIC might follow the recipe exactly but not know that 1 cup might refer to a “heaping cup” or that the client has a specific size of onion they prefer to use in their recipe.

With in-person sessions the client is often able to taste the product as it’s being produced and make any necessary changes on the fly, FIC scientists won’t have this inside knowledge. These circumstances can lead to samples that are not quite true to the client’s vision and necessitate another session for revisions.

Advantages to the remote process can include quicker and more dynamic scheduling, as well as an opportunity to field test the client’s proposed process to make sure the steps are clear and repeatable.

	MEASUREMENT	GRAMS	WEIGHT%
All Purpose Flour	3 Cups	369.00	55.24%
Lukewarm Water	1 ¼ Cups	283.00	42.37%
Instant Yeast	2 ¼ Teaspoons	7.00	1.05%
Kosher Salt	1 ½ Teaspoons	9.00	1.35%
TOTAL	**???**	**668.00**	**100.00%**

Table 1. *Weight Percent of Baguette Ingredients.*

So, what does converting a recipe to a formula look like? It simply involves measuring out each ingredient as written in the recipe, weighing that ingredient on the scale, recording the measurement, taring out the scale (resetting it to zero again), and then repeating with each subsequent ingredient.

Once the final ingredient has been weighed, all the ingredient weights are added together to get the final formulation weight. This final formulation weight is then used to calculate the **weight percent** of each ingredient. See Table 1 above for the weight percent of ingredients for a baguette recipe.

Once all the volumetric measurements have been weighed into grams (or another consistent weight-based unit like ounces), the weight percent can be calculated.

The flour in this dough formulation weighs 369 grams. The total weight of the dough is 668 grams. To get the weight percent of flour in this recipe you would divide 369 by 668 and multiply by 100 (to make a percent). 369/668 = 0.5524, 0.5524 x 100 = 55.24%.

You would then repeat with each ingredient weight to get the weight percent for each ingredient. The final sum of all the weight percentages of each ingredient should add up to 100%. If not then there was a mistake along the way!

Once a weight-based formulation has been produced, how can you use it?

Formulations are necessary for:

01. Scaling batch size for different production volumes

- When moving to a new batch size, multiply the weight percent of each ingredient by the new batch size to get the new target weight for each ingredient.
- For example, we need 500 pounds of the baguette dough from above. To know the amount of flour we need we would multiply 500 pounds by 55.24%, meaning we need 276.2 pounds of flour.

02. Ingredient ordering

- Knowing how much of each ingredient you go through in each batch will help you predict how much of each ingredient you need to have on-hand at any given time.
- Knowing how much of each ingredient you use in a set amount of time coupled with the shelf life of each ingredient can help you make bulk purchasing decisions. Buying in bulk may help reduce the unit cost of each ingredient.
- If you know you will use 5,000 pounds of flour in a year and the shelf life of flour is one year you may be able to purchase full pallets of flour for less cost per bag than if you purchase individual bags as needed.

03. Cost of Goods Sold (COGS)

- Knowing the price per unit of each ingredient and the relative amount of each ingredient in the formulation will allow you to calculate cost of goods. While cost of ingredients is never the total costs of production (labor, lease, other overhead costs), it is useful in comparing different bulk pricing options, as well as choosing vendors for each ingredient.
- Example for a 500-pound batch of dough: Batch yield is 1,000 baguettes, flour costs $0.60 per pound, 276.2 pounds of flour are needed for the batch. That means flour for this batch

costs 276.2 x 0.60 = $165.72. If we have $165.72 worth of flour in a batch of 1,000 baguettes, that means there is 1,000 / 165.72 = $0.17 worth of flour in each baguette.

- COGS will be very useful in determining the price you should sell your product for.

04. Nutrition labelling and ingredients statement

- Nutrition facts panels are often generated using a database program like ESHA Genesis R&D. This database software will need the weight-based formulation and the final serving size of the product to determine the nutrition facts information. Other processing parameters like moisture loss will be needed to ensure nutrition facts are as accurate as possible.
- Ingredients in the ingredients statement on your package are listed out by relative abundance. The ingredient with the highest weight in the formulation will be listed first and the one with the lowest weight listed last. The baguette from Table 1 would have an ingredients statement of: Flour, Water, Salt, and Yeast (not accounting for any subingredients).

05. Organic certification and other regulatory concerns

- Organic certification necessitates knowing the weight percent of each ingredient in the formulation, as well as the percent organic each ingredient is. To make a product that is “Certified Organic”, the weighted average of all potentially organic ingredients needs to

be at or above 95%. To make this more confusing, salt and water don’t count as they are inherently not organic. Oregon Tilth is a good resource for learning more about Organic certification, their resources and forms are freely available online.

- Some ingredients have a maximum legal usage level under FDA. Having your formulation weight percent will ensure you are easily able to make sure your formulation is compliant if you use any of these ingredients.

06. Reformulation

- You may need to change your formulation based on quality parameters, cost, or desired nutritional content. If the product needs to be under a certain pH to be shelf stable, you will need to know the weight percent of an acid added to your product to make it consistently safe for shelf stable distribution. You may also want to reduce the usage level of certain expensive ingredients (like vanilla) or change the amount of a certain nutrient (like sodium).

07. Exceptions

- Large facilities may use flowmeters for dosing liquid ingredients. These are expensive and operate under the assumption of knowing the density (mass divided by volume) of the ingredients. Liquid ingredients can be measured volumetrically on the small scale if and only if you know the density of the liquid you are measuring. Ultimately, you will still need to know relative weight of each ingredient for all of the above situations.

Having a weight-based formulation is one piece of the puzzle for scaling up production. The other piece is having a **detailed process outline** and a **processing flowchart**.

Much like the "Methods" section of a scientific publication, the process outline serves as a detailed list of steps that need to be followed to attain the desired result. Ensuring that this outline is as complete and detailed as possible will reduce the margin of error for processing and minimize the chance of creating product that is out of specification.

This is crucial for transitioning production to a processing facility where the original recipe creator will no longer be the one producing the product. When making a detailed processing outline, specific attention should be paid to key **processes** and **parameters**.

Processes can be as simple as ingredient weighing order, mixing steps, or cooking steps. Processes can also be highly complex; this is especially true when a product has multiple components. For example, an ice cream sandwich process outline might include making the ice cream portion, baking the cookies, assembling the sandwiches, the final packaging of the sandwiches, and the distribution to the retailer. Each of these steps may have additional subprocesses.

Parameters can include actions taken on the production floor and analytical measurements performed in a quality analysis lab. Processing-area parameters can include subdividing a large batch into individual pieces of the same weight (like dividing dough into several pieces for loaves), mixing speeds and times, baking temperatures and times, cooling times, moisture loss, and checking final product size and weight.

Measurements in the analytical lab may include water activity, pH, solids content, and moisture content. All of these different parameters can be key to ensuring product consistency, functionality, packaging information, nutrition facts, safety, shelf stability, and other regulatory concerns. More on analytical measurements will be covered in the next module.

Having these processes and parameters written out into a detailed processing outline is a useful tool for generating a processing flowchart.

Flowcharts are a visual representation of the processing outline, often with less detail. Typically, a flowchart will cover everything that happens in a facility from receiving ingredients, ingredient storage, weighing and processing ingredients, final packaging, and distribution.

While less detailed than a processing outline, a good flowchart will still capture key processing parameters like cook times and temperatures as well as critical food safety analytical measurements.

A flowchart will also help show processes that happen separately and eventually join together for the final product. An example flowchart and processing outline will be provided.

When will outlines and flowcharts be used?

- **Training new production workers**
  - Using the visual flowchart coupled with the detailed outline will help new production workers visualize how the product is made, as well as having detailed information to refer to as they are learning the process
- **Transitioning to a copacking facility**
  - Having the detailed process outline with critical quality assurance parameters will help the co-packer understand the targets for your product, helping to ensure consistency and a smooth transition.
  - The flowchart will help the new facility visualize how the product is produced and how their facility and equipment will best fit the process.
  - Changing facilities might require adjusting processing steps and parameters. A new co-packer may have a different oven that cooks the product at a lower temperature for longer. Having this information ready as the gold standard in the current space will help the new facility transition into making your product.
- **Food safety inspections, Organic certification, and third party audits**
  - Having process outlines and flowcharts available will be required during inspections conducted by local food safety authorities. This allows them to understand the process and make sure you are in compliance. They may suggest changes to your process for regulatory reasons.
  - Organic inspectors will want to understand how the product is produced to ensure there is no comingling with any non-Organic products or ingredients.
  - Third party food safety and quality inspectors (like SQF) will want to make sure you are following your prescribed protocols for producing your product and make sure you are consistently meeting your quality benchmarks.


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Pardon the pun, but this is a weighty subject. Do not worry if you are experiencing information overflow. There are plenty of resources available to you to help create a weight-based formulation, write a detailed process outline, and create a processing flowchart.

Remember to write everything down, sometimes mistakes lead to miracles – but if you keep detailed notes you can capture the magic. Combine your creativity and diligence to create a formulation and processing plan to produce your product at scale while keeping it consistently great.

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