



Applications Monograph: Permeate Permeate for Sodium Reduction

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As consumers look to reduce their sodium intake, permeate shows great promise for food formulations. Current science indicates that permeate's salt-enhancing characteristics make it ideal for replacing salt in many applications while maintaining consumer-acceptable flavor.

The 2010 Dietary Guidelines for Americans recommend that Americans consume no more than 2,300mg of sodium per day and that certain populations at high risk for hypertension consume no more than 1,500mg sodium per day.ⁱ These numbers are significantly lower than the current U.S. average consumption of approximately 3,400 mg of sodium a day.ⁱ

In 2010, Mintel found that 77 percent of survey respondents are interested in low-sodium foods/trends.ⁱⁱ Adults age 55 to 64 who watch their diet are interested in a number of food trends, including heart-healthy and low-sodium. Mintel advises that companies consider launching more products for this growing demographic.ⁱⁱ

From 2008 through 2010, 1,346 food products with claims of low/reduced/no sodium have been introduced in the U.S.ⁱⁱⁱ Plus, a 2009 report from Mintel indicates that lower sodium is emerging as a trend in healthy menu items.^{iv}

Food formulators have struggled to develop lower-sodium foods that taste good. Simply removing salt from a formulation often negatively impacts texture, flavor and functionality. Sodium replacers may increase costs to food, alter processing parameters and/or cause off-flavors, which reduces consumer acceptance. Through its salt-enhancing characteristics, permeate may be a cost-effective method for sodium reduction.

In an effort to combat these problems, researchers supported by the Dairy Research Institute™ have been conducting research on permeate and its use for sodium reduction.

What is Permeate?

Permeate (also called dairy product solids, deproteinized whey or modified whey) is a coproduct of the production of whey protein concentrate, whey protein isolate, ultrafiltered milk, milk protein concentrate or milk protein isolate. Permeate covers a family of products that have a minimum of 59 percent lactose, and a maximum of 10 percent protein and 27 percent ash.^v Composition of permeate will vary somewhat depending on the original material used. Sweet whey and milk are the most common starting materials for permeate production in the United States.

Delactosed permeate is a byproduct created by removing lactose from permeate. It contains about three times as much mineral content as permeate and about 60 percent lactose versus 80 percent for permeate. The higher concentration of calcium, potassium and magnesium in delactosed permeate can enhance the nutritional profile of many foods. The differences in composition between permeate and delactosed permeate are shown in Figure 1.

On the Label

The American Dairy Products Institute and the USDA have determined that permeate ingredients may be labeled as "dairy product solids" on product labels to reduce consumer confusion. Food processors using permeate will also need to add a milk-allergen warning statement.



Fig.1 Sample Composition of Permeate and Delactosed Permeate

	Permeate (%)	Delactosed Permeate (%)
Protein (non-protein nitrogen)	3.50	7.32
Carbohydrate (Lactose)	82.00	59.60
Fat	<1.00	0.03
Moisture	4.50	3.00
Ash	8.50	26.97
Sodium	0.83	2.00
Calcium	0.44	3.76
Potassium	2.47	6.29
Magnesium	.011	0.24

The Salt Replacer

The Wisconsin Center for Dairy Research at the University of Wisconsin-Madison — which works in partnership with the Dairy Research Institute — began conducting projects using permeate several years ago. The initial focus was on browning, flavor enhancement and cost reduction, but researchers learned that permeate also had salt-enhancement characteristics.

It is not clear which components of permeate are responsible for the salty properties. While the mechanisms are uncertain, it is possible that the non-protein nitrogen compounds — urea, creatine, creatinine, uric acid, orotic acid and ammonia — may serve as flavor potentiators. The mineral salts — calcium phosphate, magnesium, sodium and potassium — may function as salt enhancers.

The calcium in permeate may also play a role in its salty flavor. A 2009 study by Ohsu et al. revealed that various extracellular calcium-sensing receptors enhance salty, sweet and umami tastes, although these receptors do not specifically add flavor. These characteristics, known as “kokumi taste,” often appear in traditional Japanese cuisine.^{vi}

Sensory research at the Southeast Dairy Foods Research Center at North Carolina State University — which works in partnership with the Dairy Research Institute — is under way to determine the mechanisms of salty taste in permeate. A two-part study will be conducted to achieve this goal. In part one, the sensory properties and composition of commercial spray-dried permeates, milk minerals and delactosed permeate will be documented and compared. In part two, model systems will be built with permeate components to demonstrate and pinpoint the sources of salty flavor in permeate.

Prototypes using permeate for sodium reduction have been developed, as shown in Figure 2.

Other Benefits of Permeate and Delactosed Permeate

Permeate and delactosed permeate provide functional and flavor benefits to foods beyond just salt replacement. Because an average of 75 percent of permeate is lactose, the functionality of permeate is really dictated by the lactose content. The ash contains calcium, phosphorus and other valuable minerals, which will contribute to the overall mineral profile of a food product. Fat content in permeate and delactosed permeate is very low, so there is no added functionality from the fat.

What is the Dairy Research Institute?

The Dairy Research Institute™ is a 501(c)(3) non-profit organization affiliated with the Innovation Center for U.S. Dairy™ and was created to strengthen the dairy industry's access to and investment in the technical research required to drive innovation and demand for dairy products and ingredients, globally.

The Institute works with and through industry, academic, government and commercial partners to drive pre-competitive research in nutrition, products and sustainability on behalf of the Innovation Center and the National Dairy Council®.

For more information, please visit USDairy.com



Fig. 2 Differences in Sodium Content: Salt Versus Permeate

Product (Serving Size)	Control — With Salt Sodium Content (mg)	Permeate — Without Salt* Sodium Content (mg)	% of Sodium Reduction
Scones (55g)	230	110	52%
Chocolate Chip Cookies (30g)	100	40	60%
Snack Cake (55g)	45	40	11%
Pound Cake (88g)	150	80	47%
Muffins (55g)	230	70	70%
BBQ Popcorn Seasoning on 1 Cup Popcorn (16g)	290	210	28%
Broccoli Cream Soup (1 cup)	550	135	75%

Source: Center for Dairy Research, Madison, Wis.
 *In some bakery formulations, sodium-based leavening agents are responsible for the remaining system.

Technically speaking, permeate or delactosed permeate may be used in applications where lactose or whey are used. A reality of the food industry is that cost is an important factor when determining ingredient usage. The more functionality a food processor can get for the same cost, the better.

The lactose in permeate contributes to browning, is a crystallizable sugar, is less sweet than sucrose, absorbs volatile flavor compounds, attracts and absorbs synthetic and natural pigments, and has a low affinity for moisture.

Possible uses for permeate and delactosed permeate include baked goods, soups, confectionary, dry mixes, meats and dairy foods.

Baked goods

Permeate contributes to browning of baked goods by the Maillard reaction of lactose and other reducing sugars present (combined with available protein) in a formulation, which provides color when heated. Browning not only enhances appearance but also imparts a pleasant caramelized flavor.

Retaining moisture is an added benefit in baked goods. Lactose content in dough can also produce bread that retains its softness for a longer period of time and extends shelf life. This softness has been attributed to better emulsification of the fat in the formula and the increase in water-holding capacity.

Added to pie crusts, permeate can aid in emulsifying the shortening. This allows for a reduction in shortening without sacrificing the tender, flaky texture. Permeate also improves the color and flavor of the baked crust.

Soups

In addition to reducing sodium, permeate can provide flavor and contribute to the body/texture of a product for soup makers.

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Confectionary

Icings, coatings and non-chocolate candies can use permeate to reduce sweetness, while providing important crystallization characteristics. Research is currently under way to dry delactosed permeate for caramels to reduce sweeteners without impacting texture.

Dry mixes

Seasoning mixes, macaroni and cheese mixes, and seasoning blends for salty snacks could use permeate to help deliver a clean dairy flavor and reduction of sodium for these savory applications.

Meats

In addition to reducing the sodium in meats, permeate can enhance browning and protect color, mask bitter flavors and improve structure formation. The lactose in permeate provides an effective starter culture carbohydrate for the preparation of fermented sausages and cooked hams.

Dairy foods

Applications such as dips, cheese sauces, process cheese food and ice cream could also include permeate, as long as usage falls within the standards of identity. Permeate can be a good source of dairy solids and can provide a clean flavor.

Go to the Permeate Products page under Ingredients/Applications on InnovateWithDairy.com to check out these formulations that use permeate and delactosed permeate:

- Almond and Apricot Muffins
- Breakfast Bites
- Cheesy Crunchers
- Chocolate Brownies
- Cream of Broccoli Soup
- High-Protein Roll
- Pizza Dough
- Pound Cake
- Sweet and Savory Butternut Squash Soup

How to Use Permeate

In general, 10g to 11g of permeate will replace 1g of salt, or 3g to 4g of delactosed permeate will replace 1g of salt in a formulation. It is recommended to balance the addition of permeate or delactosed permeate by reducing other macro-ingredients such as flour, fat, eggs, granulated sugar and other carbohydrates. In many instances, a total cost-reduced formula can also be achieved as permeate replaces other more costly ingredients.

For more information on permeate and delactosed permeate, or for assistance with new or improved products using dairy ingredients, contact Dairy Technical Support at techsupport@InnovateWithDairy.com.

USDEC Global Ingredients Program

The U.S. Dairy Export Council® (USDEC) is a non-profit, independent membership organization that represents the domestic and export trade of more than 100 proprietary processors and cooperatives, ingredient suppliers, export traders and U.S. dairy producers. Its mission is to enhance U.S. global competitiveness and to assist the U.S. industry in increasing the volume and value of global dairy sales. USDEC is managed by Dairy Management Inc.™ (DMI).

The Global Ingredients Program provides dairy, food and beverage industries with a vast network of resources through our affiliated organizations – Dairy Management Inc., the Dairy Research Institute™ and the National Dairy Council® – to develop products to meet consumer demand around the world.

¹2010 Dietary Guidelines for Americans, <http://www.cnpp.usda.gov/DGAs2010-PolicyDocument.htm>

²Mintel. *Diet Trends*. May 2010.

³Mintel GNPD. Accessed April 2010.

⁴Mintel Oxygen. *Healthy Dining Trends*. May 2009.

⁵U.S. Dairy Export Council. *Reference Manual for U.S. Whey and Lactose Products*.

⁶Ohsu et al. Involvement of the Calcium-sensing Receptor in Human Taste Perception. *Journal of Biological Chemistry*. 2010;285 (2):1016 DOI.