**Applications Monograph: Permeate**

**Permeate for Sodium Reduction**

By Kimberlee (K.J.) Burrington

**Confectionary**

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

**Dry mixes**

Seasoning mixses, macaroni and cheese mixes, and seasonings 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 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:

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

**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.

**Diet Trends**

Healthy Eating Trends

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.i

**Healthy Dining Trends**

Reference Manual for U.S. Whey and Lactose Products

...
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.

**Other Benefits of Permeate and Delactosed Permeate**

Permeate and delactosed permeate can provide functionality 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.

**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.

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 mechanisms of salty taste. 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 mechanisms of salty taste.

**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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Other Benefits of Permeate and Delactosed Permeate

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### Other Benefits of Permeate and Delactosed Permeate

- **Sodium Reduction**: Permeate contributes to lowering sodium levels in foods such as baked goods, soups, and dairy products. The mineral salts — calcium phosphate, magnesium, sodium and potassium — may function as salt enhancers.
- **Browning**: The calcium in permeate may also play a role in its salty flavor. A 2009 study by Ohsu et al. revealed that 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.
- **Flavor Enhancement**: 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.
- **Texture Enhancement**: Permeate and delactosed permeate can provide flavor and contribute to the body/texture of foods. For example, permeate can improve the color and flavor of soups. It can also enhance the 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.
- **Moisture Retention**: 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 emulifying 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.
- **Flavor Potentiators**: The mineral salts — calcium phosphate, magnesium, sodium and potassium — may function as flavor potentiators. The ash contains calcium, creatine, creatinine, uric acid, orotic acid and ammonia — may serve as flavor potentiators. These characteristics, known as "kokumi taste," often appear in traditional Japanese cuisine.
- **Sensory Properties**: 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.

#### Applications Monograph: Permeate

**Permeate for Sodium Reduction**

<table>
<thead>
<tr>
<th>Product (Serving Size)</th>
<th>Control — With Salt</th>
<th>Permeate — Without Salt*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scones (55g)</td>
<td>230</td>
<td>110</td>
</tr>
<tr>
<td>Chocolate Chip Cookies (20g)</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Snack Cake (55g)</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Pound Cake (89g)</td>
<td>150</td>
<td>80</td>
</tr>
<tr>
<td>Muffins (55g)</td>
<td>230</td>
<td>70</td>
</tr>
<tr>
<td>BBQ Popcorn Seasoning on 1 Cup Popcorn (16g)</td>
<td>290</td>
<td>210</td>
</tr>
<tr>
<td>Broccoli Cream Soup (1 cup)</td>
<td>550</td>
<td>135</td>
</tr>
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*In some bakery formulations, sodium-based leavening agents are responsible for the remaining system.

Source: Center for Dairy Research, Madison, Wis.

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### Fig. 1 Sample Composition of Permeate and Delactosed Permeate

<table>
<thead>
<tr>
<th>Permeate (%)</th>
<th>Delactosed Permeate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (non-protein nitrogen)</td>
<td>3.50</td>
</tr>
<tr>
<td>Carbohydrate (Lactose)</td>
<td>82.00</td>
</tr>
<tr>
<td>Fat</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Moisture</td>
<td>4.50</td>
</tr>
<tr>
<td>Ash</td>
<td>8.50</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.83</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.44</td>
</tr>
<tr>
<td>Potassium</td>
<td>2.47</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.11</td>
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### Fig. 2 Differences in Sodium Content: Salt Versus Permeate

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Dairy foods

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For more information on permeate and delactosed permeate, or for assistance with new formula can also be achieved as permeate replaces other more costly ingredients.

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. 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.

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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. These numbers are significantly lower than the current U.S. average consumption of approximately 3,400 mg of sodium a day.

In 2010, Mintel found that 77 percent of survey respondents are interested in low-sodium foods/trends. 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.

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

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 replacements 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.

On the Label

The American Dairy Products Institute and the USDA have determined that permeate ingredients 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.

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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.