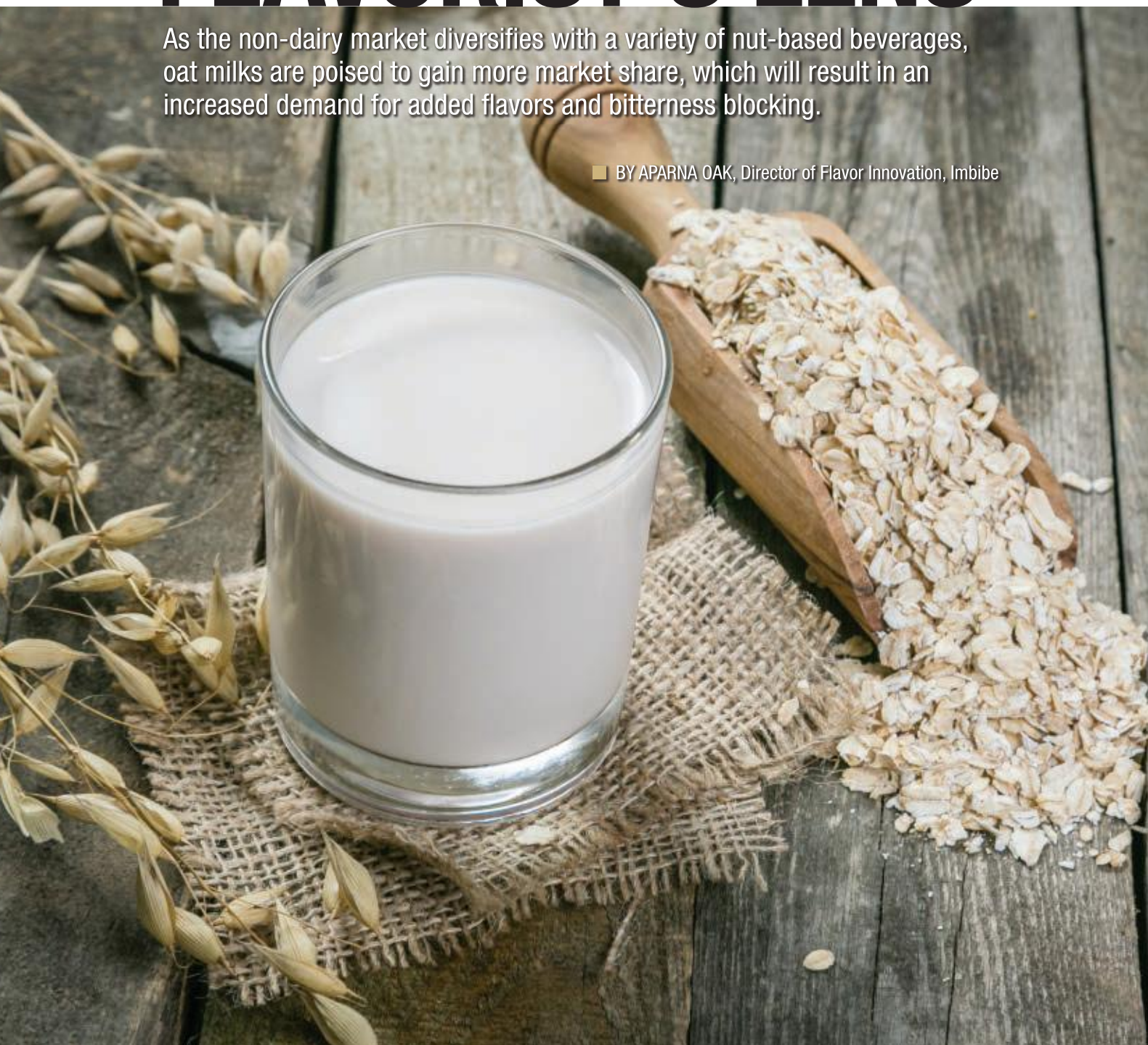


PLANT TO GLASS, **OAT MILK** FROM A **FLAVORIST'S LENS**

As the non-dairy market diversifies with a variety of nut-based beverages, oat milks are poised to gain more market share, which will result in an increased demand for added flavors and bitterness blocking.

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Take a stroll through your local grocery store and you will likely find a plethora of options for dairy alternative milks in the dairy and natural products aisles. Almond, soy, coconut, oat, rice, pea, cashew, and hemp are a few of the more well-known options on the market, but even more niche dairy alternative milks like hazelnut, quinoa and sesame are hitting shelves.

Though it's still dwarfed by dairy milk, the dairy alternative market is thriving. The U.S. dairy alternative market grew 61% from 2012 to 2018 when it reached \$2.3 billion, and is expected to surpass \$2.7 billion by 2022 with a compound annual growth rate of 4.4%^a. Driving growth is the prevalence of lactose intolerance, increased adoption of veganism and perception that plant-based products are healthier and more sustainable than its animal-based counterparts.

Currently, almond milk has the lion's share of the dairy alternative market, owning 64-percent of all sales, followed by soy and coconut milk which together account for a quarter of the market. Recently, though, there's been significant buzz about oat milk, and it could take away market share from category leaders. According to Nielsen^b, oat milk sales grew by 50% from 2017-2018 while almond milk sales grew by only 11%.

Oatly is one of most recognizable oat milks and since it was introduced to the U.S. market in 2016, the brand's distribution increased to more than 2,200 coffee shops and 1,000 grocery stores. After Oatly became available stateside, the popularity of oat milk skyrocketed, and it is so popular in coffee shops that suppliers are struggling to keep up with demand. Oatly is addressing the shortage by opening a new factory that is expected to increase volume as much as tenfold and several major players like Pepsi, HP Hood and Dean Foods launched oat milk products within the last year.

Beyond Dairy Alternatives

Although interest in oat milk is currently on the rise, it is not a new beverage and has actually been around for more than two decades. Oat milk was first developed in Sweden by the founder of Oatly during the early 1990s and Pacific Foods launched an oat milk in 1996. Like other types of plant-based milks, many early iterations of oat milk had flavor and textural flaws. The proliferation of dairy alternative



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milks over the last decade prompted suppliers to develop new technologies that improve taste and solubility of plant-based ingredients and expanded the job of a flavorist to include making less palatable flavors taste as neutral as possible. The result has been an evolution of flavor for products that once were chalky, astringent and stale to ones that taste milky, creamy and clean.

Oat milk has many advantages compared to other dairy alternative milks. Most brands and consumers want a dairy alternative milk to be reminiscent of dairy milk and many oat-based ingredients used in beverage have a relatively neutral flavor. Other plant-based ingredients like almond and pea have nutty or green notes that come through and need significant masking to taste like dairy milk.

Oat milk is also higher in fat content than most other dairy alternative milks which improves foam formation for lattes and cappuccinos. Coffee shops have been essential for increasing exposure of oat milk and the neutral flavor and ability to foam well has contributed to its popularity with consumers.

Concerns about the environment and allergens have also impacted oat milk's success. Oats are deemed more sustainable than some other plant-based ingredients because they require less water to produce. For example, it takes around 383% more water to produce one pound of almonds than it does to produce one pound of rolled or flaked oats according to Water Footprint Network^c.

Oats are also allergen-friendly for consumers with sensitivities to dairy, nuts and legumes. Many are

^a <https://www.mintel.com/press-centre/food-and-drink/us-non-dairy-milk-sales-grow-61-over-the-last-five-years>

^b <https://www.ft.com/content/4824217e-0527-11e9-99df-6183d3002ee1>

^c https://www.huffpost.com/entry/food-water-footprint_n_5952862



Coffee shops and craft coffee beverages have increased oat milk exposure. Brands like Oatly and Califia's oat milks provide neutral oat flavor with the ability to foam well, making it a popular non-dairy coffee creamer choice.

gluten-free, too, depending on the source of the oat. Although oats are inherently gluten-free, some are processed in the same factories as wheat and other grains where gluten can be introduced via cross contamination. Brands like Oatly and Califia make bold gluten-free claims on their packaging to differentiate its products and entice consumers who are avoiding the allergen.

The oat milk craze isn't expected to lose momentum any time soon and there's plenty of opportunity for innovation. Beyond just dairy alternative milks, oats are being incorporated into products like dairy alternative creamers, barista milks and frozen desserts.

Developing a dairy alternative product that has the taste, texture and mouthfeel that consumers expect is technically complex, though. Brands who are going to jump on the oat milk bandwagon need a clear understanding of the product they want to develop, especially in today's industry where clean label is standard. Primary formulation

considerations include how to achieve a stable product that delivers on the desired flavor, texture, mouthfeel, nutritional profile and cost parameters.

Important questions to ask before starting formula development include: What do you want the flavor profile to be? Are there ingredient restrictions? Are there specific claims you want to make about the product? Is there a calorie limit? What is the desired packaging? How will the product be distributed and stored? These questions will also guide packaging design and how a product will be differentiated in a saturated market.

What is Oat Milk?

Oat milk is a combination of an oat base, water, fat, stabilizers, vitamins, minerals and flavor. To create a product with the attributes that consumers want and expect, harmony between a product developer and flavorist is essential. A product developer chooses ingredients based on taste, stability, nutritionals and mouthfeel, and a flavorist

complements the formula by masking off-notes and increasing the perception of dairy-like creaminess with flavor. Basic understanding of the beverage formula and processing helps a flavorist design a supplementary flavor and masking system that is heat stable and fulfills a brand's taste, texture and mouthfeel expectations.

The main component of any oat milk is the source of oat which can be in the form of a flour, paste or concentrate. Liquid-based ingredients like oat paste or oat concentrate are more viscous and oatmeal-like than some flours. Enzymatically-treated oat pastes and concentrates are the most appealing for beverage because they are less viscous but tend to be more expensive. Oat flours have a neutral flavor and varying consistencies depend on how refined the ingredient is, but stabilization can be a challenge.

There's no standard of identity for oat milk, so how much oat is used is dependent on the desired flavor, mouthfeel and nutritional. Higher amounts of oats are required if a brand wants to make a nutritional claim like a certain amount of dietary fiber from the oats, but it would also result in a grainier flavor and increase the calories, carbohydrates and sugar content of a product. Products that use high amounts of oat also require more flavor masking, fat and stabilization work.

Oats don't have enough fat on their own to make a product creamy, so in addition to using flavor to create the perception of creaminess, product developers incorporate fats to improve viscosity and mouthfeel which gives consumers an experience similar to drinking milk. Fat is added back using ingredients like sunflower oil, rapeseed oil, or coconut cream, though the latter is less popular because it introduces a nut allergen to the beverage formula. Barista milks have more fat than original versions because it improves foam formation and creaminess in espresso or coffee. Fat is also

beneficial for using oat milk in applications like baking and some consumers find it more enjoyable than ones with less fat to drink as a replacement for dairy milk.

Formulation Considerations

Stabilizers and emulsifying ingredients like acacia gum and sunflower lecithin are added as a thickener to improve suspension and prevent fat separation in the finished product. Carbonates, phosphates and citrates act as buffers to protect proteins in oat milk and prevent the beverage from separating.

Some oat flours are more challenging to keep in suspension because they contain particles that can separate out of the beverage, negatively impacting appearance and creating an undesirable "sediment" layer at the bottom of the package. Therefore, products that use oat flour may require more gums and stabilizers than some of the pastes that are enzymatically treated.

Since oat milk is widely used as a milk or creamer in coffee, brands should consider a formula that stays stable when it interacts with the acidity of coffee. A common consumer complaint is that some oat milks separate after sitting in coffee.

Flavor, Maskers and Sweetener Considerations for Oat Milk

Most brands want a product to taste as close to dairy milk as possible because consumers are using it as a replacement for milk and adding it to products like coffee, cereal or smoothies and in culinary applications.

To make a dairy alternative product that tastes like dairy milk, flavorists use a combination of supplementary flavors and masking systems. One of the challenges with plant-based ingredients is that they have off-notes like cardboard, metallic,



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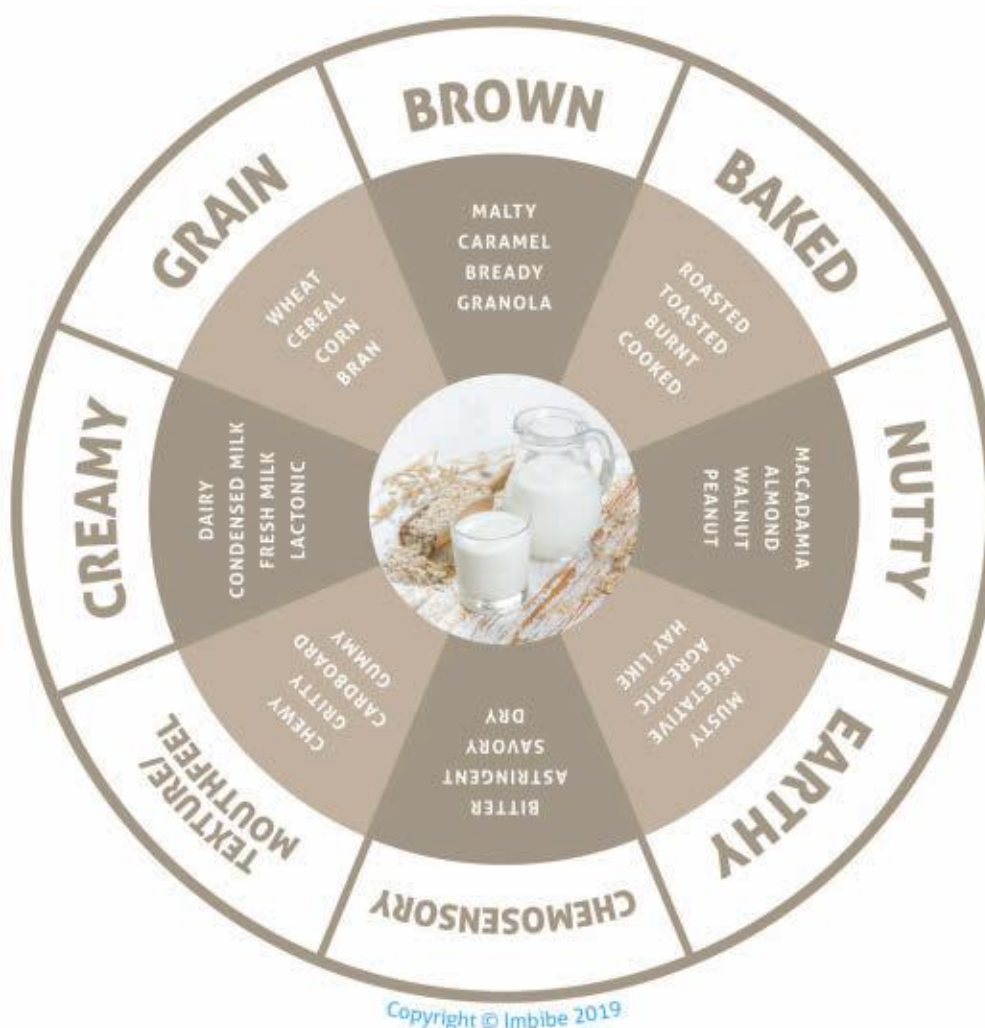
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When creating a flavor for a non-dairy milk application, the flavorist must address the off-notes of the base ingredient, while also providing a desired flavor, texture and mouthfeel.

astringency and rancidity. There is no one size fits all type of solution when it comes to dairy alternative milks, so what works for a product like pea milk may not work for an oat milk, and what works in one oat milk may not work in another.

Oat ingredients used in beverage applications can have a wide range of taste profiles from neutral to toasted or a strong cereal-like flavor. The flavor and masking system will depend on the flavor profile of the oat ingredient and the amount used in the product. Most brands want a neutral profile, but some brands may want an oat-forward flavor if it's being used in a product like a breakfast smoothie or protein shake. The latter would require tempering cardboard or astringent notes while amplifying pleasant grainy notes.

To achieve a dairy milk flavor profile, a flavorist needs to disguise the brown, toasted notes by incorporating a supplementary flavor reminiscent of

fresh dairy combined with specific masking ingredients which can be flavor-based. The supplementary flavor will have fatty, creamy notes expected from dairy milk and possibly sweeter notes to cover up the graininess of the product. The supplementary flavor is essential for rounding out and deepening the flavor of dairy alternative milks and adding a third dimension of richness and depth.

The main components that lend to the flavor of dairy products include lipids, sugars and proteins which are naturally occurring in milk. As strange as it may sound, it is also beneficial to consider the effect of the cow's diet on the flavor of the milk and incorporating attributing aroma chemicals that impart those notes.

A collection of compounds such as furans, pyrans, dairy acids, aldehydes, methyl ketones, lactones and higher chain fatty acids are the key compounds of a dairy flavor. As part of the supplementary flavor,

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these compounds impart a neutral flavor and contribute to the sweet, creamy and milky notes a consumer would expect from a dairy milk. Lactones in combination with stabilizers also create the perception of a smooth, creamy and rich mouthfeel that most dairy alternative milks lack.

These flavors are composed of heavier and non-volatile molecules which ensures the flavor undergoes minimal loss of impact during processing. However, the heaviness of the molecules can also make a flavor one dimensional. Realism can be added by incorporating lighter esters of dairy acids to impart a perception of coolness one might expect from drinking a glass of milk.

These compounds are also used as a masking agent to mute undesirable astringency or cardboard-like notes from the oat-base. A masking system creates a cleaner profile and helps the supplementary fresh dairy flavor to shine through. Products with lower oat content need more flavor supplementation than ones with higher content but increasing the amount of oats results in off-notes that require a masking system.

Another reason to incorporate a masking system is to mute toasted or brown notes that come out during processing. Oat milks are processed at ultra-high temperatures and a Maillard reaction from amino acids and reducing sugars in a formula is common for a product with grain and protein.

The off-notes are likely a result of the high oat content and sulfurous compounds generated by proteins in the formula. The heat processing causes a spectrum of aromatic compounds like pyrazines, pyrones, furans and furanones to be generated. Addition of a dairy milk flavor in combination with a masking flavor minimizes the cooked off-notes. Although, it's important to allow ample time for the beverage to rest after processing before adjusting masking flavors because many of the off-notes will dissipate.

Many brands also want a flavored version of a dairy alternative milk in addition to the original, or milk-flavored, product. Chocolate and vanilla are most common for oat milk. Vanilla notes bring sweetness to the product and cover up some of the graininess. Many brands avoid added sugars since most consumers are limiting their sugar intake but added sugars can help sweeten the product and amplify the flavor of chocolate and vanilla in an oat milk.

The popularity of oat milk in coffee will likely lead to more brands launching oat-based coffee creamers as well. These will require more stabilizers, fats, and flavors to create the thick, creamy mouthfeel a consumer would expect from half and half. It also creates opportunities for incorporating new flavors

into oat-based beverages. Creamer flavors with brown notes like hazelnut, caramel, horchata and butter toffee would complement oat milk as well.

The Future of Oat is Bright

The oat milk craze is sweeping the nation which is generating fierce competition between brands for the cleanest and best-tasting product. Entrepreneurs to industry-leaders are entering the oat milk category with high hopes of having the same success as Oatly.



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The health and wellness movement has propelled the popularity of dairy alternative milks, and while oat milk may have more calories and fat than other plant-based options, its taste and texture have won over consumers. Sustainability of oats compared to other ingredients used for dairy alternative milks and their allergen-friendly nature also add to the appeal.

In addition to winning space in the refrigerators of consumers, oat milk brands have the opportunity to increase sales by way of coffee shops if it becomes the preferred brand of baristas. Oat milk is the latest dairy alternative offering at Starbucks Reserve stores in the United States, and while Oatly is used across the pond, Elmhurst is used at stores in the states. Achieving a dairy milk flavor profile, stability in coffee and tea and using as few ingredients as possible are a few considerations for how a brand can stand out from the competition.

In addition to brands entering the oat milk category, expect brands to develop new dairy alternative innovations with oats like yogurt, ice cream, dessert toppings, spreads and more. As it stands right now, the sky is the limit for oat-based food and beverage.

