

11
21

food technology

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Advancing Food & Health Through Sound Science

Feeding the World Better



gluten-free formulating
fermented foods flourish
coffee and health
snacking trends



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Developing Plant-Based Solutions using Fats & Oils

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The Benefits of Structured Data for Food Research & Development and Quality Control Teams

Supplier Solution Webinar

On Demand

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DuraShield™ Food Protection Blends for Plant-Based Alternative Proteins

Supplier Solution Webinar

November 11 | 1 - 1:30 pm CT | Later On Demand

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Time to Kick Start Healthy Eating

Experts from a variety of disciplines examine eating and shopping trends, strategies for motivating behavior change, and the role of food science and technology.

On Demand



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Fundamental elements of sensory and consumer science.

Online

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Times and dates subject to change. Check ift.org for updates.

Keeping Diabetes in Check: Incorporating Low- and No-Calorie Sweeteners

While low- and no-calorie sweeteners (LNCS) offer benefits to many, they are especially important for those living with diabetes. “Low-calorie sweeteners can serve an important role in diabetes management,” says Dr. Keri Peterson, Calorie Control Council medical advisor. Because LNCS do not raise blood glucose or insulin levels, they empower people with diabetes to reduce their sugar consumption without sacrificing sweet taste.

Low- and no-calorie sweeteners can make glucose management plans more enjoyable. Though a diagnosis of type 2 diabetes necessitates lifestyle changes, it does not require an elimination of sweet treats from the diet entirely. “Substituting sugars with low calorie sweeteners gives those living with diabetes more flexibility in their diets, allowing them to enjoy sweet foods without affecting blood sugar,” says Dr. Peterson. Taste perception, including sweet taste, is frequently cited as an important factor in food choice, and is touted as the gatekeeper of food intake. Therefore, eliminating the sweet taste from the diet is unrealistic and, with LNCS, unnecessary. By replacing sugar with LNCS, people living with diabetes can maintain control of their blood sugar and insulin levels while still enjoying their favorites.



Keri Peterson, M.D.

Today, there are more options than ever before for foods and beverages sweetened with LNCS, available online and in stores. LNCS can be found in chewing gum, candies, ice cream, baked goods, fruit spreads and canned fruits, fillings and frostings, beverages, yogurt and more. Products labeled as “light,” “reduced-calorie,” “reduced-sugar” or “diet” often include LNCS. These sweeteners, listed on product ingredient labels, include:

- **High intensity sweeteners** such as acesulfame potassium, aspartame, saccharin, sucralose and stevia
- **Polyols (also known as sugar alcohols)** such as erythritol, sorbitol and xylitol
- **Carbohydrate sweeteners** such as allulose and fructose

Additionally, certain LNCS options can be purchased on their own to be included everyday recipes. In fact, they have become so popular that they even have their own area on grocery store shelves, conveniently located next to the sugar that they’re used to replace. These products, often referred to as “tabletop sweeteners,” vary in how and in what amount they are used to substitute sugar in recipes, but directions are typically included on product packaging for ease of use.

When part of a balanced overall diet, LNCS add variety and taste for those looking to manage their blood glucose.

HOW LOW- AND NO-CALORIE SWEETENERS CAN HELP PEOPLE WITH DIABETES



Blood Glucose Levels

Low- and no-calorie sweeteners help to lower the total sugar content of foods and beverages which can help keep blood glucose levels in check.



Living a Sweet Life

Substituting low- and no-calorie sweeteners for caloric ones can make a blood glucose management plan more enjoyable.

Sodium 160mg	7%
Total Carbohydrate 37g	13%
Dietary Fiber 4g	14%
Total Sugars 12g	
Includes 10g Added Sugars	20%
Protein 3g	

Nutrition

In spite of their sweetness, low- and no-calorie sweeteners are not reflected in the Total or Added Sugars lines on Nutrition Facts labels since they contribute little or no calories. However, polyols and allulose are still reflected in the Total Carbohydrates line, as they have a very small caloric value and a minimal impact on blood glucose levels.



Hacking the Food Supply:

Can we synthesize a more sustainable future?

FIRST 2022 Call for Proposals

IFT is calling upon our community to engage in the urgent debate about the future of food and what advancements will help us address the stress of climate change.

In 2022, FIRST- Food Improved by Research, Science, and Technology - will bring together diverse perspectives of those within the science of food. The FIRST Call for Proposals seeks novel research and innovative solutions that address promising new frontiers in extracting, synthesizing, and otherwise hacking a more humane, climate-friendly, and consumer-friendly food supply.

Submit your 2022 session proposal before December 1, 2021!

ift.org/callforproposals

first

Food Improved by Research, Science, & Technology

July 10-13, 2022



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The New Call encourages individual speaker submissions and new presentation models to make it easier for attendees to plan their schedule and to see your session.

Learn more at
ift.org/callforproposals

11 21 contents

Advancing Food & Health Through Sound Science



FEATURES

22 Feeding the World Better

by Dale Buss

CPG companies are tackling food insecurity around the globe, tailoring product development initiatives to local market nutrition needs.

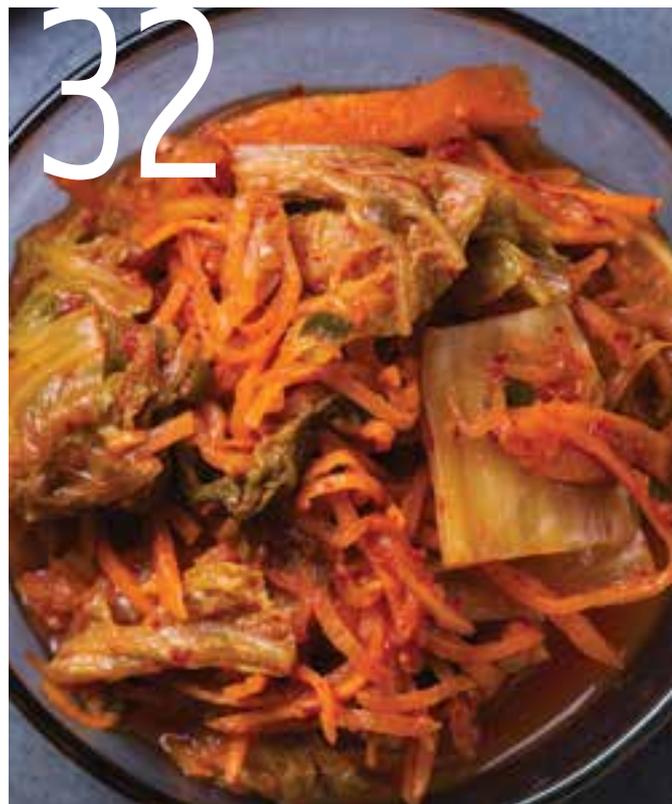
32 Not Just a Gut Feeling

by Ed Finkel

Fermented foods category sales are growing as consumer interest in the microbiome mounts, triggered in part by the COVID-19 pandemic.

22

32



Cover Pan-Pavel/iStock/Getty Images Plus

11 21 contents

Advancing Food & Health Through Sound Science

COLUMNS

9 President's Message

by Vickie L. Kloeris

Grounded in Purpose: Re-envisioning IFT's Path Forward

14 Consumer Trends

by A. Elizabeth Sloan

Consumers Have the Munchies

19 Nutrition & Diet

by Jaime Savitz

How Coffee Affects Health

20 Startups & Innovators

by Dale Buss

The Kombucha Category Evolves and Innovates

41 Ingredients

by Kimberly Lord Stewart

Move Over Bland Gluten-Free Brands

50 Nutraceuticals

by Linda Milo Ohr

Maintaining Mobility

54 Food Safety & Quality

by Gülhan Ünlü

Natural Antimicrobials: Bacteriocin Applications in Foods

58 Processing

by Ziyet Boz

How Extended Realities Will Impact Food Processing

61 Packaging

by Claire Koelsch Sand

Packaging Science Increases Food Access

68 Food Snapshot

The Consumer Sustainability Spectrum



DEPARTMENTS

10 www.ift.org

Plant-Based Proteins for Foodservice, Coffee Grown in a Lab

11 News

Boosting the Benefits of Apples, 3D-Bioprinting Simulates Wagyu Beef

16 New Products

Bite-Sized Entrées, Pasta Sauces With Kelp, Turmeric Salt

64 IFT World

Remembering Roy Hlavacek, Getting to Know Upasana Hariram

RESOURCES

6 *Food Technology* Info

66 Classifieds

67 Advertisers' Index

Food Technology ISSN 0015-6639 (print), ISSN 2578-5214 (online), November 2021, Volume 75, No. 10. Published monthly, except a combined issue in December/January by the Institute of Food Technologists, 525 W. Van Buren St., Suite 1000, Chicago, IL 60607 U.S.A. Copyright © 2021 by Institute of Food Technologists. All rights reserved. Printed in U.S.A. (USPS: 203-900). Periodicals postage paid at Chicago, Ill., and additional mailing offices. Canadian GST Registration Number is 131264855. Domestic annual non-membership subscription rate: \$190.00; New Offer: Digital Only—\$140.00 (Foreign subscriptions, postage extra; see *Food Technology* Information page). Postmaster: Send address changes to *Food Technology*, Customer Service Dept., 525 W. Van Buren St., Suite 1000, Chicago, IL 60607.



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INFORMATION ISSN 0015-6639 (print), ISSN 2578-5214 (online)

FOOD TECHNOLOGY, established in 1947, is the publication of the Institute of Food Technologists, a nonprofit scientific society founded in 1939. The Institute of Food Technologists (IFT)—a scientific, educational society with an interest in global concerns for providing a safe and wholesome food supply—maintains executive, editorial, subscription, and advertising offices at the Institute of Food Technologists, 525 W. Van Buren St., Suite 1000, Chicago, IL 60607. Phone: 312-782-8424; Fax: 312-782-8348; E-mail: info@ift.org; Web site: www.ift.org.

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CHANGE OF ADDRESS must include recent mailing label and new address with ZIP/Postal code. Allow two to four weeks for change to become effective.

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Food Technology

There is nothing
permanent except
change.

-Heraclitus

For 75 years,

IFT's Food Technology magazine has been the leading publication addressing all facets of food science and technology. Its in-depth and balanced coverage includes:

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- **Deep-dives into issues impacting the food system**
- **Best practices in formulation, food safety and processing**

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IFT

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Thanks to the immense generosity of Dr. Caldwell, this fellowship is a wonderful opportunity for a graduate student to further their academic pursuits and advance Feeding Tomorrow's mission to support the educational endeavors of students in the science of food.

Kate Dockins
Executive Director, Feeding Tomorrow



Elwood Caldwell, PhD



Enduring Support for Future Food Scientists

The late Elwood Caldwell, PhD, so firmly believed in the mission of Feeding Tomorrow—bring the best and brightest minds to the science of food—that he endowed a new graduate fellowship through a \$1 million bequest, the largest gift in the foundation's history. Applications for this new opportunity will open November 1 - December 17, 2021.

To learn more about Dr. Caldwell and make a donation to the foundation, visit the new Feeding Tomorrow website.

feedingtomorrow.org



Feeding Tomorrow brings the best and brightest minds to the science of food and helps them improve the world.

by Vickie L. Kloeris

Grounded in Purpose: Re-envisioning IFT's Path Forward

IFT is an organization on a mission. We believe that the sum of our parts will propel us forward, individually and collectively, toward a better food future. We are a community of knowledge, a community of action, and a community of science. As we collectively work to solve increasingly complex problems in our food system, we provide an essential space for food scientists and innovators in pursuit of knowledge and discovery to network, collaborate, improve themselves, and advance our profession.

This is why our mission and vision are more than convenient statements on a webpage. They are our common purpose, an evolving legacy inherited from our predecessors and made stronger and more inclusive for those who are the future of IFT. To ensure these statements and the structures created to support them continue to reflect our reality, principles, and aspirations, the IFT Board of Directors, comprised of your professional peers, reviews them on a regular basis. The board engaged in this important work recently.

As a result of a months-long process that included significant research and self-examination, our mission, vision, core values, and the areas of impact that we believe IFT must pursue have evolved, enabling us to extend our reach, expand our community, and work toward more equity in that community.

Our vision is straightforward: "We envision a world where

science and innovation are connected and universally accepted as essential to improving food for everyone."

In order to achieve that vision, we've established a mission that will take us there: "IFT is connecting global food system communities to promote and advance the science of food and its application."

For both our mission and vision, the words were chosen strategically and efficiently. The connectedness and universal acceptance that we pursue in

Our mission, vision, core values, and the areas of impact that we believe IFT must pursue have evolved, enabling us to extend our reach, expand our community, and work toward more equity.

our vision are of fundamental importance. Meanwhile, our mission continues to focus our efforts on communities, advancement, and application. Finally, we will continue to use the "science of food" language we adopted several years ago to be more inclusive of professionals innovating across the food spectrum.

While our mission and vision provide clarity of long-term purpose, it is our impact areas that give us immediate direction and calls to action. IFT is focused on three areas of impact in support of its mission and on behalf of its members and community: 1) Directly support job-related challenges with fast and simple problem-solving tools,

resources, and connections; 2) Address global system challenges by leveraging the global network, creating community, and inspiring long-term learning; and 3) Give visibility to what the food future might hold, through forecasting trends, showcasing research, and building innovation networks.

These areas of impact were carved from extensive research that IFT conducted in the past year, gathered directly from current and past members as well as other food system leaders and

designed to directly address their challenges. It is these impact areas from which IFT will design a new partnership with its members, creating new shared objectives, and designing solutions that quickly and directly address job-related and career needs. We're very excited about this way forward.

With our mission, vision, and areas of impact firmly established, the IFT Board of Directors turned its attention to the organization's core values. Without doubt, an organization's core values should be reliably consistent over time, and it wasn't our intent to rewrite these well-established, non-negotiable values. However, we felt very strongly that something was

missing. While the statements describing our values of community, integrity, passion, progress, and respect remain unchanged, we agreed that our commitment to diversity, equity, and inclusion should be enshrined in our core values with a clear statement of intent.

Inclusion is now an IFT core value, adding to the DEI mission and DEI vision that were established three years ago. Inclusion as a core value means that we promise to listen, learn, and invite input from people of all backgrounds. We will create processes to reach shared agreements and pursue equity in our community. Our decisions and actions will be informed by intentionally challenging assumptions, beliefs, and practices that maintain inequity in society and science. This, and all of our core values, are shared by all of us at IFT. They establish a clear expectation and community agreement, and one we must all hold ourselves accountable to.

It is my honor as president of IFT to share these changes with you, this evolution of our past, bridging to our future. I look forward to listening to your thoughts this year as we explore the deeper meaning behind this strategic structure and begin to develop a path forward, anchored by these principles. **FT**



Vickie L. Kloeris, MS, CFS
• IFT President, 2021–2022
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by Kelly Hensel

LEARN ONLINE

PLANT-BASED PROTEINS
FOR FOODSERVICE

Leading marketing and insights professionals Jenny Palan (Kerry) and Laurice Pouvreau (Wageningen Food & Biobased



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Research) will share their expertise in clarifying consumer desires and critical technology to develop craveable plant-based solutions in a webinar on **November 17 at 9–10:30 a.m.**

CT. Thoughtful design is critical for success in foodservice, and this session will provide the latest consumer and industry research as well as the technology and processes used to support continued innovation. IFT members can register for free (\$20 fee for non-members) by scanning the QR code or visiting content.ift.org/plant-based-proteins.

JOIN THE DISCUSSION

COFFEE GROWN
IN A LAB

The cost of coffee beans is surging—up nearly 43% this year alone. What if you could produce coffee in a lab using fewer



Photo courtesy of VTT Technical Research Centre of Finland

resources and without the need for land? Researchers at VTT in Finland have done just that using cellular agriculture. While the team is still in the process of examining the coffee biomass in detail, the early results are

promising. Read more about the research and view a slideshow by scanning the QR code or visiting iftexclusives.org/cellular-coffee. After reading the article, join a discussion on the topic taking place in IFT Connect at iftconnect.org/cellular-coffee.

PODCAST



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Exploring Fresh Produce

In a recent episode of the Sci Dish podcast, guest Max Teplitski, chief science officer for the Produce Marketing Association, and host Bruce Perkin, principal scientist and operator of Robust Food Solutions LLC, discuss increasing fresh produce consumption in school-aged children. They also shed light on how genetics can make delicious fruits into manageable crops and how “new” produce is introduced to the market. Listen to the IFT Sci Dish podcast at ift.org/scidish.

IN-DEPTH RESEARCH

Sensory Characterization
of Avocados

A study published in the *Journal of Food Science* examines the sensory characteristics of California-grown Hass and 3-29-5 (GEM) avocados using descriptive analysis and consumer panels. Both panels were conducted five times across the 2019 harvest season. The consumer panel indicated that Hass samples had a consistent sensory profile over the harvest season, whereas 3-29-5 changed substantially, becoming more closely associated with a positive eating experience late in the harvest season. Read the study at content.ift.org/JFS-avocados.

THIS MONTH'S LIST

ORGANIC
TRACEABILITY
COMMENTS

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IFT recently submitted comments to the U.S. Dept. of Agriculture providing input on the modernizing organic traceability discussion document prepared by the Certification and Accreditation Subcommittee. IFT detailed the following two suggestions for moving forward:

1. Pilots to clarify structure, process, and roles.
2. Opting for a decentralized vs. centralized storage.

Read the comments at content.ift.org/IFT-Comments.

by Margaret Malochleb

Boosting the benefits of apples

Data from more than 100 apple varieties has been collected on a new platform developed by Ohio State University scientists in an effort to improve the breeding process and boost the health benefits of America's favorite fruit.

The platform combines the genetics behind specific traits and information on hundreds of chemical compounds, ranging from sugars and acids to antioxidants, that contribute to the health benefits of apples. By showing relationships between genetics and the phytochemicals

found in apples, the platform could help streamline the breeding process, which sometimes requires decades for a new cultivar.

"We looked for strong relationships at locations in the genome that are not well studied in apple and looked for which compounds we could identify and which had nutritional value," explained study author Jessica Cooperstone in a press release. "We could go from untargeted data all the way to finding candidate genes responsible for compound production—which researchers can then validate." The goal, she added, was to take a holistic approach that would improve



A new platform containing data from more than 100 apple varieties could help streamline the breeding process and enhance health benefits.

© PicturePartners/iStock/Getty Images Plus

News Bites

- **Cargill** has entered into an agreement to acquire **Aalst Chocolate Pte. Ltd.**, a Singapore-based chocolate manufacturer.

- **CP Kelco** announced that it will invest more than \$50 million to expand production capacity for **NUTRAVA** citrus fiber in the company's facility in Matão, Brazil.

- **Emmi Roth** has acquired **Athenos**, maker of cheese, hummus, and pita chips, to complement the range of Emmi Roth's locally produced and imported specialty cheeses in the United States.

- **FONA International**, creator and manufacturer of complete flavor solutions, ranked No. 2 on *Fortune* magazine and Great Place to Work's

2021 Best Small and Medium Workplaces in Manufacturing & Production in the nation.

- **IFF** has entered into an agreement to sell its Microbial Control business unit to **LANXESS**, a specialty chemicals company, in a transaction valued at \$1.3 billion.

- **Ingredion** signed a strategic distribution agreement with **Batory Foods** to consolidate Ingredion's distributor reach in the West and Central Midwest of the United States.

- **McCormick & Company**, along with Guatemalan spice supplier **Nueva Kerala** and Heifer International, announced the launch of the Cardaforestry project, which aims to increase smallholder farmer resilience and improve the quality of

cardamom and allspice sourced by McCormick through agroforestry systems by 2023.

- **Nestlé Professional USA** has partnered with the World Resources Institute (WRI) to bring WRI-certified Cool Food Meals to out-of-home dining locations. The low-carbon dishes will incorporate plant-based proteins from *Sweet Earth Foods*. Nestlé also announced plans to work with the company's network of more than 500,000 farmers and 150,000 suppliers to support and accelerate the transition to a regenerative food system and initiate new programs that address the social and economic challenges of the transition.

- **PepsiCo** announced plans

to invest in a new \$256 million food manufacturing plant in Poland, which will manufacture a range of snacks, including *Lay's* fried and oven-baked products and *Doritos*.

- **Prinova Group** has entered into a definitive agreement to acquire **The Ingredient House**.

- **Sokol Custom Food Ingredients** announced a new partnership with **Sunkist Growers** for the development and production of a line of better-for-you *Sunkist*-branded dressings and sauces.

- **Tyson Foods** plans to invest \$300 million to build a 325,000-square-foot plant in Danville, Va., for the production of fully cooked branded chicken products, including *Any'tizer Snacks* and *Chicken Nuggets*.

nutrition without “sacrificing yield, disease resistance, and flavor.”

The research team plans to use the data to get a better understanding of health-promoting compounds of interest and employ biotechnological approaches that could speed up flowering and fruit production.

Food freezing concept enhances safety, quality

A recent study conducted by the U.S. Department of Agriculture’s Agricultural Research Service (ARS) and University of California–Berkeley scientists concluded that isochoric freezing, which works by storing foods in a sealed, rigid container filled with a liquid, could cut energy use by as much as 6.5 billion kilowatt-hours each year while reducing carbon emissions by 4.6 billion kg, the equivalent of removing roughly 1 million cars from roads.

Unlike conventional freezing, in which

food is exposed to air and freezes solid at temperatures below 32°F, isochoric freezing preserves food without turning it to solid ice. As long as the food stays immersed in liquid, it is protected from ice crystallization.

Isochoric freezing also allows for higher quality storage of fresh foods such as tomatoes, sweet cherries, and potatoes, which can be difficult to preserve using conventional freezing methods. Another advantage of the technique is that it kills microbial contaminants during processing.

“The entire food production chain could use isochoric freezing—everyone from growers to food processors, product producers to wholesalers, to retailers,” said Tara McHugh, co-leader of the study and director of the ARS Western Regional Research Center in Albany, in a press release. “The process will even work in a person’s freezer at home after they purchase a product—all without requiring any major investments in new equipment. With all of the many potential benefits, if this innovative concept

catches on, it could be the next revolution in freezing foods.”

ARS and UC–Berkeley have applied for a joint patent to use isochoric freezing in the preservation of food and are seeking commercial partners to help transfer the technology to the commercial sector.

3D-bioprinting simulates Wagyu beef

Scientists from Osaka University have 3D-printed a meat alternative, using stem cells isolated from Wagyu cows. The meat alternative contains muscle, fat, and blood vessels arranged to closely resemble conventional steaks. The research provides an important advancement in efforts to create an environmentally friendly and sustainable way of producing cultured meat alternatives.

Wagyu is known for its high content of intramuscular fat, which provides the

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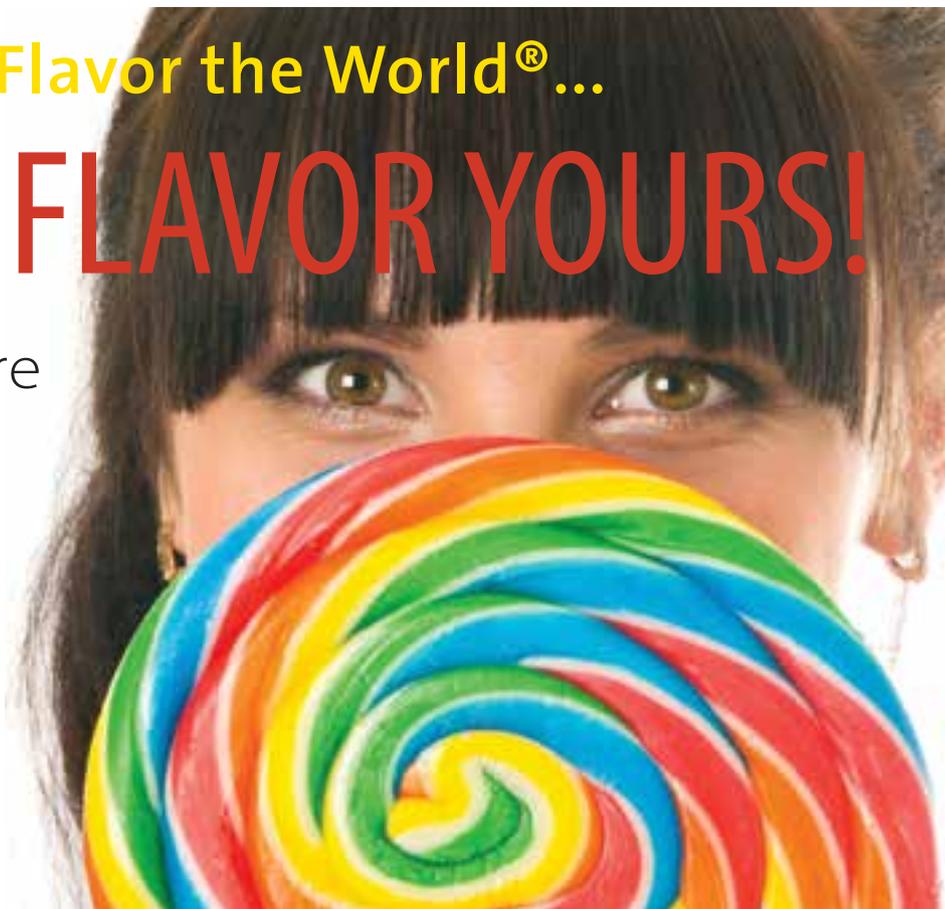
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characteristic rich flavor and distinctive texture of beef. The 3D-printed meat represents a step up from many currently available cultured meat alternatives, which fail to reproduce the complex structure of real beef steaks.

To produce the structures that characterize Wagyu beef, the researchers used two types of stem cells, bovine satellite cells and adipose-derived stem cells, coaxing them to differentiate into various types of cells needed to produce the cultured meat. Once individual fibers, including muscle, fat, or blood vessels, were fabricated from the stem cells using bioprinting, the fibers were then arranged in 3D to reproduce the histological structure of real Wagyu meat.

“By improving this technology, it will be possible to not only reproduce complex meat structures, such as the beautiful sashi of Wagyu beef, but to also make subtle adjustments to the fat and muscle components,” said senior author Michiya Matsusaki in a press release. The development means that consumers would be able to order cultured meat with their desired amount of fat, based on taste and health considerations.

Improving sustainability in dairy processing

Whey is one of the most polluting byproducts in the food processing industry, largely due to its high salt content. Recently, researchers at the University of Illinois at Urbana–Champaign were able to remove and recycle up to 99% of excess salt from whey while refining more than 98% of the protein content, using an electrochemical redox desalination process. Study results are published in the *Chemical Engineering Journal*.

The researchers used a chemical redox-coupled dialysis system, which comprises two independently controllable channels for the whey waste and the electrodes, separated by a pair of ion-exchange membranes, to create a reversible redox reaction that results in continuous desalination. The desalination process uses up to 73% less energy and functions at 62% of the operating cost associated with conventional desalination systems, according to the researchers.

During the protein purification process, positively charged sodium ions move from the



Scientists were able to remove and recycle up to 99% of excess salt while refining more than 98% of protein content from whey byproducts produced during dairy processing. © RossHelen /iStock/Getty Images Plus

feed to the redox channel and become chemically reduced at the negative electrode. The negatively charged chloride ions move to the redox channel when the reduced ions are oxidized at the positive electrode, resulting in a sustainable regeneration of the redox couple. The redox channel maintains its electrolyte concentration by releasing removed ions to the feed channel; recovered sodium chloride can then be reused to season cheese, making it a net-zero waste process.

“Remarkably, the performance of protein purification and salt recovery was maintained over multiple cycles, demonstrating outstanding stability and cyclability,” said Xiao Su, study co-author, in a press release. “Overall, our redox-electrochemical process offers a sustainable and electrified platform for the recovery of valuable proteins from dairy production waste, with envisioned integration with renewable electricity in the future. We hope this will be the start of research into sustainable food manufacturing in general.”

Eating fruit and veggies fosters happiness

New findings published in the *Journal of Happiness Studies* are the first of their kind to unravel the connection among happiness, the consumption of fruit and vegetables, and exercising. Researchers from the University of Kent used an instrumental variable approach to show that the consumption of fruit and vegetables and exercising make people happy and not the other way around.

Findings demonstrate that lifestyle decisions are influenced by an individual’s ability to delay gratification and apply self-control, which positively affects well-being. The research also shows that men appear to exercise more while women eat more fruit and vegetables.

“There has been a bigger shift in recent years for healthier lifestyle choices,” said study co-author Uma Kambhampati in a press release. “To establish that eating more fruit and vegetables and exercising can increase happiness as well as offer health benefits is a major development. This may also prove useful for policy campaigns around environment and sustainability.” **FT**



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Correction

A table that appeared in the magazine’s October issue cover feature titled “Beyond Ransomware: Securing the Digital Food Chain” included an error. In Table 2, “Types of Cyberattacks That Create Disruption and Can Affect the Food Supply Chain and Customer Confidence in the U.S. Food Supply,” the term “Internet Protocol theft (IP)” was incorrectly used to describe “accessing data with intent to steal trade secrets, plans, research information.” It should have said “Intellectual Property (IP)” theft.

Consumers Have the Munchies

Consumers are snacking more than ever. On average, U.S. adults are eating 2.7 snacks per day, with an increasing number of younger adults consuming five or more snacks daily, according to an August IRI *State of the Snack Industry* webcast.

U.S. snack sales were up 5% for the period from January 1 to June 13, 2021, versus a year ago, per IRI. Indulgent snacks now hold the largest market share (33%, up from 28% in 2019), followed by “permissibly indulgent,” i.e., slightly healthier snacks.

The increase in snacking isn’t limited to the U.S. market.

Around the globe, nearly half (46%) of consumers say they are snacking more than before the

pandemic, according to Mondelez’s 2021 *State of Snacking* report. Sales in the global snack industry reached \$1.2 trillion in 2020, Mondelez reports.

In the United States, the top 10 snack categories are enjoying above average sales growth. Sales of frozen novelties are up 26% versus a year ago for the period from January 1 to June 13, 2021, according to IRI; sales of “other” salted snacks grew by 22%. Other strong snack and treat product categories and their sales growth are as follows: nonchocolate candy, +14%; tortilla chips, +12%; chocolate candy/ice cream, each +10%; cookies/potato chips, each +8%; crackers, +6%; and yogurt, +4%. Meat

snacks, natural cheese cubes, rice/popcorn cakes, and frozen snacks/appetizers are additional pockets of growth.

Early morning and late night are the fastest-growing snacking dayparts, according to IRI Executive Vice President Sally Lyons Wyatt. The Hartman Group’s *Redefining Normal: Spring 2021 Eating Occasions* report notes that the average number of foods/drinks consumed at all snack occasions has increased since 2019, led by early morning at 3.3 versus 2.5 in 2019; mid-morning, 3.1 versus 2.1; and late night, 2.7 versus 2.2.

According to Datassential’s 2021 *FLAVOR Database*, cookies are America’s most loved snack. (See table on page 19 for more information.)

Emerging Opportunities

With the ongoing work-from-home trend estimated to add roughly 33 million at-home lunch and breakfast occasions, portable ethnic mini meals that do double duty as snacks, such as Saffron Road’s new fusion *Artisan Wraps* in varieties including *Samosa With Chickpeas* and *Butter Chicken*, will find a welcome market. Jimmy Dean’s bite-sized *Omelet Minis* packaged in a microwavable cup are perfectly positioned as an early morning snack.

Sales of fresh snack kits have regained momentum. Refrigerated lunch product sales grew 36.4% for the year ending June 2, 2021, according to IRI data. In the first quarter, fresh snacking/salad vegetables ranked seventh among the food categories posting the highest absolute dollar gains.

New *Hillshire Farm SNACKED!* refrigerated snack packs for kids combine pepperoni, salami, or turkey with cheese and a sweet treat and include a *Pepperoni with Confetti Cake Bites* and *String Cheese* variety.

Frozen appetizer/snack sales topped \$3.1 billion, up 14.6% for the year ended May 16, 2021, per IRI. Sales of Asian appetizers and hot/spicy morsels, driven by the popularity of buffalo sauce, each jumped 28%. Multi-serve snacks are gaining share.

Non-European ethnic flavors and forms are go-to frozen snack options. Feel Good Foods introduced *Uncured Bacon & Cheddar Mini Pierogies* for snacking. Regional styles, including Korean, Shanghai, and Vietnamese, grew faster than Asian snacks overall.

With one-quarter of consumers making more snacks at home, and sales of baking products/ingredients up 18.7% versus two years ago for the year ended May 15, 2021, per IRI, unique baking mixes/kits and refrigerated doughs will stay center stage. Pillsbury’s new bite-sized *Cookie Dough Poppins* can be eaten raw or baked.

IRI also reports that one-third of consumers plan to socialize more at home, which suggests there are market opportunities for products that cater to home-entertaining needs. Sales of fresh produce party trays and deli trays both showed strong growth this spring and summer.

Consumers are increasingly embracing more traditional foods such as eggs, pizza, and soup as snacks, according to IRI data. Feel Good Foods’ new gluten-free *Detroit-Style Square Pan*

Saffron Road wraps deliver a globally inspired comfort food option.

Photo courtesy of Saffron Road Foods



Most Loved Snack Options. From Datassential 2021

Snack	% Who Like or Love It
1. Cookie	87%
2. Potato Chips	86%
3. Chocolate Candy Bar	84%
4. Popcorn	81%
5. Tortilla Chips	77%
6. Fudge, Graham Crackers, Pretzels*	69%
7. Cheese Puffs	66%
8. Corn Chips, Saltine Crackers, Trail Mix*	65%
9. Caramels, Cheese Crackers, Chocolate Sandwich Cookies, Vanilla Wafers*	64%
10. Granola Bars	63%

*Tied in popularity.

Pizza comes in a *Truffle Mushroom* variety and includes a baking tray. Campbell Soup introduced *Well Yes! Power Bowl* single-serve soups.

With half of millennials being frequent seafood consumers, according to FMI's 2021 *Power of Seafood* report, fish, seafood, and sea vegetables are snack product development options with high market potential.

Neptune Fish Jerky comes in four varieties, including *Sweet Citrus Ginger* and *Spicy Cajun*.

Foodservice Influences

Late afternoon and after-dinner restaurant snack visits increased 3% over last year as of February 2021, while traffic at other day-parts is down, per NPD's CREST service. More substantial meal offerings, including pizza and burgers, have been the best performers.

Sliders, followed by chicken bites, corn dogs, crab cakes, meatballs, pizza, quiche, calzones, and egg rolls, are the most menued savory minis in restaurants, per Datassential's

September 2021 *MenuTrends*.

The Shake Shack's *Korean-style Gochujang Chick'n Bites*, Captain D's *Lobster Bites and Shrimp*, and *Meatloaf Roadies* sliders from Logan's Roadhouse are among the best-performing new restaurant snack introductions, per Datassential's *SCORES* September 2021 database.

Restaurant-branded snacks, such as Utz's *On-the-Border Mexican Grill & Cantina Thins*, are well positioned for growth. Chef-inspired snack flavors are a missed opportunity for food marketers.

Gourmet chips, pretzels, snacks, and appetizers were the third fastest-growing specialty food category in 2020, up 19%, according to the Specialty Food Association's 2021 *State of the Specialty Food Industry* report.

Protein, ethnic, plant-based, and healthier versions are driving the dip category, where sales were up 28.6% versus 2019, per IRI. DiscoverFresh Foods now offers a *Pepperoni Pizza* dip. Lakeview Farms' *Rojo's Cantina Dips* include real beef or chicken

and come in varieties such as *Chicken Fajita Dip* and *Beef Taco Dip*. Vermont Creamery introduced fresh *Goat Cheese Dips* in varieties such as *Red Pepper & Lemon*.

Add excitement to the most consumed savory snack flavors—cheddar, barbecue, garlic, ranch, peanut butter, and onion—with the addition of specialty salts (e.g., pink Himalayan), regional barbecue flavors, or specialty cheese flavors, per a T. Hasegawa report titled *2021 Flavor Flash: Snacks*.

Hot/spicy snacks remain in vogue. Pepperidge Farm unveiled a limited-edition *Jalapeno Popper Goldfish* cracker variety, and Setton Farms offers *Scorpion Pepper Pistachios*.

Younger consumers want more international snacks and flavors, including Asian (especially Japanese and Thai), Latin beyond Mexican, and bolder Middle Eastern tastes, according to T. Hasegawa data. Emerging global snack flavors include kimchi, adobo, sesame, olive, and curry.

Meal flavors in snacks, such as *Pringles Cheeseburger* chips and *Chile Con Queso* crisps in the United Kingdom, are an exciting flavor twist, as are charcuterie, coffee, and liquor flavors emerging in the United States.

According to Kerry's 2021 *Botanical State of Mind* global consumer survey, black pepper, followed by ginger, basil, turmeric, and rosemary, are the most appealing botanical flavors for salty snacks.

Healthier Preparations

More than half of consumers want functional snacks that offer health benefits beyond nutrition, according to IRI's Lyons Wyatt; 41% look for organic and natural

snacks. Nearly one in five looks for snacks that are vegan (18%) or vegetarian (19%).

Just over one-quarter of those who claim to be following a trendy diet such as keto or paleo say that they buy specialty snacks to support their program, IRI reports.

Healthier on-trend preparations such as *pop bitties* air-popped ancient grain chips from Mark's Mindful Munchies are grabbing the spotlight. *Tyson Air Fried Spicy Chicken Bites* can be prepared in either an oven or an air fryer, and the company says they contain 75% less fat and 35% fewer calories than fast-food versions.

Mondelēz International's *Dirt Kitchen* brand is testing a better-for-you snack bar that uses mechanical pressure/ultrasound technology to eliminate the use of binders and added sugar.

RIND Snacks makes crispy, thin-cut fruit chips, including its latest offering, *Orange Chips*, and advises consumers to "Keep it Real. Eat the Peel." Don Pancho Authentic Mexican Foods launched *Grain Free Tortillas* and *Grain Free Chips* this summer.

According to Datassential's 2021 *Plant-based HotShot* report, one-third of meat alternative users have increased their consumption of meat alternative snacks and appetizers in the past year; 35% are eating more plant-based jerky; and 30% are having plant-based charcuterie.

Four in 10 parents with kids at home purchased alternative salty snacks in early 2021, according to T. Hasegawa, and 34% of millennials did so. **FT**



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[NEW PRODUCTS]

by Margaret Malochleb



Bite-sized entrées

Freeli Foods has debuted a lineup of bite-sized refrigerated entrées that can be enjoyed right from the pouch or heated in the microwave for an instant meal. Perfect for a lunch or quick snack, the grab-and-go meals are available in five versions.

Mac & Cheese is made with farm-fresh cheddar and American cheeses mixed with durum wheat pasta. *Pasta & Meat Sauce* starts with al dente pasta and combines it with rich tomato sauce, hearty cooked beef, and Parmesan cheese. *Chicken Noodle* upgrades a favorite soup with chunks of chicken breast, egg noodles, English sweet peas, and garden carrots. *Chicken Teriyaki* starts with tender chicken, brown rice, and veggies, and adds sweet teriyaki sauce. *Burrito Bowl* features traditional burrito flavors in one package that combines savory black beans, brown rice, and Monterey Jack cheese.

Entrées from Freeli Foods can be found online at freelifoods.com and in the refrigerated section of select retailers nationwide for a suggested retail price of \$5.49.



Pasta sauces with kelp

Ocean's Balance recently introduced *Mariner's Pasta Sauces*, a plant-based lineup made with sustainably farmed and harvested kelp from the Gulf of Maine. The gluten-free, sugar-free sauces are available in *Marinara* and *Arrabbiata* versions.

According to Ocean's Balance, seaweed consumption is on the rise in the United States, thanks in part to its umami flavor, eco-friendliness, and array of essential vitamins and minerals, including iodine, fiber, potassium, and iron. "Seaweed adds irresistible flavor and dense nutritional benefit to any food," said Ocean's Balance

CEO Mitch Lench in a press release. "It's time that Americans move beyond 'seaweed as Asian' and start thinking of seaweed as an everyday ingredient on our kitchen tables."

The sauces are designed to be used over pasta, on pizza, combined with seafood, or as the base for stew, and are suitable for consumers following plant-based, keto, and paleo diets. Packaged in 24-ounce recyclable glass jars, *Mariner's Pasta Sauces* can be found online at oceansbalance.com and at retailers nationwide for a suggested retail price of \$7.99.

Turmeric salt

Former Shark Tank competitor **JADA Brands** recently added *Turmeric Salt* to its line of vegan salts. Suitable as a table salt, rub, or bouillon, the all-purpose seasoning is made with unrefined sea salt, turmeric, onion powder, garlic powder, and black pepper.

Turmeric Salt provides a simple way to add a boost of flavor to recipes while reaping the antioxidant and anti-inflammatory properties of turmeric. The Non-GMO Project Verified product is compatible with paleo and vegan diets and is free of gluten, soy, and sugar. It



also contains no anti-caking agents, no MSG, and no manufactured food additives.

JADA's Turmeric Salt can be found online at Amazon and JadaBrands.com for a suggested retail price of \$8.99 for a 3.3-ounce container. **FT**



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by Jaime Savitz

How Coffee Affects Health

Coffee is the second most consumed beverage in the United States behind water, and it is one of the most widely consumed beverages worldwide (O’Keefe et al. 2013). Over the past several decades, researchers have studied the effects of coffee consumption on cardiovascular health because even small effects may have a significant impact on public health given the beverage’s popularity. Previous studies have yielded mixed results as to whether coffee consumption is beneficial or harmful to cardiovascular health, leading to many misconceptions that persist today.

The good news for coffee drinkers is that recent studies have consistently linked coffee consumption with a lower risk of mortality from cardiovascular disease (CVD), coronary heart disease, and stroke (Poole et al. 2017). In a 2020 study from Japan, increased coffee intake was associated with a decreased risk of all-cause mortality in both men and women. Mortality from stroke was reduced only in men, however, while mortality from heart disease was reduced only in women (Sado et al. 2020). Another 2020 study using data from the *Norwegian Women and Cancer Study* had similar results, with coffee intake of 4 to 6 cups/day associated with a 21% lower risk of death from CVD when compared with coffee intake of <1 cup/day (Lukic et al. 2020).

Moderate coffee consumption has also been associated with a lower risk of heart failure. When compared to those who did not drink coffee, people who drank an average of 4 cups/day had an 11% reduced risk of developing heart failure. Intake of ≥10 cups/day resulted in a return to the baseline risk level (Mostofsky et al. 2012).

Hypertension, or high blood pressure, is a known risk factor for CVD, stroke, and heart failure. Experimental studies have repeatedly demonstrated that coffee is

associated with acute increases in blood pressure, partially due to higher circulating concentrations of norepinephrine and epinephrine and greater arterial stiffness (Mostofsky et al. 2012). But these effects appear to diminish over time with regular coffee consumption (O’Keefe et al. 2013).

Other studies have found that increased

The composition of coffee, and thus its effects, can vary greatly depending on the types of beans and the methods of roasting and brewing used.

coffee consumption may decrease the risk of developing type 2 diabetes, which is yet another risk factor for CVD, stroke, and heart failure (O’Keefe et al. 2013, Poole et al. 2017). Conversely, coffee has been shown to have a negative effect on blood lipids, with higher levels of total cholesterol, low-density lipoprotein cholesterol, and triglycerides associated with increased coffee intake. These effects, though, appear to be mitigated when filtered coffee is consumed rather than boiled coffee (Poole et al. 2017).

So how can coffee have such effects?

Apart from caffeine, coffee contains other bioactive compounds such as chlorogenic acids, cafestol, and kahweol, all of which contribute to coffee’s impact on cardiovascular health (Farias-Pereira et al. 2019). Chlorogenic acid and caffeine act as antioxidants and have been shown to increase insulin sensitivity and glucose metabolism, thus decreasing the risk of type 2 diabetes (O’Keefe et al. 2013, Poole et al. 2017). The diterpenes cafestol and kahweol may similarly act as antioxidants and inflammatory mediators, though they are also responsible for the undesirable effect of increasing one’s serum cholesterol by reducing bile acid synthesis (Farias-Pereira et al. 2019, Lukic et al. 2020).

Coffee Composition Varies

The composition of coffee, and thus its effects, can vary greatly depending on the types of beans and the methods of roasting and brewing used (Farias-Pereira et al. 2019). For instance, some estimate that the amount of caffeine in a given 8 fl oz cup of coffee can range from 95 to 200 mg

(O’Keefe et al. 2013), and both caffeine and diterpenes are found in higher concentrations in boiled coffee than in filtered coffee (Lukic et al. 2020). In preparing filtered coffee, many of the diterpenes are caught by the filter paper, which is why their cholesterol-raising effects are seen only with boiled coffee intake. Light and medium roast coffees are generally higher in chlorogenic acids than dark roast coffees because roasting degrades the compound (Farias-Pereira et al. 2019, Poole et al. 2017).

In sum, moderate coffee consumption of 3–4 cups/day appears to have a beneficial effect on mortality from CVD, stroke, and heart failure. While recent studies have been able to shed some light on the biological mechanisms behind these effects, the specifics are poorly understood. Further research is needed to determine whether other forms of coffee, such as espresso, instant, and decaffeinated coffee, have similar effects. **FT**

References cited are available via hyperlinks in the digital version of this column.

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The Kombucha Category Evolves and Innovates

Kombucha was the better-for-you beverage that the industry didn't see coming, a truly grassroots "maker" phenomenon that was turned into a trail-blazing beverage option for the health conscious by a man who wanted to help his mother recover from breast cancer. Since entrepreneur GT Dave essentially created the category in the United States with *Synergy* kombucha in 1995, it's grown to a \$1.3 billion market that has sucked in even giants such as PepsiCo and Coca-Cola.

A couple of decades in, the kombucha category remains a font of bottom-up innovation. Playful flavor varieties, various treatments of the bacterial blob that floats in traditional kombucha, and even "hard" interpretations that lean into kombucha's natural alcohol content are all contributing to the continued growth of a beverage that has helped spark a healthfulness revolution in what Americans drink.

Sales growth has slowed considerably over the last couple of years, according to Beverage Marketing Corp. And some analysts dispute that kombucha ever truly will become a widely popular beverage in the United States. "Kombucha has increasingly become mainstream, but it remains a niche category—considerably smaller than most of the mainstream beverage categories," says Gary Hemphill, Beverage Marketing's managing director.

Nutritional Attributes

Kombucha is essentially a fermented tea drink whose nutritional efficacy comes from what's known as a SCOBY, short for "symbiotic colony of bacteria and yeast." In *Synergy* and nearly all early versions of kombucha, this colony manifested in an unsightly blob referred to as the "mother," which floats in the drink. Early adopters were drawn to its potential health benefits, which advocates say include the actions of antioxidants, the bacteria-killing advantages of acetic acid, and cutting the risk of heart disease, Type 2 diabetes, and even cancer.

Many other new, nutritious beverages appeared over the past 15 years, giving health-minded Americans lots of options when it comes to turning wasted beverage calories into health-boosting ones. But kombucha kept gaining on younger consumers who were proving more and more adventurous. The growing popularity of fermented foods in general also is helping buoy kombucha. (See feature article on fermented foods on page 32.)

The core kombucha consumer is 25 to 45 years old, usually consumes a diet high in plant-based foods, and exercises routinely, Dave says. "They tend to be a younger generation that does not like soda or sugary drinks and has a more adventurous palate that fits the flavor profile of traditional raw kombucha."

Brewing Up Options

Among the newer brands is *Camellia Grove*, a regional kombucha made in Oregon.

"We concentrate on tea-forward kombucha, says CEO Joe Mayol. "We don't add any artificial flavors or additional juices. It appeals to tea lovers and those who've been turned off by kombucha in the past."

The brand's approach includes straining out the mother, leaving the kombucha with more of the mouthfeel of traditional teas and other mainstream beverages. "Our product is still live, but we found that a lot of people didn't like the blob," Mayol says. "We know it's often a sign of live kombucha, but we see that as a little off-putting."

Meanwhile, *Rowdy Mermaid*, a kombucha outfit in Colorado, has "a functional take based on plants, herbs, mushrooms, and roots," says founder Jamba Dunn. "We don't have a SCOBY. We've created a very low-acid-tasting kombucha, one that is plant- and flavor-forward. It still has all the natural benefit and all the natural acids, just none of the unwanted flavor notes."

Another huge factor has been the entry of some beverage giants into the category. PepsiCo purchased a seven-year-old



GT Dave with a big batch of kombucha. Photo courtesy of GT's Living Foods

kombucha startup, KeVita, in 2016, and Coca-Cola last year began testing a drink called *Cidewinder*, that Coke said was like kombucha but with less sugar.

Adventurous flavors also have driven kombucha sales. KeVita, for example, offers *Dragonfruit Lemongrass*, *Blueberry Basil*, *French Oak Apple*, and *Lavender Melon*. "KeVita has helped to democratize kombucha by giving it a more accessible flavor profile and presentation," says Duane Stanford, editor of *Beverage Digest*.

Even while hard kombuchas have appeared, latent alcohol from fermentation has remained a pesky issue for traditional kombucha makers. Dave has proposed legislation that would protect the trace alcohol of kombucha from regulatory threats, in part by establishing a standard of identity, "which will preserve kombucha's integrity," he says, "for years to come." **FT**

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BY DALE BUSS

Feeding the World Better



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CPG companies are tackling food insecurity around the globe, tailoring product development initiatives to local market nutrition needs.

Canned turkey puree that seamlessly adds protein to Guatemalan cuisine. Low-salt seasonings that cut dangerously high sodium levels in Japanese diets. A smartphone app at a retailer in Turkey that gamifies healthy eating and rewards produce purchases. Infant formula that's fortified with iron to address a particular deficit in the Egyptian diet. A new high-fiber, ready-to-eat cereal to boost the microbiome of Latin Americans. Upcycled waste from papaya processing that is combined with whey into a tasty snack for children in Ethiopia.

Over the last decade or so, global food companies have fielded these products and many more aimed at appealing to indigenous tastes and leveraging local resources to help curb malnutrition and hunger. In spots across the developing world, such initiatives not only are helping to alleviate diet and hunger problems bite by bite, but they're also providing valuable lessons to companies, governments, and nongovernmental organizations (NGOs) about how to become more effective in their Sisyphean struggle to fill every stomach around the globe, every day.

Hunger and poor nutrition are ancient scourges, of course, and they're ever more threatening as the world's population stays on course to balloon to about 10 billion people by 2050, from almost eight billion now, and from five billion just 35 years ago.

The grim statistics about food insecurity are more ponderous than any other measure of the state of humanity. There were as many as 800 million hungry people in the world in 2020, according to this year's *State of Food Insecurity in the World* report jointly produced by the Food and Agriculture Organization of the United Nations, the World Health Organization (WHO), and other groups. Food insecurity affects about one-quarter of the world's population. About 2 billion people globally suffer from malnutrition, according to WHO, and as a result, one in five children in some regions experience stunting, according to UNICEF.

But while it's people in developing countries who largely have sustained the suffering from these conditions, the evolution of post-industrial society in the West has added two more problems. Obesity and diabetes have sprung to crisis proportions in developed countries where the availability of food isn't an issue but poor dietary choices have created epidemics of these

two diseases. In fact, WHO says that the number of overweight and obese worldwide about equals the number of people who are malnourished.

Of course, warnings about an unabated inability to feed ourselves have long been an important aspect of apocalyptic fear mongering, from Paul Ehrlich's *The Population Bomb* in 1968 to today's global-warming activists who point out that changing climate patterns have begun to wreak havoc with agricultural production. And doctors and dietitians have been clanging the bell over runaway diabetes and obesity in the West for nearly as long.

Denizens of the developed world have been gamely trying to stem the toll of obesity with slow progress in a turn toward more healthful diets and more physical activity. And over the last decade or so, health leaders' battle against malnutrition has been tending to "improve very slowly," says Nicolas Gausseres, vice president of health for Group Danone.

But COVID created a major disruption in any progress. The disease—and how governments and businesses reacted to it—shut down economies, crimped farm output and raw materials processing, and jangled supply chains everywhere, making food production and distribution an unexpected challenge that is still being resolved even as the pandemic hangs on. "COVID," Gausseres estimates, "increased the number of undernourished people by more than 100 million."

Private Sector Support

It's little wonder then that the United Nations (UN) recently framed the hunger crisis as an area where even the broad-based organization that represents a collection of most of the world's governments could use some help from the private sector.

"It's time to end this suffering," said David Beasley, executive director of the UN's World Food Programme (WFP), in September as he announced the Zero Hunger Private Pledge. "To succeed, WFP and the entire community need the creative drive, energy, and commitment of the private sector."

Fortunately, the severity of global hunger and malnutrition has grown and become more apparent precisely during a new era in which companies are paying more attention than ever before to why they do what they do. They're reflecting on "purpose" at the



Feeding the World Better

Nutrition Cubed

Of all the wonders of the future depicted on *The Jetsons* television series in the early 1960s, the least believable one—including flying cars and a robotic housekeeper—might have been the pills that George, Jane, Judy, and Elroy ate as their meals.

And yet, here we are a half-century later, with *MealCubes*. Talk about a potential curb on global hunger.

A dozen of the gummy-type pieces of candy include all the micronutrients yielded by an entire balanced, healthy dinner—and soon could be available around the world.

Matt Elonis, CEO of the startup he called Meepo, says that a repast representative of all the nutrients squeezed into a pack of *MealCubes* would be a four-ounce piece of salmon, a sweet potato, half an avocado, and two cups of kale.

“We look at *MealCubes* as a vehicle,” says the former home-delivery entrepreneur. “It’s not about a specific nutrient profile; we aim to launch a wide variety of them. Governments are trying to meet protein requirements and

the micronutrients lacking in their region. We’ve found a way to condense this much nutrition in that small a space and make it palatable across different needs.”

Elonis says he found himself thinking about the water content of all the food he was lugging around in the delivery business. “What if we could recreate the world’s healthiest meals in a lighter format that didn’t spoil?” he wondered.

He aimed to condense nutrients as much as possible by including “exact amino-acid profiles,” 25 grams of protein, fiber content, fats, carbs, and micronutrients in a candy-like, 420-calorie package of gummies available in cherry, orange, and green apple flavors.

The amino acids and peptides in *MealCubes* are wrapped in emulsions that allow them to break down over a few hours, “not spike the bloodstream,” Elonis says. “We want to imitate what happens in nature.”

Meepo’s first markets for *MealCubes* have been government customers around the world, including militaries, says Elonis, who is now commercializing *MealCubes*. They’re also available online for about \$5 a pack.

But one of Elonis’s first major surprises about fielding *MealCubes*, he says, was the variety of potential customers and applications that arose. They include travelers, athletes, senior care centers, victims of natural disasters whose access to food suddenly has been cut off, and even people attending music festivals who might worry about food safety yet not want to carry a bunch of provisions around.

And, of course, there are the masses of hungry around the world. “During the pandemic, a lot of people starved,” Elonis says. “So having something like [*MealCubes*] with a long shelf life of three years could be important for a lot of use cases, such as nutrition assistance programs.”

initiative, under which Kellogg has pledged to “nourish one billion people with our foods,” “feed 375 million people in need with food donations and expanded child-feeding programs,” “nurture people and our planet by supporting one million farmers,” and engage “1.5 billion people in the issue of global food insecurity through advocating on behalf of children facing hunger, ensuring an ethical supply chain, and supporting diversity and inclusion.”

Clearly, companies are combining altruistic aims with business goals in nearly every innovation aimed at the truly hungry. The benefits to the world from corporate commitments to fight food insecurity, and from the help that comes through their products, donations, education initiatives, and community-building programs, are obvious. But also, such efforts strengthen CPG and ingredient companies by testing and stretching their R&D and technology capabilities in ways that wouldn’t otherwise occur. And, of course, there are business opportunities for them in probing markets in the developing world, getting consumers there to appreciate new products and brands, and helping boost the sustainability of agricultural supply chains and subsistence lifestyles.

The key for CPG companies in North America, Europe, and Asia to make a difference, however, is how they translate these kinds of sublime, ESG-oriented aims into improvement in the feeding and nutrition of individual humans around the world. For huge enterprises whose stock-in-trade is developing and deploying things that people want to eat, this effort is being translated into a collective push to innovate products especially aimed at the food insecure and malnourished.

NGOs like the Consumer Goods Forum are there to help them. “You can have global



Photo courtesy of Meepo

prompting of consumers, employees, and increasingly proactive efforts by major shareholders to push environmental and social governance (ESG) goals. And for food companies with a global purview, their ESG strategies quite naturally are landing in the area of solving hunger and malnutrition.

Kellogg, for example, has come up with a new strategy it calls Better Days, which crystallizes its “purpose, platform, and commitment,” says Neil McGowan, senior director of global well-being and regulatory for the company.

Addressing hunger and malnourishment is a major aim of this

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Feeding the World Better



Hormel Foods developed a shelf-stable canned turkey product to address nutritional needs in markets including Guatemala. Photo courtesy of Hormel Foods

ambition, but unless you're understanding local food cultures and local behavior change, it's difficult to have impact on the ground," says Sharon Bligh, director, health & wellness, for the not-for-profit that works with retailers, manufacturers, academia, and governments to battle hunger and malnutrition, and currently is engaged in such projects in 10 countries.

The grim statistics about food insecurity are more ponderous than any other measure of the state of humanity.

"We help connect companies that want to make a social impact going beyond the short term," she says.

How Hormel Has Helped

On its own more than a decade ago, Hormel Foods concluded it could supply products to developing countries where lack of protein is a major component of malnutrition and hunger, thanks to the company's expertise in meat and shelf-stable products. Researchers targeted Latin America because, in

particular, local diets there "rely mainly on starchy staples—corn and beans and rice and tortillas," says Melissa Bonorden, R&D development leader for Hormel.

"There's not a lot of high-quality protein there. We knew a meat product could be important. There's also not a lot of diversity in these diets, so we wanted to bring in concentrated sources of nutri-

ground to understand the dietary habits and nutritional deficiencies in the standard diet in Guatemala."

Hormel and its *Jennie-O* turkey unit came up with a shelf-stable puree of white and dark turkey meats called *Spammy*, so that a cook can simply stir it into whatever they're making. "If they're going to make rice and beans, they stir it in," Bonorden says. "They can use it in eggs, or in a pizza topping. It just gets integrated into their regular diet and requires little behavior change. It's not a new food."

Spammy is packaged in a 3-ounce, shelf-stable can. "Not everyone in Guatemala has refrigeration, so it was important to come up with a product that didn't require it," Bonorden says. The company now distributes about 2 million cans a year, mostly via school kids, who take it home to their parents.

Over the past few years, Hormel has added an education component to the program, helping establish more than 20 different "learning centers" with NGOs in Guatemalan villages. And, Bonorden says, the

tion," Bonorden continues. "And we learned that vitamin D and vitamin B12 are in especially low concentrations, so we wanted to focus on those micronutrients."

Soon after the effort started in 2008, Hormel focused on Central America, and then Guatemala, based on relationships with NGOs, including Food for the Poor. "We relied on these partners," Bonorden explains. "Rather than making assumptions from the American Midwest about what was needed, we worked with them on the

whole enterprise is a bonus for the increasing number of Hormel employees who want to travel south and help out. “They can help distribute product and serve meals and just help with volunteer efforts there,” Bonorden says.

Addressing Local Needs

Danone surveyed the situation in Egypt a few years ago and found that iron deficiency is a huge problem among Egyptian children and adults. “We decided to take this as a challenge and refocus our efforts, on both kids below three years old and kids above three years old,” Gausseres says. Danone came up with iron-fortified infant formula products under its *Bebelac* brand, and flavored milks and yogurts with “Vita-Iron” under its *Dango* brand for older kids, and then added an education program for parents and the medical community “with communications to raise awareness around these deficiencies and different ways to fight it.”

Kellogg addresses malnutrition and hunger as important elements of an overall product development strategy that emphasizes two things: improving the human microbiome through fiber-rich foods, and leaning into plant-based protein because of the company’s conviction that the globe can’t support an overreliance on animal-based products.

Fortification of its ready-to-eat cereals with vitamins and minerals long has been a key part of Kellogg’s approach to the market, and now the company is homing in on “fiber intake [that] remains woefully low across the globe,” McGowan says. This includes the recent release of *Nutri Digest*, a new fiber-fortified cereal brand in Latin America.

Wanting to help mitigate food insecurity and malnutrition isn’t just a pursuit for consumer-facing companies but also for the industry’s B2B community. For example, Arla Foods Ingredients is mainly a producer of whey ingredients. It is working with the Global Alliance

Africa Gains From Nestlé’s Nutritional Products Focus

Hunger, unfortunately, is a global phenomenon, and no food company has more of a worldwide reach than Nestlé, so “our efforts to make nutritious products are critical,” says Celine Worth, R&D program manager for affordable nutrition for the Swiss giant. “We’re accelerating our efforts to develop more affordable nutritious products for consumers, particularly those in emerging countries.”

The company is “focused on development of more products by adjusting processes and recipes, using local raw materials as well as affordable, high-quality cereals and protein sources,” Worth says. “We also fortify products with locally relevant micronutrients such as iron, iodine, zinc, and various vitamins.”

Africa has become a particular focus for Nestlé’s efforts to combat food insecurity and malnutrition. Sub-Saharan Africa is home to about 1 billion people, and about 40% subsist on less than \$2 a day. Micronutrient deficiencies in iron, zinc, iodine, and vitamin A are prevalent, especially in low-income households, and often there is malnutrition associated with the lack of high-quality protein, Worth says.

So Nestlé has been collaborating with

universities in Ghana, Nigeria, Senegal, Cote d’Ivoire, and Benin, as well as the Swiss Center for Scientific Research in Cote d’Ivoire. The company is helping to “develop new and innovative technological solutions that consider the local relevance and raw ingredients as well as consumer dietary needs and preferences,” Worth says, and it is supporting students from the region in their own food-based careers.

The company also has been innovating highly nutritious products aimed at the particulars of local cuisines in Africa. It has been providing fortified *Maggi* bouillon cubes in Central and West Africa, for instance. In 2020 alone, Nestlé provided nearly 200 billion servings of micronutrient-fortified foods and beverages in emerging countries around the world.

And in Southeast Africa, Nestlé recently launched *Cerevita Instant Sour Porridge*, an affordable, nutritious product made with whole grains and cereals. It is fortified with key vitamins, fiber, and protein to help tackle local nutritional challenges, and *Cerevita* costs about 20%–25% less than similar locally available products, Worth says.

Arla Foods Ingredients is working on a project to convert waste from papaya processing into a nutritious snack for people in Ethiopia. Photo courtesy of Arla Foods Ingredients





Feeding the World Better



Ajinomoto created DeliDawa seasoning specifically for the Nigerian market. Photo courtesy of Ajinomoto

for Improved Nutrition (GAIN) and other partners this year to launch a four-year project to turn papaya fruit that otherwise would be wasted into a nutritious and affordable snack for low-income consumers in Ethiopia.

Papayas are a source of income for more than 890,000 farmers in Ethiopia. They're also highly nutritious, being particularly rich in vitamins A, B, and C. But each year, about 30% of the crop is lost to spoilage. The company's efforts have focused on drying major quantities of papaya close to where it's grown—perhaps via solar energy—to provide the pulp for a dried-fruit protein bar that contains milk and whey-based ingredients.

"We'll fortify it with vitamins and minerals and hope to end up with a tasty, safe, affordable snack targeting children," says Charlotte Sorensen, business development manager and senior project manager for affordable nutrition activities for Arla Foods Ingredients.

Ajinomoto is known globally as a major provider of umami seasoning through its production of monosodium glutamate (MSG), but the company has been harnessing its

overall expertise in ingredients and seasonings for a project in Nigeria to develop a local seasoning called *DeliDawa*.

Traditionally, Nigerian women produce a seasoning locally that is made from fermented locust beans and called *ududu*. Preparing it is labor-intensive and is done in the open air; one unfortunate aspect is that *ududu* is highly pungent and attracts lots of flies. Ajinomoto researchers believed that a product called *natto*, made from fermented soybeans instead of locust beans, could sidestep the negatives of making *ududu* and still satisfy Nigerian tastes.

"It took around one-and-a-half years, but we were able to develop *DeliDawa*, which is made under much more hygienic conditions than *ududu*, is sold at a very affordable price, is convenient to use, and frees the local women from laborious work," says Manasi Deodhar, Ajinomoto's global communications manager. "We are also turning our attention to similar local seasonings in surrounding countries."

But Ajinomoto's experiences also demonstrate that delivering new products that abate hunger or food insecurity somewhere on the

globe isn't always as easy as having effective R&D. For example, the company has been attempting to get a plant-based, ready-to-use-therapeutic food (RUTF) into the field because it believes the product could treat severely malnourished children around the world. An RUTF is an energy-dense, mineral- and vitamin-enriched, fortified food that can be consumed with no preparation needed. About 80% of RUTF procurement is done by the United Nations International Children's Emergency Fund, and it currently accepts only RUTFs made with peanut and milk, per standards set by WHO.

Ajinomoto's proposed plant-based RUTF is made with soy, maize, and sorghum and fortified with added amino acids. The company worked with the Japanese International Cooperation Agency and some NGOs to prove the product's efficacy in a trial in Malawi, Deodhar says. It can be mass-produced at about 10% lower cost than what it would replace.

"But WHO guidelines say that more than 50% of the amino acids in RUTFs need to come from dairy, and so our product still isn't approved," she says. »»

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Frontier Co-op helps support a training center in Madagascar for its member farmers. © Agence-Odds-Mahadera

Fighting Hunger at the Farm Level

It will take even more than innovative products, improved distribution, governmental backing, and effective marketing to turn the tide against hunger because improving consumption habits is only one-half of the equation. Equally important is ensuring the sustainability of food production in and for developing nations, and that means improving the viability of subsistence farming across three continents. Keeping hunger at bay is a matter of helping farmers optimize and even grow their enterprises for the sake of their families and their communities.

Western companies are helping in this arena, too. Frontier Co-op, for instance, sells spices and herbs in the United States under the *Simply Organic* and *Aura Cacia* brands, and sources them from more than 40,000 member farmers around the world. So Frontier's Well Earth program, started in 2007, touches growers and communities across the developed world by assisting farmers in myriad ways.

"Some of it is about helping our farmer partners make a sustainable supply chain focused around food," says Frontier CEO Tony Bedard. "Some of it is

focused around helping them run a good, sustainable business, and some is focused around helping them get access to education, clean water, and those kinds of things. The world is made up of thousands of farmers who live on a hectare or two of land and consolidate their product for markets."

So, in Madagascar, where much of the world's vanilla crop is grown, since 2019 Frontier has contributed \$50,000 to a program that "trains the next generation of farmers to avoid vanilla as a single cash-crop dependency," Bedard says. The program teaches them to diversify their crops and to add in other income earnings such as breeding chickens and ducks and even fish farming.

"We're also helping give them that business acumen to save for a rainy day," Bedard explains, with Frontier even helping open a bank for microlending to these farmers. "We're trying to get them to realize that when the price of vanilla is really high, they've got to put money in the bank. We've got to start to change this vicious cycle, so we're trying to create fundamental change in their approach to business."

Roles for Smaller Players

Even with increasing involvement by the titans of the world's food business, there's also a role to play for smaller companies, who number in the thousands in the developing world. For example, in India, GAIN has been working with more than 300 makers of edible oils that are a crucial part of diets in the world's second-most-populous country. Already, GAIN and allies have managed to get companies that supply about 70% of the nation's cooking oil to fortify their products with vitamins A and D, and now the goal is to get the cooking oil industry to agree to new national nutritional standards.

While 18 big suppliers representing about 40% of the market have backed the efforts so far, the key will be getting agreement from most of the 289 small companies that comprise about 60% of the market, says Tarun Vij, GAIN's director for India and also head of global drivers for food system change for the organization.

"They're the guys who reach the last mile, the smaller districts in our country, the schools in the tribal areas, with this important advancement," Vij says. "While it would be convenient to work only with the bigger players, it's extremely important to get the small ones in these markets on board."

Developed nations also have nutritional blind spots beyond their universal struggles with obesity and diabetes, and CPG companies are addressing those, too. Ajinomoto worked with the Japanese government to target salt consumption, which is generally high in Japan, especially in the Northeast, having much to do with high consumption of preserved foods.

So, beginning in 2014, Ajinomoto teamed with the government and local media in Iwate Prefecture in a concerted effort to cut salt consumption there, largely by introducing its own seasonings as a substitute. MSG has two-thirds less sodium than table salt, and Ajinomoto says it doesn't compromise flavor.

The effort featured seminars, distribution of low-salt recipes in grocery stores, media attention, and even the local government's declaration of the 28th of each month as "Salt Awareness Day."

"We helped reduce people's salt intake by 10% to 20%," Deodhar says. "We have expanded this program to six prefectures across the Tohoku region in northern Japan, and plan to grow it to another 39 in the

future.” Plus, she adds, Ajinomoto expects to replicate the approach in other developed countries where high salt intake is a health problem, including Brazil and Vietnam.

Tapping Into Retail Partnerships

Retailers can play a role too. For instance, the Consumer Goods Forum works with its company members and with food retailers to create and promote healthy three-ingredient recipes that involve a CPG product and a vegetable. They calculate the recipe’s nutritional bona fides and promote it in the store and online.

“Essentially, the CPG basically subsidizes the price of the vegetable, and the consumer gets the vegetable for free,” Bligh says. “Everyone wins. It increases the sales of organics and vegetables.”

In another approach, the Migros supermarket chain in Turkey worked with the Forum to create a smartphone app that encourages

purchases of produce and other healthy foods by providing information, gamification of their choices, and price discounts on fruits and vegetables. Fifty-two percent of shoppers at Migros opted into the app during the test and began tracking their healthier-eating progress quarterly, and sales in better-for-you food categories at Migros increased by 5% during the test.

When the Forum took the basic app model to Colombia, they worked with Exito, a supermarket chain in the northern part of the country where iron deficiency is a major aspect of malnutrition. Through the app, Exito promoted and price-discounted shrimp, which is high in iron, and boosted consumption.

There was another element in the success of the nutrition app in Migros and Exito: backing by health, government, and political leaders, which can have outsized impact in developing countries compared with

First World audiences, who may believe that they are too sophisticated for such appeals. In Turkey, for example, the minister of health was heavily involved. And in Colombia, the effort even managed to recruit First Lady Maria Juliana Ruiz. “Those kinds of things really work,” Bligh says.

In spreading the word about iron-fortified *Dango* in 2020, Danone put up billboards in Cairo featuring the brand’s red-and-blue monkey mascot. And to support its efforts to promote gut health and gut microbiome diversity in Australia and New Zealand, Kellogg promoted what it calls “the world’s first functional zoo displaying animatronic, interactive gut bacteria,” highlighting the importance of feeding fiber to good bacteria to maintain digestive balance. **FT**

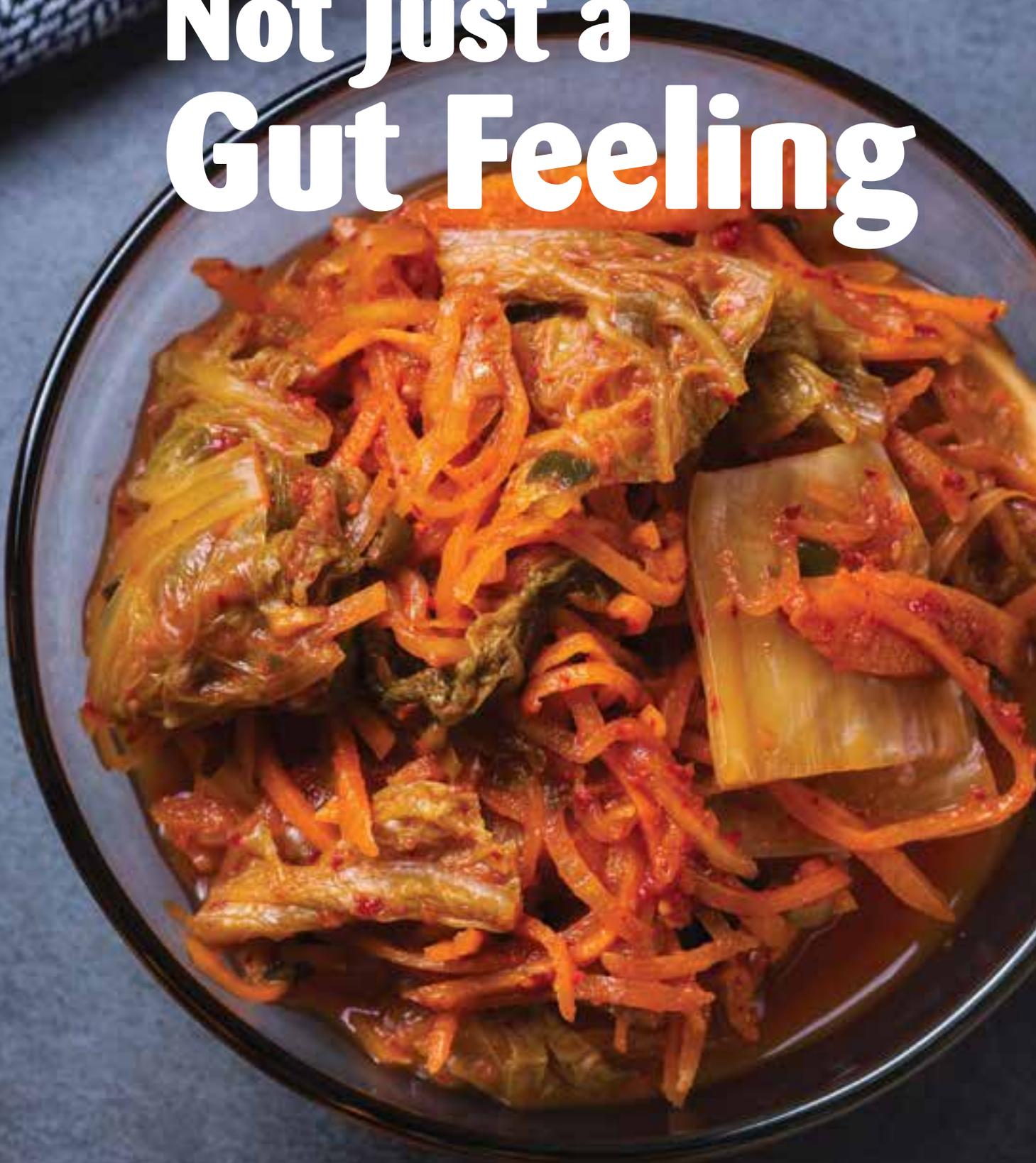
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A Global Alliance for Improved Nutrition technician performs qualitative testing of vitamin A in fortified milk. Photo courtesy of Global Alliance for Improved Nutrition



BY ED FINKEL

Not Just a Gut Feeling



Fermented foods category sales are growing as consumer interest in the microbiome mounts, triggered in part by the COVID-19 pandemic.

The use of fermentation in the culinary arts dates back to prehistoric times as a method of preservation, and virtually every culture has a rich history of using some type of fermented foods and beverages—for example, kimchi in Korea, kefir in Russia, tempeh in Indonesia, and sourdough bread in Egypt.

Fast forward to the third decade of the 21st century, and fermentation is attracting renewed attention and interest in the wake of the COVID-19 pandemic, as consumers become more aware of the importance of gut health and the potential for warding off harmful bacteria—while growing their “good” cousins to build immunity.

Bob Hutkins, the Khen Shahani professor of food science at the University of Nebraska–Lincoln, definitely has noticed more chatter about fermentation since the pandemic began. “It checks off all the boxes—artisanal, local, natural, sustainable, innovative,” he says. “People are making sourdoughs at home; they’re making kimchi at home; they’re going to kombucha bars. It’s definitely got the Gen Xers and the millennials intrigued.”

Hutkins adds that larger companies that never had products in the category have been either swallowing up smaller ones, or developing their own divisions and product lines. “So it’s clearly not just the small companies, although that’s where a lot of the innovation is coming from,” he says. In addition to specialty companies, food industry heavyweights like Danone, Cargill, and ADM will be key players, agrees Research and Markets.



Fermented foods researcher Bob Hutkins says fermented foods have attracted the attention of millennial and Gen X consumers in particular. Photo courtesy of Bob Hutkins

Market Size and Growth

SPINS data presented in a webinar by The Fermentation Association divides fermented foods into 10 categories with 57 individual

Not Just a Gut Feeling

product types. Fermented foods comprise 1.4% of overall food and beverage sales and saw 4% growth for the 52 weeks ending October 4, 2020, reaching \$9.2 billion in sales in the United States, the SPINS figures show. (The figures exclude the large categories of alcoholic beverages and cheese to better observe trends in other areas.)

Yogurt-related products are by far the dominant subcategory, with 83.1% of overall sales and 2.8% growth to \$7.6 billion for that 52-week period. Nonalcoholic beverages made up another 8.6% of sales and grew 4.4% to \$791.6 million. The smaller slices grew significantly more: pickles and fermented vegetables, 4.7% of the category (and including individual items like sauerkraut and kimchi), rose 17% to \$435.6 million; fermented sauces, 2.7%, were up 24% to \$250 million; sake, 0.4%, rose



More consumers are tuning in to the immunity-boosting potential of fermented foods, reports Lu Ann Williams of Innova Market Insights. Photo courtesy of Innova Market Insights

Fermentation Bubbling Onto Menus

Fermented foods and beverages are appearing more often on restaurant menus than they did a decade ago, although they're still a relatively unusual phenomenon, according to Datassential.

The firm's MenuTrends database shows that 2.4% of menus contained fermented offerings in 2011, up to 3.5% in 2021—an increase in total number of 48% over the 10-year period. Such menu items are most often found at fine dining restaurants.

Sour cream was the most frequent fermented item as measured by Datassential, followed by soy sauce, vinegar, yogurt, sourdough, sauerkraut, miso, and kimchi. Pickled vegetables experienced the fastest four-year growth; next was kombucha, up 117% and found on 2.3% of menus.

Data from Technomic show that fermented ingredients such as kimchi and fish sauce are trending, and some are showing year-over-year growth. Miso is popping up during unexpected meal occasions like cocktails and desserts, Technomic found.

16% to \$36.4 million; miso, 0.2%, increased 26% to \$20.8 million; and plant-based meat alternatives, 0.2%, were up 26% to \$21.8 million.

Yogurt sales had declined slightly before the pandemic but have since rebounded to a higher baseline, SPINS found. The same was true for fermented sauces, non-alcoholic beverages, and pickles, SPINS reported. Overall, kimchi, fermented sauces, and tempeh are driving the most growth.

Research and Markets has estimated that the fermented food and ingredient market will reach \$689.3 billion in sales globally by 2023, driven by greater income, higher population, and increasing health awareness among consumers. European countries like the United Kingdom and Germany show the greatest promise for market penetration, according to Research and Markets, while the United States and North America overall are the next most promising. The fastest growth will come in South America and Asia-Pacific, particularly in

China and India, the research firm forecasts.

Innova Market Insights predicted in 2018 that fermentation would be a key trend, and the company has observed an 11% average annual growth in fermented product launches globally since then, up 38% total in Western Europe, 31% in "Australasia," and 30% in the Middle East/Africa, according to Lu Ann Williams, global insights director at Innova.

"It has grown a ton during the pandemic, which has fast-tracked the public's knowledge of fermentation," says Amelia Nielson-Stowell, editor at The Fermentation Association. "It's had a significant impact on many businesses. Health-conscious consumers are flocking to fermented foods because of the health impact. There's a widespread acknowledgment that ... microorganisms can boost your gut microbiota and your immune system."

"Not surprisingly, with the focus on having a strong immune system and gut health over the past 18

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Fermented foods are tapping into current trends, including the move to products that are fresh and local, according to Amelia Nielson-Stowell of The Fermentation Association. Photo courtesy of The Fermentation Association

Fermentation Association. “In some cases, it’s buoyed the whole category; in others, it’s been a shift between different types of fermented foods.”

Nurturing the Microbiome

People are more conscious of the benefits for the digestive system that the probiotics in fermented foods offer as well as their immunity-boosting properties, Research and Markets notes.

Marketing products that boost gut health first gained traction in the 1990s, although it was hampered by regulations, especially in Europe, says Williams of Innova Market Insights. Her company’s recent survey of 10,000 consumers across 10 markets showed that

months, we’ve seen a surge in a lot of fermented foods,” adds Neal Vitale, executive director of The

Miso is among the fermented foods growth categories. © PamelaJoeMcFarlane/E+/Getty Images



about one-quarter had purchased products to improve their gut health in recent months.

“A day doesn’t go by without a story about the microbiome. Social media is full of people talking about it, and doctors on TikTok post videos explaining new developments,” she says. “COVID has put immunity top-of-mind as a health priority. We see a slightly higher percentage of consumers looking at immunity-boosting functions, as opposed to gut health alone.”

Packaged Facts notes that brands wanting to appeal to consumers based on gut health or immunity should offer products that are either sugar-free or made without added sugar or sweetener, as such consumers tend to be sugar-averse. This group of shoppers skews female, younger, flexitarian, and interested in organic, clean label, and other health claims.

True fermented foods contain live microbes, as opposed to those where the microbes are either removed or heat-treated, Hutkins says, noting that the microbes are killed, for example, in the baking of sourdough bread—whereas they are very much alive in kimchi, sauerkraut, or cultured dairy.

“The reason why those foods were popular for the previous 10,000 years is because they enhanced the preservation of foods, and they could prevent you from getting sick from occasional *Salmonella* or *E. coli*,” he says. “That’s still one of the strengths: live microbes can out-compete many of the pathogens in the gut and provide what we call colonization resistance. ... They can communicate with the immune system and modulate immunity.”

Many consumers are drawn to fermentation for health-related reasons, agrees Alex Lewin, a board member at The Fermentation Association and author of *Real Food Fermentation* and *Kombucha, Kefir and Beyond*. “The gut biome, gut health angle is certainly something that

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nobody was talking about—definitely not 10 years ago and probably not even much six or seven years ago,” he says. “People in the United States are fascinated by food in a way they absolutely weren’t 20 years ago. Part of that is trying to find food that’s healthy and going to make them feel good. Fermented foods do have a legitimate claim in that regard.”

Nielson-Stowell notes scientific studies establishing these gut health benefits are somewhat limited in breadth because

cofounder of Cocomune, which has produced plant-based cultured products for foodservice since 2018 and for retail since 2019.

“Right now, we’re shooting very broadly, adding probiotics we’re selecting based on the scientific evidence: ‘How many clinical trials there are of a certain strain. How well did it perform in those trials?’” he says. “That doesn’t mean that strain is going to take refuge in each person, or that it’s going to work wonders for their health.

Marketing products that boost gut health first gained traction in the 1990s, although it was hampered by regulations, especially in Europe.

there’s not a lot of money behind them, the raising of which is a key pillar of The Fermentation Association’s mission. In addition to potential COVID-related benefits, she’s seen studies showing a lower risk of cardiovascular disease and type 2 diabetes along with longer life spans, as well as studies that link fermented foods with lower inflammation and improved immune response.

The *KeVita* fermented drink brand performed internal research in late 2020 about shifting consumer behaviors and attitudes toward wellness and boosting immunity during the pandemic. The company found consumers are paying more attention to their diets but expect products in the nonalcoholic categories *KeVita* plays in to perform “double-duty,” supporting one’s immune system first and foremost—but also tasting delicious.

Consumers are already well aware of the gut health benefits associated with fermented products although there’s no one-size-fits-all answer, says Klaus Ravnholt, president and

In the future, you’ll be able to do much more personalized stuff. That’s going to grow the probiotics market. The question then becomes: ‘How can you marry that with consumer products that need to be sold at retail? How do you individualize that, to some extent?’”

Kheedim Oh, a board member at The Fermentation Association as well as founder and “chief minister of kimchi” for Mama O’s Premium Kimchi, believes more and more consumers are following the science about gut health—and potential linkages to areas like mental health. “No one thing is going to save you. You have to have this holistic approach,” he says, referring to COVID-19, adding that this includes supporting one’s immune system.

What’s New?

While dairy products like yogurt will remain the major subcategory within fermented foods, and kombucha enjoys the most launches outside that subcategory, others will continue to grow, partly with the help of



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communities on social media that have coalesced around them, Williams says, adding that top benefit claims tend to be organic, vegan, and probiotic.

“There are conversations about the benefits of eating other fermented foods like sourdough, cheese, sauerkraut, miso, and kimchi,” she says. “There is still a lot of consumer interest in authentic and natural products, and these products are supported by great storytelling. The market for fermented foods is only getting started.”

Hutkins is concerned about a trend he’s noticed among manufacturers of some fermented foods who want to make shelf-stable products by heat treating them to guard against the possibility that live microbes will produce gas and make them more acidic—and then adding other microbes that don’t produce gas. “They call them fermented foods with live microbes, but that belies the intent of what fermented foods should be,” he says.

Other trends that Hutkins notes include the addition of probiotics to fermented foods; the branding of fermented foods as being sustainable, natural, healthy, or organic; and an increase in restaurants making their own fermented foods. “There is a culinary interest in fermented foods that did not exist 10 or 20 years ago,” he says. “I would have never imagined making, for example, miso in a restaurant. But it’s being done.” (See sidebar on page 34 for foodservice trends.)

Nielson-Stowell sees less and less in the way of shelf-stable fermented foods. “The most dynamic brands are moving to the refrigerated section,” she says. “Ten years ago, Americans would think about mushy, beige-colored sauerkraut, sitting on a condiment tray at a baseball game. Today, we have brightly colored, fresh, crisp, uniquely flavored sauerkraut. Local is really big. Artisanal brands are coming out. Food as medicine has



The founders of Cocojune expect the market for products formulated with probiotics to grow as research into their benefits expands. Photo courtesy of Cocojune

been a big trend. We’ve seen brands that put that on their labels: ‘live cultures.’ They’re labeling these with more scientific terms than we have seen before on food products.”

Kimchi, kombucha, kefir, and tempeh are growing in popularity, as is hard kombucha, says Lewin, an advisor to a brand in the latter space called *Dr. Hops*. “Kimchi certainly has made it—it was never obscure, exactly—but it started its rise with the Korean barbecue taco stands in L.A., and now it’s a normal thing, almost. You find it in regular mainstream grocery stores,” he says. “Regular kombucha came from obscurity. Now it’s . . . significant.” Kefir isn’t that different from a drinkable yogurt and might rise or fall about the same as the yogurt category, he adds, while “tempeh is on the rise, first of all among people who want to avoid animal products.”

Plant-based products competing against yogurt have the advantage of not needing to be as locally tied as dairy companies, according to Ravnholt. “As a brand, you can play a little wider,” he says. “We’ve been tripling our volume every year. The overall market’s grown a lot. The natural channel in retail already has a lot of shelf space allotted toward plant-based yogurt. . . . While fermented foods have always been one of the big pillars of processed foods, overall, it’s only growing.”

Ravnholt believes plant-based dairy brands will continue to innovate, working to improve the taste, texture, and nutrition of products. “We’ve gotten it sort of right, but we still want to improve it,” he says, adding that Cocojune is rolling out a product this fall called *Overnight Oats* that he likens to a probiotic rice pudding. “Millennials take their oats, soak them in yogurt in the

Not Just a Gut Feeling



KeVita Shots are effervescent water-based shots that deliver 3 g of prebiotic fiber per 2-ounce bottle. Photo courtesy of KeVita

fridge, and then the day after, it's like pudding, almost," he says. "We're taking that concept and marrying it with our yogurt. What you get is a cultured product that has a different texture than yogurt."

KeVita expects nonalcoholic fermented beverages to continue to perform well in 2022, and the company has added *Prebiotic Shots* in three flavors—*Beet Lemon*, *Blueberry Mint*, and *Turmeric Ginger*—to meet this demand. The company already had offered three other such beverages: *Sparkling Probiotic Drink*, *Master Brew Kombucha*, and *Apple Cider Vinegar*. (See the Startups & Innovators column on page 20 for more on the kombucha category.)

Oh, whose company most recently rolled out a hot sauce called *Kimchili Sauce* and who stages an annual event called *Kimchipalooza*, expects kimchi sales to stay strong. "I'm fortunate to be making a food that's truly a superfood, and that can help support your immune system, something we all need in this day and age," he says. **FT**

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by Kimberly Lord Stewart

Move Over Bland Gluten-Free Brands

Formulations for gluten-free have advanced significantly since the early days of rice flour and tapioca as the standard replacements for wheat flour and other gluten-containing grains. Costs have dropped, which helps shoppers. Consumers, meanwhile, are more sophisticated in their expectations for gluten-free product development. This means that for formulators and marketers of gluten-free products, it's time to consider that gluten is not consumers' only concern; they want nutrition, taste, *and* confidence that the product is safely free of gluten.

"While people with celiac disease and gluten intolerance had few or no options in consumer packaged goods 20–30 years ago—and only limited options 10 years ago—virtually all segments of that market have gluten-free options today," says Laura Allred, regulatory manager for the Gluten Intolerance Group.

"Availability of gluten-free food is a change that has had a dramatic impact on the consumer experience," Allred continues. "Barely 10 years ago, consumers often had to shop extensively, sometimes traveling considerable distances, to find the products that were available to them. Today, gluten-free products are widely available at mass merchandisers, supermarket chains, and c-stores, as well as most natural product retailers."

When giving up gluten, there is a natural expectation to find favorite gluten-free versions that match palate-pleasing wheat-food memories, but such offerings are not always available. Product selection is getting better, however.

"There is always a dream of better specialty options, things like croissants or puff pastry, but the fact is that you can find a gluten-free version of most retail products. So consumer needs are largely being met in terms of food options," says Allred.

It's not all sweetness and light. "The two areas where there is still some attention needed are quality—

companies seeking new formulations, agrees. "Gluten-free formulations are getting better, but some are just a very starchy version of something that used to have fiber, protein, and substantial texture," she says.

As knowledgeable formulators—and even some consumers—recognize, simply getting rid of gluten without considering the nutritional



Gluten-free ZENB pasta is made from yellow peas. Photo courtesy of ZENB

does the product taste good and have a good texture—and, most importantly to us, is there assurance that it is safe?" Allred continues.

Kantha Shelke, principal of Corvus Blue and a consultant to

implications may be introducing a whole new set of problems.

"Consumers are beginning to understand that there are health implications if formulators don't match up the nutritional qualities of



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the original ingredients,” Shelke says. The solution lies in technology, innovative ingredients, and active consumer engagement.

Celiac, Non-Gluten Sensitivity, and Just Because

A market survey from Research and Markets estimates that about 30% of adults in the United States eat gluten-free. Though only about 1% of the population (1 in 133 individuals) must avoid gluten because of the autoimmune disease celiac sprue, there are significantly more people who want to eat gluten-free. These consumers can be divided into two primary camps: non-celiac gluten sensitivity (yes, it’s a real thing) and those who simply prefer to avoid gluten.

While not always understood or accepted, non-celiac gluten sensitivity (NCGS) or non-celiac wheat sensitivity (NCWS) may affect from .5% to 13% of people in the United States. Researchers say that NCGS and NCWS are somewhat defined, but there are no single biomarkers for diagnosis, and it may or may not be caused by gluten and other components in wheat.

“It has been suggested that gluten is not the only trigger of symptoms in NCGS. Other components that may cause the sensitivity include amylase-trypsin inhibitors, lignans, agglutinin, and fermentable oligo-, di-, and monosaccharides and polyols (FODMAPs),” say NCGS study researchers (Barbaro 2018).

What is clear about NCGS is that it affects more women than men and is higher among teens and those who are in their 30s and 40s. Symptoms overlap with irritable bowel syndrome and include gastrointestinal discomfort, muscle aches and pains, and rashes, as well as foggy brain—described as an inability to concentrate—fatigue, and headache.

As for those who opt to avoid gluten out of preference but do not have celiac disease or NCGS, the numbers are no less substantial. According to a longitudinal study about the values of non-celiac



The gluten-free Scotty's Everyday Keto lineup has expanded to include cupcake and biscuit mixes as well as bread and pizza crust mixes. Photo courtesy of Scotty's Everyday

individuals who avoid gluten, as many as 13% of adults aged 25–36 years valued gluten-free food. They were four to seven times more likely to value food production practices that are local, organic, non-GMO, and minimally processed (Christoph et al. 2018).

Nutritional Concerns

While the trend toward gluten-free purchasing continues to grow, with the category expected to show a

fasting glycemia, and higher body mass index.

Consequently, fortification with fiber and other missing nutrients is important for gluten-free formulators to consider. There are growing concerns about using isolated ingredients because intact fibers act very differently in the body than individual ingredients, warns Shelke.

“There are many other agonists in ingredients that impose health benefits,” says Shelke. “For instance,

When formulating for gluten-free customers, it is important to take the time for due diligence to understand the health ramifications for the end user.

compound annual growth rate of 2.0% through 2030, eating gluten-free without a doctor’s supervision may increase the risk of other health concerns (Research and Markets 2021). When wheat-containing foods are compared with gluten-free foods, the latter lack fiber and minerals, including calcium, iron, magnesium, and zinc, in addition to vitamin B12, folate, and vitamin D. Studies show that individuals who follow a gluten-free diet may consequently show higher total cholesterol, impaired

highly refined starches affect triglycerides, and digestion requires more cholesterol while consuming pure carbohydrates such as those in gluten-free foods. The growing incidence of babies born with spina bifida (neural tube defects), which had been eradicated in the United States, is attributed to low-carbohydrate and gluten-free diets that do not benefit from folate added to grain products such as wheat. We are trying to better understand what happens when humans eat an abun-

Move Over Bland Gluten-Free Brands continued...



The quality of gluten-free bread is improving thanks to the availability of new ingredients and formulation technologies. © Chameleonseye/iStock/Getty Images Plus

dance of gluten-free foods.”

Another concern is higher blood levels of heavy metals, including mercury, cadmium, and lead, as well as arsenic levels in urine. According to a National Health and Nutrition Examination Survey study, those following a gluten-free diet tested higher for these heavy metals, likely as a result of eating more rice and fish.

All of these concerns mean that when formulating for gluten-free customers, careful consideration of health ramifications is required. “Some gluten-free foods are being made by enterprises that quickly formulate and do not take the time to find out how the structure will

change the physiological implications of the food,” says Shelke.

New Regulations

In August 2020, the U.S. Food and Drug Administration (FDA) passed new laws (finalized in October 2020) for foods that contain fermented or hydrolyzed ingredients and that bear the gluten-free claim. The final rule, “Gluten-Free Labeling of Fermented or Hydrolyzed Foods,” is for foods like yogurt, sauerkraut, pickles, cheese, green olives, and FDA-regulated beers and wines. It also covers hydrolyzed plant proteins that improve flavor or texture in processed foods such as soups, sauces, and seasonings.

The FDA rule states: “Because gluten proteins in hydrolyzed and fermented foods are no longer intact and, currently, cannot be adequately detected and quantified through testing, the final rule states that FDA will determine compliance based on records kept by the manufacturer to show that their foods are gluten-free before fermentation or hydrolysis.” This means the food must meet the definition of gluten-free *before* undergoing fermentation or hydrolysis, in addition to evaluating any potential cross contamination during the manufacturing process.

“The new FDA ruling on fermented or hydrolyzed products added some clarity—and some confusion,” says Allred. “The important part is that it clarified that any food that is fermented or hydrolyzed as part of its processing must start from gluten-free starting materials. That means that no wheat, rye, or barley should be present in the ingredients prior to the addition of the microorganisms, chemicals, or enzymes used for fermentation or hydrolysis. They instituted this ruling because the current gluten test kits on the market are not accurate at measuring gluten that has been broken down or degraded, so there is no good way to

Gluten-Free Consumer Fast Facts

44% of consumers aged **31–40** said they would buy gluten-free products, compared with **34%** of all consumers.

39% of consumers in the income range of **\$75,000–\$150,000** said they would buy gluten-free products.

48% of shoppers who primarily shop at Whole Foods said they would buy gluten-free products.

Source: Lynn Dornblaser, Mintel 2019

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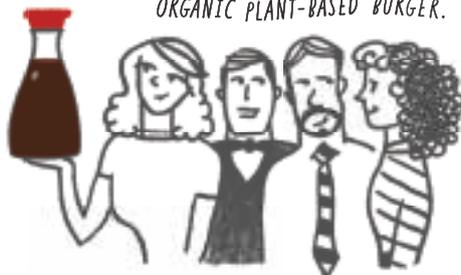
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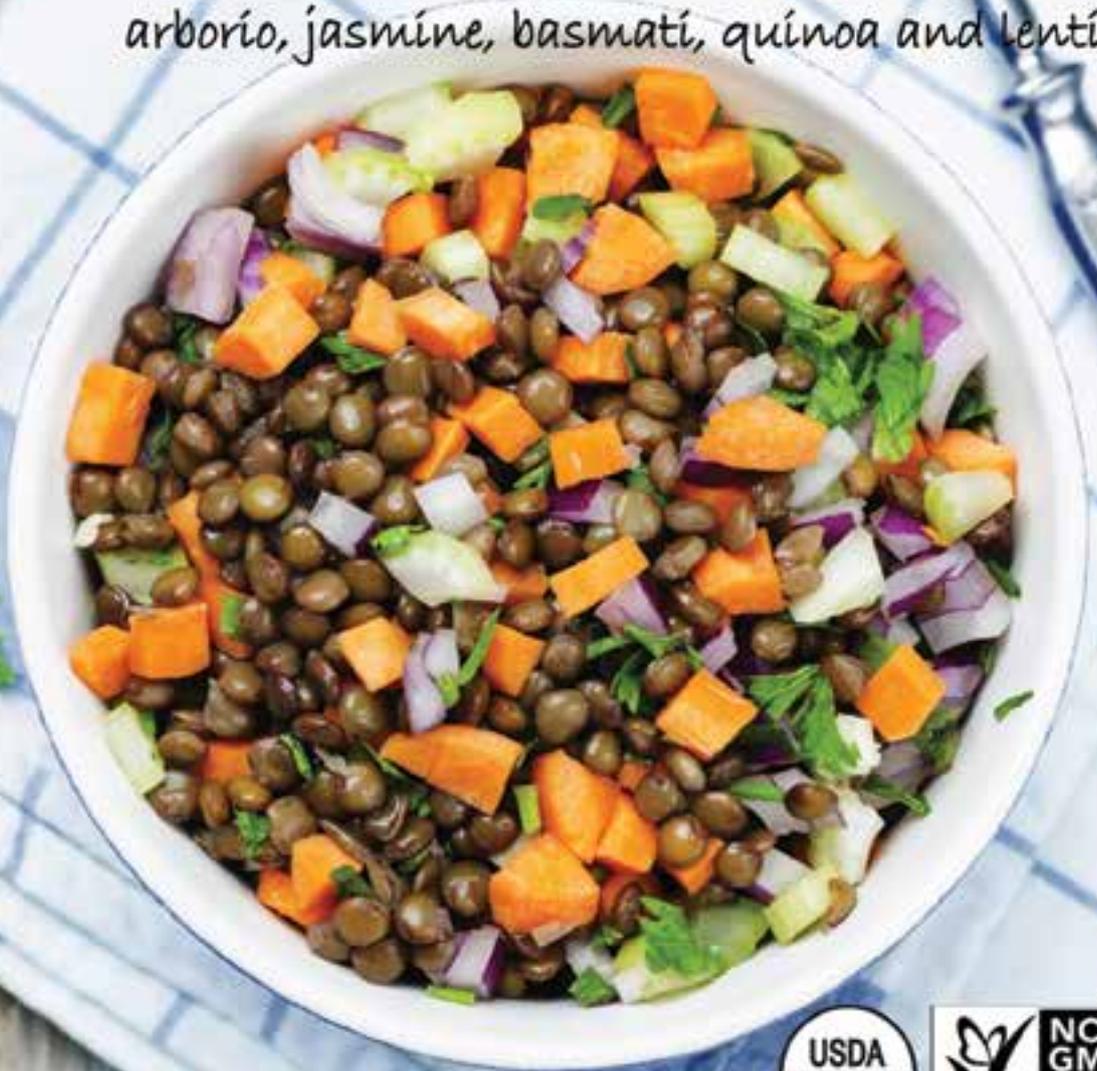
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Move Over Bland Gluten-Free Brands continued...

test a product after fermentation or hydrolysis has taken place.”

So what does this mean for the potential gluten content of microorganisms and enzymes used for fermentation or hydrolysis? This is especially important for yeasts and bacteria grown in mediums that contain wheat or barley. If these microorganisms are then used in very small amounts to ferment or hydrolyze a finished product where no other gluten-containing ingredients are introduced, does that mean the finished product is not gluten-free? Allred says that the enzyme industry requested that enzymes be exempt from the new FDA ruling, but this did not fly with the FDA. The agency did say that the amount of an enzyme used in a product would be a consideration in determining whether the finished product could be considered gluten-free.

“We are unsure how the FDA will ultimately regulate in this area, but we have been asking all of our clients to gather information on the components of the growth media used for any of their enzymes, yeast, probiotics, or other cultures, and to look at the amount of these cultures in relation to the total volume of their finished product, so that they can be prepared regardless of the direction taken by the FDA,” Allred says.

Supply Chain Gaps

It’s no secret that COVID-19 has put strains on supply chains, especially for specialty foods like gluten-free. In May 2020, the FDA issued a temporary policy, which allows food manufacturers to make minor formulation changes to their products without updating their product labeling. As of press time, this policy was still in place.

“Of utmost importance is [that] every manufacturer needs to know every ingredient is gluten-free,” says Shelke. “When purchasing from multiple suppliers, the risk for cross contamination is higher.”

Allred says barley is of particular concern. “Since wheat is also an allergen that is required to be declared under the Food and Allergy Labeling and Consumer Protection Act, the unintentional addition of a barley-based component may be the



Tortilla maker Mission Foods offers gluten-free cauliflower tortillas.

more likely scenario,” she says.

“This is one reason that GFCO (a gluten-free certification program created by the Gluten Intolerance Group), along with all of the other major celiac disease foundations, endorses the passage of the Food Labeling Modernization Act of 2021,” Allred continues. “Among many other things, this act will require all gluten grain sources to be declared on product labels in the same way that the major food allergens must be listed.”

Paleo, Keto, FODMAP Drive Demand

One of the drivers for gluten-free product development is growing demand for vegan, keto, paleo, and FODMAP foods. “The gluten-free industry continues to grow alongside the other major growth sectors in consumer packaged goods, especially vegan and vegetarian foods,” says Allred. “These products were

once largely made from wheat gluten, but are now made from a variety of grain, plant, and even fungi-based proteins.

A good-tasting, nutritious, and gluten-free bread is the Holy Grail of this market. As a result of the many ingredient restrictions associated with keto, paleo, and FODMAP, innovation is moving along to produce breads with greater rise or loft, flavor, and a more than acceptable texture. The gap between commercial reality and consumer expectations is narrowing.

Previous strategies for making gluten-free breads focused on replacements. Today, there are two primary strategies for creating wholesome, good-tasting gluten-free breads: 1) choosing scientifically proven ingredients such as emulsifiers, enzymes, fats, fibers, hydrocolloids, and proteins, and 2) adapting technological advances such as high hydrostatic pressure, ohmic heating, and sourdough technologies.

The following list includes advances in ingredients that solve baking challenges associated with gluten-free:

- **Arabinoxylans (AXs)**, which are hemicelluloses found in the cell walls of many cereals, are being tested for use in gluten-free bread. To date, the most success has been with water-extractable AXs to stabilize the dough, which “results in an enhanced gas retention that prevents early coalescence of gas cells and was found to be crucial for achieving higher specific volume and a homogeneous fine bread crumb structure,” according to research (Bender et al. 2020).

- Grouping enzymes together via **cross-linking** enhances elasticity and consistency in gluten-free batter, bread volume, and crumb softness.

- **Sourdough technology** is not new, but it is attracting interest in gluten-free baking as it allows for the

Move Over Bland Gluten-Free Brands continued...



Nestlé's Life Cuisine brand taps into cauliflower as an ingredient in its Gluten Free Lifestyle lineup.

removal of additives, making the product appeal to clean label consumers, and it improves texture. Choosing the right starter cultures for the fermentation of gluten-free dough is critical. Strains that have been tried with success include *Lactobacillus fermentum*, *L. plantarum*, and *L. paralimentarius*.

• **High hydrostatic pressure**, traditionally used to thermally preserve fruit juices, is now being used for gluten-free bread making. The application of high pressure increases batter elasticity and improves volume and texture in buckwheat, teff, white rice, and oat doughs.

Standout Gluten-Free Products

Pastas are right behind bread as a must for gluten-free customers. Giovanni Santi, president of Santi Consulting, specializes in the development of new gluten-free pastas. He says that the pandemic opened up a new category for gluten-free pasta—shelf-stable microwavable pasta meals in a cup.

"These cups allow people to have a plant-based quick meal at home with no requirement for refrigeration. The quality is high, and the flavor is good, especially with the addition of cauliflower, sweet potatoes, and zucchini," he says. Santi says the overlap between keto and gluten-free will likely continue as

gluten-free pastas and breads add fiber and proteins.

Here's a sampling of other products that are carving out space in the gluten-free category:

- **Scotty's Everyday** broke the taste barriers for keto-friendly/gluten-free breads and cupcakes with products that feature a light, airy texture and are high in fiber, low in carbohydrates, and free of nuts.

- **Carbonaut** breads, made from flax, millet, sunflower seeds, and psyllium, satisfy gluten-free and keto consumers with their light and wholesome texture. The company is soon to launch bagels and pizza crusts.

- **Cauliflower** remains a star ingredient for gluten-free. Nielsen estimates that sales of packaged cauliflower products grew 71% from 2019 to 2020. The *CauliPower* brand skyrocketed with the introduction of cauliflower pizza crust. The company set the stage for making the white vegetable as popular as green kale.

Today, the food company is continuing to launch new products, including gluten-free cauliflower pastas.

- Lastly, peas continue to take center stage for their versatility and nutrition. Among pasta aficionados who do not want to sacrifice taste or nutrition, ZENB, a maker of single-ingredient whole yellow pea pastas, gets high marks for fiber, protein, clean taste, and the ability to sop up pasta sauce.

"With the rise of other diet trends such as paleo, keto, and Whole30 (which all happen to be primarily gluten-free), new flours are gaining mass appeal," says Allred. "Products made from vegetables, fruits, beans, and nuts are boosting health benefits and finding their way onto store shelves in the form of baking mixes, tortillas, snacks, and more.

Cauliflower is a great example—from pizza to pasta, this vegetable has become a standout performer. There is a great deal of creativity coming out of the industry, and it is exciting to watch and see how it will continue to innovate." **FT**

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Maintaining Mobility

Healthy bones and joints affect adolescent development, overall wellness for all ages, and the ability to stay active with aging. Conditions like arthritis and osteoporosis are associated with weak bones and joints; maintaining bone and joint health lessens joint pain, supports exercise/activity recovery, and reduces risk of bone fractures.

Calcium, vitamin D, and magnesium are well-known bone health nutrients. Calcium helps build and maintain bones while vitamin D helps the body absorb calcium. Magnesium aids in proper calcium and vitamin D regulation. Glucosamine and chondroitin sulfate have been popular joint health supplements. Both are structural components of cartilage, have anti-inflammatory properties, and are thought to help slow cartilage deterioration and reduce pain in the joints.

As consumers become more in tune with

their health and diets, more ingredients are entering the mobility market.

Collagen Peptides

Collagen peptides are popular in the beauty foods market as well as for joint health. And while collagen peptides are appearing in an increasing number of foods and beverages, a recent analysis indicated that there is still opportunity for more growth. Conducted by Frost & Sullivan and commissioned by PB Leiner, the analysis, *Is Collagen Here to Stay?*, indicated that the market for collagen peptides is growing at about 8% per year (CAGR, 2020–2024). Frost & Sullivan expects momentum to accelerate and climb to reach new heights (PB Leiner 2021). The report said that, based on the developmental path followed by more mature health ingredients such as probiotics and omega-3s, collagen peptides are still in the very early stages of their product life cycle.

PB Leiner is the supplier of *SOLUGEL* collagen peptides. Recently, another study commissioned by the company and carried out at Florida State University indicated that consuming *SOLUGEL* can bring about reductions in pain and discomfort in physically active middle-aged people (PB Leiner 2021). Those consuming 10 g per day of *SOLUGEL* collagen peptides saw a 36% improvement, according to the Knee Injury and Osteoarthritis Outcome Score, indicating significant reductions in pain and improvement in knee functionality. The study was presented at the 18th International Sports Nutrition Society Meeting and is due to be published later in 2021.

Another collagen peptide ingredient, GELITA's *FORTIGEL*, was also recently used in a study with young, healthy men and women experiencing knee joint pain. *FORTIGEL* bio-active collagen peptides are optimized to regenerate cartilage, maintain joint mobility, and minimize joint discomfort. Zdzieblik et al. (2021) confirmed that the oral intake of *FORTIGEL* led to a statistically significant reduction of activity-related joint pain in young active adults suffering from knee joint discomfort. In total, 180 active men and women aged between 18 and 30 years with exercise-related knee pain but no diagnosed joint disease completed the trial over a period of 12 weeks. Participants were randomly assigned to the group that received 5 g of specific collagen peptides or to the placebo group.

Turmeric and Curcumin

Turmeric is enjoying increased consumer attention thanks in part to its anti-inflammatory properties, which contribute to its benefits in joint health. Thanawala et al. (2021), for example, showed that a turmeric extract (*TurmXTRA 60N* [60% natural curcuminoids], Nutriventia) helped to alleviate knee pain and improve joint function in healthy subjects with chronic knee pain. Test subjects received either 250 mg of the formulation (150 mg curcuminoids) or a placebo for 90 days.

Curcumin is one of the main curcuminoids in turmeric. *Curcugen* (DolCas Biotech) is a self-affirmed GRAS curcumin formulation that was shown to play an anti-inflammatory role in an acute exercise model (DolCas Biotech 2021). In the double-blind, placebo-controlled study, 24 participants were randomized to either a daily dose of 500 mg of *Curcugen* or the equivalent dose in rice flour prior to an intense exercise protocol of 50 hurdles and 50 drop jumps. Joint range of motion, soreness, and markers of inflammation and oxidative stress were significantly better in the *Curcugen* group 72 hours

Collagen peptides have been shown to maintain joint mobility and minimize joint discomfort.

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post-exercise, demonstrating its capabilities in accelerating post-workout recovery. In addition, following an exercise bout, acute serial supplementation with *Curcugen* at 500 mg improved knee range of motion and thigh pain tolerance when compared directly with the placebo.

Another curcumin ingredient, *BCM-95* (Arjuna Natural) was shown to be effective in reducing pain and other symptoms of knee osteoarthritis. *BCM-95* is a fusion of curcuminoids and turmerone-rich essential oil components. For the study, 193 patients diagnosed with osteoarthritis of the knee were randomized to receive either *BCM-95* as a 500 mg capsule two times daily, or a 650 mg tablet of paracetamol (pain reliever and fever reducer) three times daily for 6 weeks. Knee

arthritis symptoms of pain, joint stiffness, and diminished physical function improved significantly compared with the placebo group. In addition, the test group's serum inflammatory markers, CRP and TNF-alpha, were also reduced compared with the placebo (Arjuna Natural 2021).

Eggshell Membrane

Eggshell membrane is a source of collagen, glucosamine, chondroitin, hyaluronic acid, and calcium. Kiers and Bult (2021) demonstrated that eggshell membrane extract successfully relieved knee osteoarthritis pain. In the double-blind, placebo-controlled study, 150 male and female volunteers, 40–75 years of age and diagnosed with knee osteoarthritis were randomly assigned to the

eggshell membrane group (300 mg) or a placebo group for 12 weeks. The eggshell membrane group reported improved pain and daily life functioning scores.

In a multi-center study, Eskiurt et al. (2019) observed reduced pain and stiffness in subjects with grade 2 and grade 3 knee osteoarthritis taking a natural eggshell membrane (*NEM*, ESM Technologies) supplement. This was observed within 7 to 30 days, and the benefits persisted for 90 days. Researchers concluded that *NEM* can be considered as a safe, natural intervention for inclusion as part of a comprehensive clinical protocol in the management of knee osteoarthritis. One hundred sixty-six subjects (males, 32; females, 134; age ≥ 40 years) with grade 2 or 3 knee osteoarthritis for 1–5 years were

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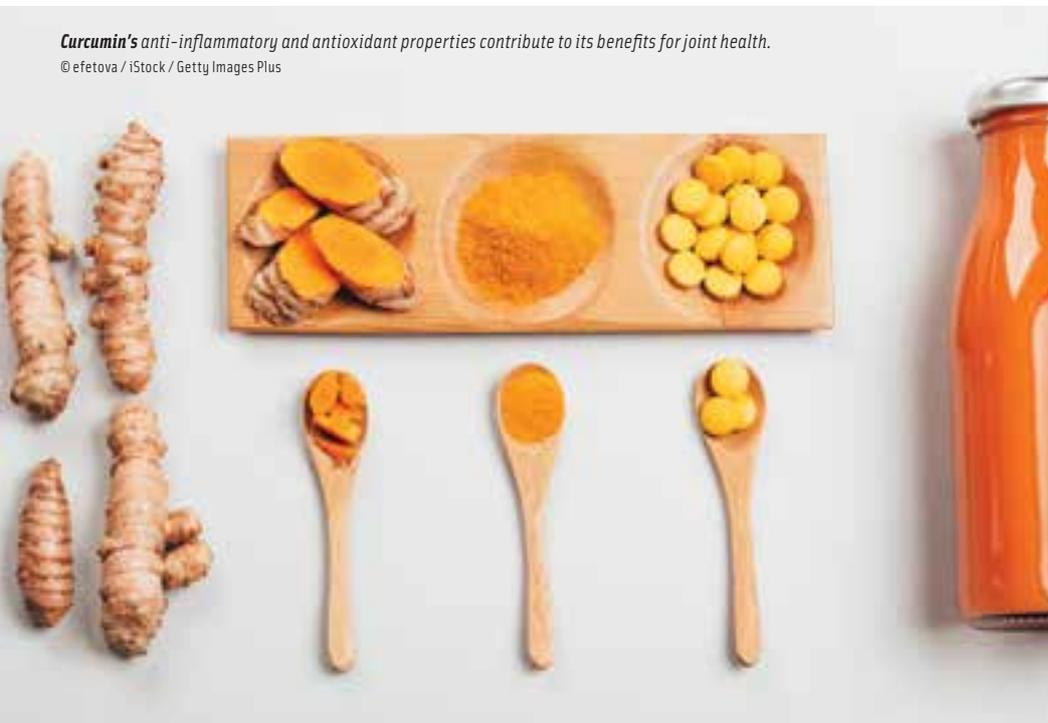
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Maintaining Mobility continued...

Curcumin's anti-inflammatory and antioxidant properties contribute to its benefits for joint health.
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randomized to either *NEM* (500 mg once daily) or a placebo for 30 days. After 30 days on the placebo, the placebo group crossed over while remaining blinded and was provided with *NEM* (500 mg) for an additional 60 days.

Probiotics

Probiotics are known for benefiting immunity and digestive health, but some have been associated with bone health, potentially aiding in the bone remodeling cycle. *Probi Osteo* (Probi AB) is a probiotic bone health concept, based on the combination of the proprietary strains *Lactiplantibacillus plantarum* HEAL9, *Lactiplantibacillus plantarum* HEAL19, and *Lactocaseibacillus paracasei* 8700:2. Preclinical studies suggested that probiotics may support normal inflammatory responses, which when elevated, have been coupled with

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increased bone resorption. Jansson et al. (2019) monitored the impact of *Probi Osteo* on the bone density of 249 healthy, early postmenopausal women over a 12-month period. Treatment reduced the lumbar spine bone mineral density loss compared to placebo. The results of the study showed that intake of *Probi Osteo* may reduce bone loss and support strong and healthy bones.

As consumers focus on bone and joint development, maintenance, and strength, the tried and true nutritional ingredients as well as novel

nutraceuticals will help create foods and beverages that promote healthy mobility. **FT**



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Learning Objectives

- Biologically based preservation (biopreservation) methods that do not ferment foods are among the newest methods of food preservation.
- Bacteriocins can be applied to foods in various forms: 1) partially purified bacteriocins; 2) fermented products (fermentates) containing bacteriocins; 3) bacteriocin-producing (bacteriocinogenic) cultures; and 4) bacteriocins incorporated into coatings and packaging films.
- The first and best-characterized bacteriocin from lactic acid bacteria is nisin.

Glossary

Biopreservation: A modern food preservation method that deals with application of lactic acid bacteria and their metabolites—bacteriocins in particular—in nonfermented foods.

Bacteriocin: Ribosomally synthesized antimicrobial proteins produced by bacteria that are active against closely related bacteria but not on the producer organism.

Nisin: A bacteriocin with GRAS (generally recognized as safe) designation from the U.S. Food and Drug Administration, widely used to control *Clostridium botulinum* spores as well as *Listeria monocytogenes* cells.

Pediocin: A bacteriocin that is effective against *L. monocytogenes* cells.

Natural Antimicrobials: Bacteriocin Applications in Foods

Since their discovery almost a century ago, bacteriocins have been recognized as promising antimicrobial agents with possible food, clinical, and veterinary applications.

Bacteriocins are toxic proteins produced by a given strain of bacteria that are active against closely related species but not on the producer organism (Perez et al. 2014). As natural antimicrobials, bacteriocins are an appealing alternative to chemical antimicrobials in the wake of continuing consumer demand for ready-to-eat, convenient, and more “natural” foods that use fewer chemical antimicrobials to control microbial growth (Verma et al. 2014).

In addition, several bacteriocins are potential alternatives to conventional antibiotics used to treat human infections, especially antibiotic-resistant infections (Ng et al. 2020, Shin et al. 2016). Some other bacteriocins have documented anticancer (Zimina et al. 2020, Yang et al. 2014) or antiviral activities (Soltani et al. 2021), and select bacteriocins promote animal growth and/or control bacterial infections in cattle, swine, and poultry production (Hernández-González et al. 2021, Ng et al. 2020).

Biologically Based Preservation

Biologically based preservation—biopreservation—methods that do not ferment foods

Because bacteriocins are colorless, odorless, and flavorless molecules, they do not change sensory, chemical, or physical properties of foods.

are among the newest methods of food preservation. Lactic acid bacteria (LAB) and their metabolites are used in biopreservation because LAB have biopreservation capabilities that other foodborne bacteria lack, in addition to generally recognized as safe (GRAS) status from the U.S. Food and Drug Administration. While biopreservation largely focuses on foods that are not fermented, LAB bacteriocins can also enhance fermented

food quality by preventing undesirable bacteria growth and stimulating growth of the starter cultures used in fermentation.

The use of bacteriocins as biopreservatives has several reported benefits (Gálvez et al. 2007):

- Longer shelf life for foods
- Additional safety during potential temperature abuse
- Reduced risk of contamination by foodborne pathogens during food processing and/or storage
- Reduced economic losses from food spoilage, voluntary and mandatory food product recalls, and foodborne illness outbreaks
- Use of minimal processing without compromising microbial food safety, allowing better retention of macro- and micronutrients and enabling preservation of desirable organoleptic properties of foods

Bacteriocin Food Applications

Because bacteriocins are colorless, odorless, and flavorless molecules, they do not change sensory, chemical, or physical properties of foods. Several bacteriocins are functional at low pH values, a broad range of salt concentrations, and high temperatures, so they can be used in applications in a wide variety of food products (Perez et al. 2014).

Bacteriocins can be applied to foods in various forms (Figure 1): 1) partially purified bacteriocins; 2) fermented products (fermentates) containing bacteriocins; 3) bacteriocin-producing (bacteriocinogenic) cultures, such as *BioSafe*; and 4) bacteriocins incorporated into coatings and packaging films (da Costa et al. 2019). The application of partially purified bacteriocins and fermentates has been more common due to their

Figure 1. Examples of Commercially Available Partially Purified Bacteriocins, Bioactive Powders, and Bacteriocin-Producing Cultures.
(Chikindas et al. 2018; López-Cuellar et al. 2016; Chr. Hansen, Kerry)

Application Category				
Microorganisms Present	Antimicrobials Present	Target Microorganisms and/or Applications	Commercial Name	Company
Partially purified bacteriocins				
	Nisin A	Control against gram-positive bacteria and/or spores in dairy, culinary, meat, bakery products, and beverages	<i>Nisaplin</i>	Danisco
	Nisin	Control against gram-positive bacteria and/or spores in meat, sausages, and cheese	<i>Chrisin</i>	Chr. Hansen
	Nisin		<i>Delvo Nis</i>	DSM
	Pediocin	Control against <i>Listeria monocytogenes</i> (meat products)	<i>Alta-2341</i>	Kerry
Bioactive powders				
	Mixture of antimicrobials	Yeasts, molds, bacteria, spores	<i>MicroGARD fermentates</i>	DuPont
	Line of cultured dextrose and cultured dairy from fermentation	Food protection and preservation ingredients for bakery products, dairy products, meat products, plant-based meat products, prepared meals	<i>DuraFresh</i>	Kerry
	Portfolio made from fermented wheat, rice, and other common food substrates	Food protection and preservation ingredients for bakery products	<i>UpGrade</i>	Kerry
Bacteriocin-producing cultures				
<i>Lactococcus lactis</i> subsp. <i>lactis</i> B5-10	Nisin A	Prevention of late blowing and off-flavors caused by clostridia present in milk and cottage, feta, and ripened cheeses	<i>BioSafe</i>	Chr. Hansen
<i>Pediococcus acidilactici</i> + <i>Staphylococcus carnosus</i> + <i>Lactobacillus sakei</i>		Control against <i>Listeria monocytogenes</i> (Italian salami)	<i>Bactoflavor Flora Italia</i>	Chr. Hansen
<i>Pediococcus acidilactici</i> + <i>Pediococcus pentosaceus</i> + <i>Staphylococcus carnosus</i> + <i>Staphylococcus xylosus</i> + <i>Lactobacillus sakei</i> + <i>Debaryomyces hansenii</i>		Control against <i>Listeria monocytogenes</i> (fermented meat)	<i>SafePro B-LC-007</i>	Chr. Hansen
<i>Pediococcus acidilactici</i>		Control against <i>Listeria monocytogenes</i> (fermented meat)	<i>SafePro B-LC-20</i>	Chr. Hansen
<i>Propionibacterium freudenreichii</i> DSM 706 + <i>Lactobacillus rhamnosus</i> DSM 7061	Undefined bacteriocins	Inhibition of mold and psychrotrophs in cottage cheese	<i>HOLDBAC</i>	DuPont
		Reduction in spoilage by inhibiting growth of yeasts and molds in plant-based fermented food and vegetables	<i>HOLDBAC YM VEGE</i>	DuPont
<i>Lactobacillus plantarum</i> + <i>Staphylococcus carnosus</i>	Plantaricin and carnosine	Control against <i>Listeria monocytogenes</i> (fermented sausage and cooked ham)	<i>ALCMix1</i>	Danisco DuPont
Starter, live, and protective cultures		Food protection and preservation ingredients for meat and plant-based meat products	<i>Saga</i>	Kerry
Starter, live, and protective cultures for fermented dairy		Food protection and preservation ingredients for dairy products	<i>Fargo</i>	Kerry

Natural Antimicrobials: Bacteriocin Applications in Foods continued...

efficacy (Silva et al. 2018).

LAB Bacteriocins

Nisin, produced in several natural variants by *Lactococcus* and *Streptococcus* species, is the first and best characterized bacteriocin from LAB. It is the only bacteriocin licensed in more than 50 countries as a biopreservative (Shin et al. 2016, Verma et al. 2014) and is sold as a partially purified product of dairy or non-dairy fermentations, marketed under names such as *Nisaplin*, *Chrisin*, and *Delvo Nis* (Figure 1).

Many factors affect the activity of nisin against bacterial spores, including temperature and pH, and nisin is a more effective antimicrobial at lower temperatures and under acidic conditions. In addition, nisin is often used in combination with other technologies such as thermal processing, modified atmosphere packaging (MAP), high pressure processing, pulsed electric fields, and other antimicrobials (Silva et al. 2018). For example, the refrigerated shelf life of liquid whole eggs extends from 6–11 days to 17–20 days when nisin is added, at a concentration of 5 µg/ml, before pasteurization. In fresh fish packaged in an atmosphere of CO₂, nisin extends the shelf life and, more importantly, delays

botulinum toxin production by *Clostridium botulinum* type E strains. The combination of nisin and MAP is more effective in preventing growth by *Listeria monocytogenes* on raw pork compared with nisin or MAP use on its own (Montville and Chikindas 2013).

Nisin is widely used to control *C. botulinum* spores as well as *L. monocytogenes* cells, although *L. monocytogenes* cells are much more sensitive to nisin than *C. botulinum* spores are. While 200 IU/ml nisin is sufficient to reduce *L. monocytogenes* cells by 6 logs, 10,000 IU/ml nisin is required to reduce *C. botulinum* spores at a similar level (Montville and Chikindas 2013). Nisin prevents biofilm formation by *L. monocytogenes*. It also sensitizes *C. botulinum* spores to heat, resulting in potentially reduced thermal treatments of foods—an application approved in some countries but not in the United States (Matthews et al. 2017).

L. monocytogenes can also be inhibited by pediocins and pediocin-like bacteriocins, which are small heat-stable proteins produced by LAB. Pediocin PA-1, pediocin ACh, sakacins (A and P), leucocins A, bavaricin MN, and curvacin A are well-studied bacteriocins in this group. As

covered by European patents, pediocin PA-1 can be used to extend shelf life of salads and salad dressings and to ensure safety of cream cheese, cottage cheese, meats, and salads against growth by *L. monocytogenes* (Montville and Chikindas 2013).

Bioactive Powders

Bacteriocins can be incorporated into food products as bioactive powders, especially when a concentrated form of natural antimicrobial is needed. These bioactive powders often contain a mixture of antimicrobial compounds (bacteriocins, organic acids, etc.). Powders are usually derived from cultivating the producer strain in an appropriate microbiological growth medium, followed by heat inactivation of the bacterial cells and then drying the medium (Soltani et al. 2021).

Commercial bioactive powders, such as *MicroGARD*, are effective against an array of yeasts, molds, and bacteria (Figure 1).

What's Ahead

Successfully adding specific bacteriocins to foods may be limited because of a narrow spectrum of antimicrobial activity as well as poor solubility, slow diffusion, uneven distribution, and

partitioning in the food matrix. Using encapsulation technologies, as well as incorporating bacteriocins into coatings and packaging films and applying bacteriocins on food surfaces, has been successful in overcoming such limitations (da Costa et al. 2019, Ünlü et al. 2015).

Since nisin received GRAS status from FDA in 1988 (FDA 2021), numerous bacteriocins with unique structures and diverse modes of antimicrobial activity have been discovered and reported. Further research is necessary on the safety, production, and prospective applications of these bacteriocins. Extensive research on bacteriocin immunogenicity and toxicity, for example, is essential to confirm bacteriocin safety, and clinical studies are needed for approval of bacteriocins by the World Health Organization and regulatory agencies such as FDA. This is an exciting time for basic and applied bacteriocin research and development that will lead to future applications in food biopreservation as well as clinical and veterinary applications of bacteriocins. **FT**



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Commercial bacteriocins, bioactive powders, and bacteriocin-producing cultures are being used in fermented meats and dairy products.

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How Extended Realities Will Impact Food Processing

The information age—where physical experiences gradually give way to digital interfaces—is in full swing. Immersive technologies merge the physical and the digital or simulated world to provide a sense of being immersed in 360-degree environments.

Immersive technologies, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), offer opportunities to interact with virtual objects and digitally overlaid real objects and places in order to enhance experiences. Although immersive technologies have been

life cycle of emerging technologies, indicates a new maturation era for these technologies.

Differentiating AR, VR, and MR

In VR, users are fully immersed in simulated environments that are different from their physical environment. Headsets, also called “head-mounted display,” provide a 360-degree view of simulated space, creating a sense of being in an alternative environment. *Oculus Quest 2*, *Oculus Rift*, *HTC Vive*, *HP Reverb G2*, and *Valve Index* headsets allow a touch-free input for operating a VR

overlying digital elements and does not necessarily require a headset or controlled device. AR can be facilitated through 2-D headsets, holographic handheld mobile devices, or smart goggles such as *Google Glass*.

Applications of AR include the worldwide gaming phenomenon *Pokémon GO*, interior decoration apps via mobile devices, and small displays of information that appear before the eyes through goggles such as *RealWear* and the early version of *Google Glass*.

MR capitalizes on the benefits of both VR and AR by articulating and anchoring objects in physical space with added spatial understanding of the physical environments (i.e., spatial computing). *Microsoft HoloLens*, *Magic Leap*, and *Real View Hologscope* headsets create a mixed reality by overlaying objects such as annotations and 3-D graphics on a physical environment, thus enabling recognition of the physical components, matching the digital objects with them, and allowing users to interact with the digital and physical objects.

Mobile phones that use LiDAR (light detection and ranging) scanner technology to provide a depth map of surroundings open new possibilities for implementing MR applications.

Extended Reality

Extended Reality (XR), an umbrella term that represents VR, AR, and MR, extends the real world by simulating or adding digital components and unfolding a new set of interactive possibilities. XR creates disruptions not only in gaming and entertain-

available since the mid-20th century, excitement over VR and AR innovation has mounted in the past two decades, which have been marked by the development of third-generation devices. However, the recent disappearance of VR and AR from the Gartner Hype Cycle, which tracks the

system. Common examples of VR include virtual tours of museums and real estate listings featuring simulated or recorded environments of physical spaces.

Augmented reality, on the other hand, enhances the actual physical environment of the user by



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ment, but also in healthcare, education, manufacturing, marketing, real estate, retail, and the military.

According to research conducted on immersive technologies in education, training, behavioral sciences, telepresence, human-computer interaction paradigms, storytelling, psychology, ethics, and experiential design, immersive technologies are expected to completely transform how we interact with the digital world in both social and work envi-

Training and Troubleshooting

Because it allows workers to train at their own pace, XR is valuable for employee training and onboarding and promotes learning retention. In addition, XR can introduce manufacturing lines, construction sites, or unfamiliar procedures—which may be costly and/or have safety risks—to a new workforce in low-risk environments. Lockheed Martin, in collaboration with Azure Mixed Reality Services, reduced costs by

workforce, which tends to have an affinity towards digital tools and data.”

Malone notes that MR tools have been used to allow employers to compress weeks of training into as little as three days. Case studies from various industries have shown an average 25%–30% increase in productivity with 46% faster task completion rates with the use of MR-assisted training (Deloitte 2019).

Manufacturers can also benefit

Mixed reality capitalizes on the benefits of both virtual reality and augmented reality by articulating and anchoring objects in the physical space with added spatial understanding of the physical environments.

ronments. The global AR and MR market is expected to reach \$326.1 billion by 2027, with a compound annual growth rate of 63% between 2020 and 2027, according to a MarketResearch.com report.

Developments in the Internet of Things, headgear, cloud computing, mobile devices, and big data drive demand for XR, particularly in the gaming and medical industries. There are opportunities for the food industry to take advantage of XR technologies in areas including remote work environments, workforce training, inspection, marketing, and customer support. The successful implementation of XR in the food industry has lagged over the past decade, however. With rapid developments in software and hardware, as well as a shifting work and operational culture spurred by changes during the COVID-19 pandemic, it is likely that this will change and XR will be adopted rapidly in the food processing industry during the next decade.

93% and shaved more than 7 hr off an 8-hr activity in its spacecraft manufacturing operations area, the XR Association reports.

Taqtile, an industrial XR solutions provider, develops strategies to train frontline workers through the digital platform Manifest. Kelly Malone, chief customer officer for Taqtile, says remote work setups during the COVID-19 pandemic demonstrated frontline workers’ need for support from remote working specialists. He maintains that “80% of the workforce, corresponding to 2.8 billion people, is deskless” and “this portion of the workforce has not benefited from the ongoing digital transformation advantages.

“A retiring generation is also taking accumulated years of institutional knowledge on equipment and processes with them, causing added burden on businesses to train the upcoming workforce,” Malone continues. “Immersive technology solutions address a growing need for training a next-generation

from MR-assisted routine maintenance and line inspections with remote support options and material handling. Operators working to troubleshoot equipment or process lines can perform tasks by receiving step-by-step instructions through a mobile device or MR headset. This enables a workflow collaboration in a “see what I see” manner.

According to a study conducted by Deloitte to assess live remote support options, 84% of the 200 industry operators surveyed preferred remote live guidance through MR systems versus a standard video call, leading to 32% improvement in problem-solving during downtimes and 50% fewer errors (Deloitte 2019).

The Manifest platform integrates routine maintenance with step-by-step instructions and remote live support. For example, subject matter experts can guide operators to conduct a maintenance or troubleshooting task with information displayed on a specific part of the equipment through MR headsets. »»

How Extended Realities Will Impact Food Processing continued...



Extended reality applications can play a valuable role in employee training and onboarding.
Photo courtesy of Taqtile

Assistance can also be provided via previously constructed workflows. Operators can perform tasks by interacting with pictures, videos, and spatial indicators, such as overlaying 3-D digital ink or pointers over the physical space and overlaying sensor data from the equipment. In addition, evidence can be created to follow instructions during a routine maintenance

activity. Internet connectivity limitations can be overcome by integrating offline operations with prerecorded instructions in the AR platform.

processing facilities via compatible web browsers, mobile phones, and VR goggles. Patrón distillery offers AR and VR experiences to consumers, taking them through the production, aging, and bottling of its tequila.

Experiential marketing strategies by food brands include Remy Martin's AR integration with

Extended reality creates disruptions not only in gaming and entertainment, but also in healthcare, education, manufacturing, marketing, real estate, retail, and the military.

nance activity. Internet connectivity limitations can be overcome by integrating offline operations with prerecorded instructions in the AR platform.

Marketing and Consumer Retention

The most widely implemented examples of XR applications may come from the marketing and sales areas due to the powerful storytelling features of immersive technologies. Food and beverage events, including the IFT annual event, have seen a growing traction in implementation of 360 tours.

Food companies are utilizing VR 360 tours to invite suppliers and customers in for a glimpse of their facilities and operations. For example, Farm Food 360 from Canada provides online virtual tours of Canadian apple orchards, livestock farms, and egg, oat, and cheese

Microsoft HoloLens in 2017, Coca-Cola's "Holiday Magic" campaign with AR apps, and Kraft Heinz's interactive placemats in restaurants for gaming and AR-based recipe books for ketchup in restaurants, among many others. Despite the creative opportunities in marketing and consumer engagement, a clear understanding of the user journey and interaction with the product is essential, and implementation of these strategies integrated into a top-down digitalization ecosystem is needed (Rivera-Pesquera et al. 2021).

Opportunities and Challenges

The use of XR in food manufacturing operations can provide productivity, maintenance, training, and marketing benefits. However, for XR technologies to be fully incorporated in the food industry, several challenges must be overcome. For example,

companies must not only target XR applications, but they must also integrate XR into a greater top-down digital transformation scheme. Some operators may resist wearing headsets or using AR-based software. The lack of internet connectivity can be a barrier to online-supported solutions.

Deploying these technologies in an unsecure manner can also be a vector for data breach and hacking activities. "The secure systems that use one-way data transfer as a part of supervisory control and data acquisition systems minimize the risks by reducing the data control," says Taqtile's Malone.

Also, even though AR technologies enable interaction with preconstructed interactive elements and facilitate feedback, AR systems cannot currently detect mistakes during operations, Malone points out. He adds that use rates within industry are expected to increase as more digitally savvy individuals enter the workforce.

To overcome technology challenges, processors can start small by implementing less-sophisticated mobile device-based solutions to prevent new technology rejection among employees. Business and investment leaders can also benefit from increased learning and engagement training in XR as well as increased monitoring of operations. **FT**

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by Claire Koelsch Sand

Packaging Science Increases Food Access

For 25 years, the International Covenant on Economic, Social and Cultural Rights (within the United Nations International Bill of Human Rights) has recognized adequate food as a human right. While undernourishment declined 4.3% from 2001 to 2019 as a percentage of the population, according to the Food and Agriculture Organization of the United Nations, it is now rising again. Between 2019 and 2020, the prevalence of undernourishment increased from 8.4% to around 9.9% (FAO 2021).

Historically, food access issues have involved mainly marginalized people. But the projected impact of climate change on the entire packaged food system means many people who are not part of that group will also be facing food access challenges at least intermittently.

The ability to grow food is being compromised by drought, wildfires, floods, and colder and warmer regional spikes resulting from climate change. Moving up the supply chain, relocation of food processing and packaging facilities is increasingly necessary when crops commonly grown near existing facilities cannot adapt to the changing climate. In addition, disasters such as tornadoes that destroy food processing and packaging facilities hinder food access. The consolidation of packaging and food manufacturing has only exacerbated this situation: Global food distribution demands infrastructure that can both produce and deliver food safely.

Fortunately, effective disaster management can help manage food access risk, along with an expanded array of solutions including food sovereignty, a larger degree of equity among different population groups, and social justice reform (Rosenberg and Cohen 2018). But these food access solutions all require safe packaged food made possible by innovative packaging science.

Intelligent Packaging Solutions

Many food packaging technologies can address food access by providing extended shelf life. Intelligent packaging that links

foods from farm to fork, such as radio frequency identification (RFID) and near-field communication (NFC), is the cornerstone of improving food access. It can track where food is and what condition it's in, and facilitate transferring food to those in need. The proposed Section 24 of the U.S. Food and Drug Administration's Food Safety Modernization Act identifies specific foods to be tracked at critical tracking events, such as farms, manufacturers, retailers, and consumers along the supply chain (FDA 2021).

To aid in the multifaceted nature of food access and ensure food is authentic, existing tracking systems aligned with Global Standards 1 also can be linked with intelligent packaging technologies such as sensors, nutrition linked to the consumer's health needs, fraud detection, and hyperautomation. Intelligent packaging that can monitor shelf life is advancing from current temperature integrators (such as Evigence sensors) programmed to mimic the growth kinetics of pathogens like *E. coli*, to rapid commercialization of H₂S, CO₂, and ethylene sensors integrated into packaging for red meat, chicken, and produce. Using this technology, consumers would know if food were safe or not safe to eat.

Still other intelligent packaging monitors food throughout a cold supply chain. Emerson internet-connected sensors, for example, allow access to real-time temperature data. Intelligent packaging equipped with decentralized identifiers can use cryptographic

trust to verify food chain of custody, impeding food fraud and ensuring food arrives at the intended destination. In addition, hyperautomation links artificial intelligence, machine learning, and robotics to connect small- and large-scale farms, packaging and food manu-



Packaged retort foods are popular donations to food banks due to their long shelf life.
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facturing operations, and autonomous logistics to the arrival of food at food banks and disaster relief centers.

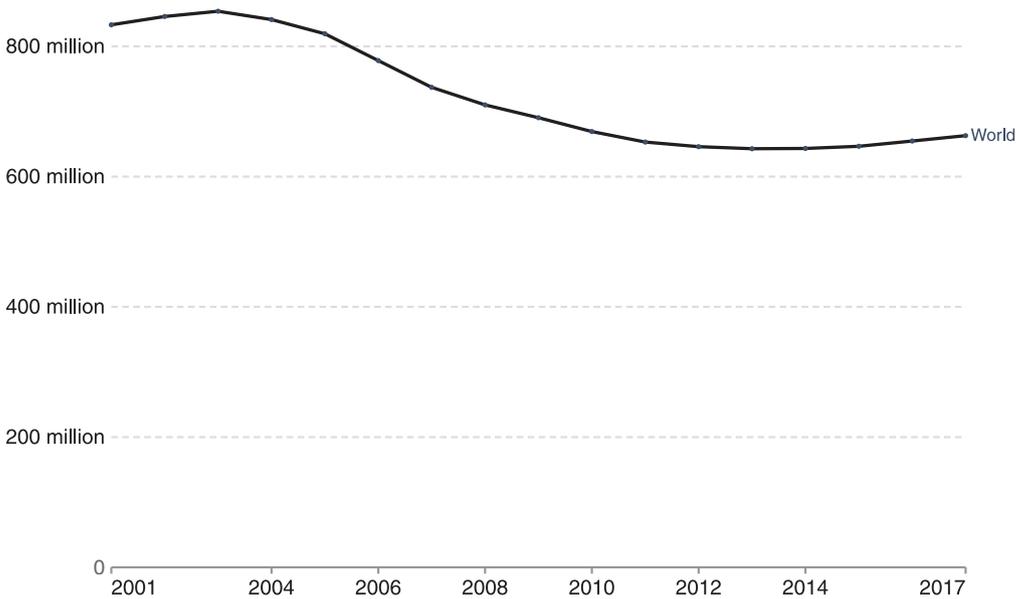
Fermentation Expansion

Many consumers do not always have access to a variety of nutrient-rich safe foods. Fermentation, retort and aseptic packaging, and high pressure processing (HPP) and package barriers all can help provide widespread food access; package requirements vary with the food and the type of processing.

Pickling and fermentation food packaging has a long history, and today packaging and refrigeration work in unison to stabilize bacteria promoted in the fermentation process. Although fermented foods represent only 1.4% of the food market, kimchi sales are growing at 90% and gochujang at 56%, according to The Fermentation Association. »»

Packaging Science Increases Food Access continued...

Figure 1. Global Number of People Who Are Undernourished (Our World in Data 2021).



popular donations to food banks due to their long shelf life.

Reliable destruction of *Clostridium botulinum* is essential in retort processing, requiring packaging to be resistant to temperatures approaching 300°F for a variable time. Within retort temperatures, polymers move from a crystalline to an amorphous state. This transition causes oxygen permeability to increase and layers within a multilayer package to separate due to differential flexing. For example, during retort processing, the polymer flexes, but the glass within retort pouches made of glass-coated films does not flex, resulting in loss of seal and overall package integrity.

To protect metal cans, inner coatings provide abrasion and scratch resistance and also are resistant to acid and salts. Bisphenol A (BPA)-based epoxy coatings, used since the 1950s, have recently been replaced by non-BPA-derived epoxies.

Aseptic Requirements

Packaging food within aseptic pouches increases food access for people who do not have consistent refrigeration. Aseptic packaging connects packaging and food within a closed system in a sterile environment, which demands packaging that is resistant to sterilization methods such as H₂O₂ and ultraviolet light and high-temperature filling (Voicu et al. 2017). Sufficient mechanical strength also is needed for aseptic carton and pouch formats to enable high-speed production with optimized seals. For example, barley-based milk producer Take Two employs aseptic packaging within a polymer bottle and achieves a shelf life of 12 months.

HPP Packaging Advantages

HPP packaging allows for less thermal-intensive processing to extend the shelf life of

Fermentation packaging requirements include acid resistance, pressure control, oxygen and moisture barrier, and temperature monitoring. For example, yogurt requires a low oxygen barrier to enable *Bifidobacterium* (facultative anaerobic) growth vs. lactic acid (aerobic) bacteria. In addition, yogurt packaging needs either temperature resistance to hot filling prefermented yogurt or temperature resistance to hot filling properties to promote fermentation. In both scenarios, the packaging needs to withstand UV-C/B, ebeam, or hydrogen peroxide sterilization before product filling.

Retort Packaging Evolution

Retort packaging has evolved from Nicolas Appert's corked glass jars in the early 1800s, to glass jars equipped with metal closures, to steel and aluminum two- and three-piece cans, to multilayer retort pouches first used in the 1960s. Unsurprisingly, packaged retort foods are



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refrigerated food, from sliced deli meats to juice, by more than 16 weeks. This additional shelf life is gained by destroying or depleting the microbial load within a packaged food. Because foods are less heat and time processed than with retort processing, more nutrients are retained, and fewer preservatives are required.

HPP consists of an initial heating (when necessary) of the confined fluid and packaged food, followed by application of adiabatic pressure ranging from 100 to 800 MPa for approximately 20 min. Because the air trapped inside the packaging presents greater compressibility than the food, headspace reduction is needed to ensure uniform processing. Without this reduction, nonuniform treatment and packaging deformation can occur, so HPP employs flexible packaging as the primary package vs. metal cans, glass, or paper-based packaging.

Due to the compression and decompression resulting from HPP, films with coatings such as metallization or inorganic matter can suffer damage, which may lead to loss of barrier and morphological changes in the packaging. HPP also affects crystallinity, so it alters sorption and migration and tensile strength. In addition, delamination can occur when processing at higher pressure (>600 MPa).

Product-Specific Package Barriers

Whether food has been minimally or fully processed, food packaging protects it from lipid oxidation, browning, moisture gain, and microbial growth. Active packaging technologies such as antimicrobial, modified atmosphere packaging, and oxygen absorbers also extend product shelf life.

The requirements for packaging barrier, however, depend on

the product. Nuts and cured meat with a high degree of mono- and polyunsaturated fats require an oxygen barrier and often a nitrogen replacement of available oxygen within the package. Freeze-dried product demands an excellent moisture barrier—North Bay Trading, for example, packages its Thousand Lakes Food Company freeze-dried *Dried Mixed Vegetables* within a foil multilayer resealable standup pouch.

Regardless of the packaging method, centralized packaging has allowed food byproducts to be recovered and turned into upcycled food, which increases food access by reducing waste. The Upcycled Food Association estimates that more than 400 upcycled products are now available from centralized food packaging facilities. **FT**



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Remembering Roy Hlavacek

Roy G. Hlavacek, former vice president of communications at IFT and a major force in shaping IFT's communications efforts from 2001 to 2007, passed away on August 29.

Hlavacek joined IFT as associate publisher of *Food Technology* and director of publications, overseeing ift.org and World Food Net, the largest virtual community and trade show

for the food industry. Later, as vice president of communications, he developed and implemented the IFT and Research Chefs Association collaboration, including the IFT/RCA Culinology demonstrations held at IFT's annual event; a partnership with Wiley-Blackwell to publish the *Journal of Food Science*; the launch of the *IFT Weekly*-newsletter; Nutra-ceuticals, Food, Medicine & Health, and Culinary Concepts columns; and IFT digital online

sponsorships/advertising programs.

Prior to his roles at IFT, Hlavacek directed the overall print publication and digital sales, editorial, and publishing initiatives of *Prepared Foods*. Earlier in his career, he served as publisher and editor of *Food Processing*, where he launched the annual *Top 100 Food Companies Report* and the *Food Processing Guide & Directory*.

A member of IFT since 1965, Hlavacek served as chair of the

Chicago Section, as a member of the University of Illinois Food Science Department Advisory Committee, as a judge in the Du Pont Awards Program, and as director of the Food Processing Machinery and Suppliers Association. He held a B.S. in mechanical engineering from the University of Illinois and an MBA from the University of Chicago. **FT**

Have some news to share about yourself or another IFT member? Email mmalochleb@ift.org.

Getting to know Upasana Hariram

Each month, we meet one of IFT's valued volunteers.

Passion is a driving force for Upasana Hariram. "I love what I do," she says of her work at Merieux Nutrisciences, where she leads a team in executing microbial challenge studies for food industry customers, adding that "passion and interest drive me to work harder towards my goals."

While earning a master's degree in food science from the University of Massachusetts Amherst, Hariram worked on a United States Department of Agriculture-funded study to understand the prevalence of the foodborne spore-forming organism *B. cereus* in retail spices sold in the United States. In her current role at Merieux Nutrisciences, she helps R&D and food safety teams at food companies make decisions on the stability and safety of their formulations by inoculating their products with pathogens or spoilage organisms.

Hariram was introduced to IFT as a student at UMass Amherst and was "thrilled to have a local section and a place to network

with peers when I moved to Chicago," she says. She began volunteering with the Chicago Section (CSIFT) in the membership committee, welcoming new members and organizing events, as well as finding speakers to discuss their research and areas of interest.



"Additionally, I have served as secretary of CSIFT and the Chicago Food Science Foundation," she says. "I have also been engaged with national IFT in the Emerging Leaders Network program and judging product development competitions."

A particularly meaningful opportunity for Hariram has been her work with the Chicago Food Science Foundation board. "By participating in activities for education scholarships, and fundraising events for the next generation of food scientists, I've been able to make meaningful contributions to the community and enrich others' lives," she recalls.

As a self-described "foodie," Hariram not only enjoys trying new foods but finds fulfillment "using my creativity in helping [customers] design studies to ensure food safety and provide novel solutions to study operations. I also enjoy sharing my knowledge via posters, publications, and presentations."

When asked for her perspective on the essential issues facing science of food professionals, Hariram says, "I think the biggest challenge would be to have a holistic approach to food production which can promote sustainable agriculture, carbon neutrality in food production, traceability and safety of food through the supply chain, and address malnutrition and hunger." Given Hariram's passion for food safety and her track record of meaningful career and volunteer contributions, she is certain to find new opportunities to help advance solutions to these pressing problems while elevating the future of food science.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION.

1. Publication title: Food Technology. **2.** Publication No.: 0015-6639. **3.** Filing Date: 09/23/2021. **4.** Issue Frequency: Monthly Except Combined Dec/Jan Issue. **5.** Number of Issues Published Annually: 11. **6.** Annual Subscription Price: \$190.00. **7.** Complete Mailing Address of Known Office of Publication: Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830. Contact Person: Alexis Pelaez (312) 782-8424. **8.** Complete Mailing Address of Headquarters or General Business Office of Publisher: Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830. **9.** Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor: Publisher: Christie Tarantino-Dean, Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830; Editor: Bill McDowell, Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830; Managing Editor: Mary Ellen Kuhn, Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830. **10.** Owner: Institute of Food Technologists, 525 W. Van Buren Street, Suite 1000, Chicago, IL 60607-3830. **11.** Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities: None. **12.** Tax Status: The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes: Has Not Changed During Preceding 12 Months. **13.** Publication Title: Food Technology. **14.** Issue Date for Circulation Data: August 2021. **15a.** Total Number of Copies (Net Press Run): Average No. Copies Each Issue During Preceding 12 Months: 11,064; No. Copies of Single Issue Published Nearest to Filing Date: 10,130. **15b.** Paid Circulation: (1) Mailed Outside-County Paid Subscriptions Stated on PS Form 3541: 12-Month Average: 10,079; Actual No. Nearest to Filing Date: 9,229; (2) Mailed In-County Paid Subscriptions Stated on PS Form 3541: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0; (3) Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0; (4) Paid Distribution by Other Classes of Mail Through the USPS: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0. **15c.** Total Paid Distribution: Average No. Copies Each Issue During Preceding 12 Months: 10,079; Total No. Copies of Single Issue Published Nearest to Filing Date: 9,229. **15d.** Free or Nominal Rate Distribution: (1) Free or Nominal Rate Outside-County Copies Included on PS Form 3541: 12-Month Average: 619; Actual No. Nearest to Filing Date: 521; (2) Free or Nominal Rate In-County Copies Included on PS Form 3541: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0; (3) Free or Nominal Rate Copies Mailed at Other Classes Through the USPS: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0; (4) Free or Nominal Rate Distribution Outside the Mail: 12-Month Average: 0; Actual No. Nearest to Filing Date: 0. **15e.** Total Free or Nominal Rate Distribution: Average No. Copies Each Issue During Preceding 12 Months: 619; No. Copies of Single Issue Published Nearest to Filing Date: 521. **15f.** Total Distribution: Average No. Copies Each Issue During Preceding 12 Months: 10,698; Total No. Copies of Single Issue Published Nearest to Filing Date: 9,750. **15g.** Copies not Distributed: Average No. Copies Each Issue During Preceding 12 Months: 366; No. Copies of Single Issue Published Nearest to Filing Date: 380. **15h.** Total: Average No. Copies Each Issue During Preceding 12 Months: 11,064; No. Copies of Single Issue Published Nearest to Filing Date: 10,130. **15i.** Percent Paid: 12-Month Average: 94.21%; Actual No. Nearest to Filing Date: 94.66%. **16.** Paid Electronic Copies: **16a.** Paid Electronic Copies: Average No. Copies Each Issue during Preceding 12 Months: 1,510; No. Copies of Single Issue Published Nearest to Filing Date: 1,448. **16b.** Total Paid Print Copies + Paid Electronic Copies: Average No. Copies Each Issue During Preceding 12 Months: 11,589; Total No. Copies of Single Issue Published Nearest to Filing Date: 10,677. **16c.** Total Print Distribution + Paid Electronic Copies: Average No. Copies Each Issue during Preceding 12 Months: 12,208; No. Copies of Single Issue Published Nearest to Filing Date: 11,198. **16d.** Percent Paid: 12-Month Average: 94.93%; Actual No. Nearest to Filing Date: 95.35%. **17.** Publication of Statement of Ownership: The Statement of Ownership will be printed in the 11/01/2021 issue of this publication. **18.** Signature and Title of Editor, Publisher, Business Manager, or Owner: William T. McDowell, Editor-in-Chief, Date: 09/23/2021. I certify that all information furnished on this form is true and complete.



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The Consumer Sustainability Spectrum

Research from Kerry identified four consumer archetypes that illustrate behaviors, associations, priorities, and purchase drivers regarding sustainability.

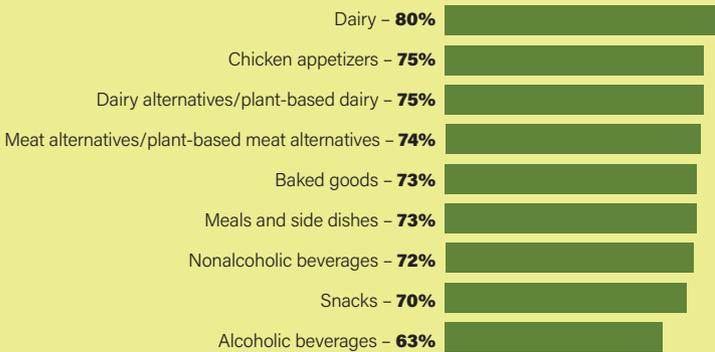
Priorities by Archetype

49%

Global consumers who prioritize sustainability at various levels

Inactives	Passives	Followers	Frontrunners
See sustainability as important but not a key purchase driver. Price and lack of intention are key barriers. No gender or generation skew.	Prioritize sustainability but disenchanted by lack of resources, products, and planning. More likely to be women and older Gen X and boomers.	Purpose-driven, and will switch to brands that are more sustainable. More likely to be Gen Z and younger millennials.	Torchbearers who will trade off price, convenience, and brand affinity to support sustainability. More likely to be older millennials.
<p>North America 10%</p> <p>Global 6%</p>	<p>North America 21%</p> <p>Global 24%</p>	<p>North America 31%</p> <p>Global 23%</p>	<p>North America 38%</p> <p>Global 46%</p>

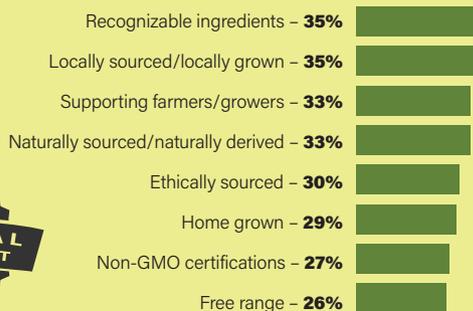
Sustainability Importance by Product Category



Top Drivers: Health and Nutrition



Top Concerns: Food and Ingredient Sourcing Practices



Top Concerns: Food Production Practices



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-Socrates

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