



FOOD, NUTRITION & SAFETY MAGAZINE

PFNDAI

BULLETIN FEB 2026

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NUTRITIOUS FOOD OPTIONS FOR THE
GROWING GLOBAL POPULATION

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2nd Floor, Mahalaxmi Chambers, 22 Bhulabhai Desai Rd., Mumbai - 26 (India)

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THE SNACK REVOLUTION: MODERN CHANGE IN MEAL PATTERN



The three-meal pattern namely breakfast, lunch and dinner, is fast changing especially in urban India. There are many reasons for that.

The nuclear families, with both parents working, are finding very difficult to have traditional role of housewife to prepare the meals for the families. There is not only shortage of time but also very little energy left after the whole-day work along with travel to and from workplace. Some families try to use travel time to do preparations like peeling, sorting, cutting of vegetables etc. However, public transport has become so crowded, these activities are impossible for most.

Parents also would love to spend more time with their children either as 'quality time' or taking their homework or simply watching TV or playing video games. This certainly is unwinding from the stress of their job and other worries.

School going children earlier had full school day but since schools have shifts of morning and afternoon, this creates problems with even breakfast. Thus lifestyle changes have made traditional life very difficult directly affecting the meal pattern.

Some families try to get minimally processed or

processed foods to cut the time and rigor of meal preparation. Others try to order all sorts of food that not only saves a lot of time and efforts but also to suit individual tastes of parents and children.

Another phenomenon has started recently namely the omnipresent snacking. All types of snacks are now entering the market and replacing traditional wafers and cookies and sweets. These are high protein foods with other essential nutrients that would take care of all the nourishment that body needs. These may be bars, khakhras, pasta, and even nutritious cookies, sweets, chocolates and savouries, beverages and shakes, as well as some fast foods.

The snacks are easy to buy any place. They are easy to carry and consume when needed. So when people don't have time, energy or patience to prepare and sit down for a meal, either because of compulsion or by choice, snacks become most convenient. Thus snack food industry is growing fastest globally and in India as well.

We may tell people the importance of proper meal pattern especially for proper nutrition and health. However, modern people and more commonly the Gen Z population, have their own

mind.

If our dietary advice has to have any impact to them, we now start thinking of changing the way to advise. If we tell them to go back or stick to 3-meal pattern instead of omnipresent snacking, they won't listen. So, is it possible to guide them considering the new way of eating?

It may be necessary to first conduct a survey to find out to what extent the changes in diet pattern. Accordingly, we need to tell them how to plan their new style of eating how much and what foods. The labels are on all food products so it would be easier to keep a tab on nutrients. We need to expand the nutrient information to include dietary fibre and some important vitamins and minerals. Gen Z is quite savvy of using this information and feeding into their phone apps. We may also need some apps to evaluate the nutrient intake from the snack foods so people could just feed in the data and find out if they are eating right.

Already people are using apps for counting steps they walked or how many push-ups they did etc. This additional app could also help them eat adequate nutrients along with the foods they like to eat.

Prof Jagadish Pai, Editor, PFNDAI

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WHO ASSURES CONSUMERS WHEN A FOOD SCARE ERUPTS



AUTHOR

Dr Joseph I Lewis,
Chairman, Scientific Advisory
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A video channel seeking to challenge the claim of "100% antibiotic-free" eggs triggered a cancer scare by relying on a test result reporting 0.73µg/kg of AOZ (3-amino-2-oxazolidinone), even though the value was below the extraneous maximum residue limit (EMRL) of 1.0µg/kg. While the parent antibiotic breaks down, its stable metabolite, AOZ, is tested for presence. FSSAI promptly dismissed the alleged link between eggs and cancer as scientifically unsupported and misleading, reiterating that nitrofurans and their metabolites are strictly prohibited at all stages of poultry and egg production. Despite prohibition, its presence would indicate either illegal use or adventitious contamination. Stating that EMRL is a detection limit, not a permissible level of use, or that eggs in India pose no risk of cancer, sounds defensive.

Consumers need an explanation of how they are kept safe. First, is AOZ present? And if present, is there a risk of harm? The law envisions a language of authoritative finality, eliminating

all forms of speculation, especially those evoking fear when none exists. Risk communication (u/s 3zm; 3zp) addresses three critical factors: (a) presence of a food hazard, e.g., nitrofurans; (b) severity of risk, in this case, carcinogenicity; and (c) exposure to harm. It requires a simple explanation of how an Authority uses risk assessment and risk management to establish an EMRL, which represents inadvertent presence.

Whenever any chemical substance is added to or present in food, a safe maximum permissible exposure, described by a health-based guidance value (HBGV), is derived by scientific experts based on examination of relevant experimental data and animal or human studies. From these, the NOAEL dose represents the highest level of exposure of 'no response' to an adverse effect; thereafter, with increasing dose levels, a point of departure (POD) begins with the LOAEL, the lowest observed adverse effect level. Toxicological limits are typically expressed in units such as "milligrams or micrograms per kilogram body weight", relating to a safe exposure for every individual. Because nitrofurans are carcinogenic, there is no "safe level of intake", and maximum safe human exposure cannot be established; hence, no HBGV. What then?

Risk assessors calculate the margin

of exposure (MoE) by comparing a toxicological reference point obtained from animal studies to the estimated human dietary exposure. Similar to, but not identical to, the NOAEL, the benchmark dose (BMD) indicates a POD towards an adverse effect, represented by the statistical benchmark dose lower confidence limit (BMDL). Regulatory bodies, the EU/India and others use MoE data to establish the EMRL/RPA (reference point for action), which is the lowest concentration reliably detected using advanced instrumentation/ methodology. It is chosen for a purpose. For instance, if a metabolite is present at - or below - the EMRL of 1.0µg/kg, the resulting MoE is usually far above 10,000, indicating that trace contamination at the detection limit does not pose a health hazard. A simple analogy is about "keeping a safe distance". An MoE of 1 is like standing on the very edge of a cliff; your exposure is the same as the toxic dose: a great concern of falling off. An MoE of 10,000 is like standing 10 km away from that edge.

The large buffer zone, representing 'zero tolerance' for carcinogens, if explained, should reassure consumers that they are safe. When consumers understand how Regulatory Authorities keep them safe, they know who to trust above all others. That's the endgame for habitual scaremongers. Prove them wrong.

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ALTERNATIVE PROTEIN SOURCES:

NUTRITIOUS FOOD OPTIONS FOR THE GROWING GLOBAL POPULATION



AUTHOR

Dr. Shashank Bhalkar

Executive Director, PFNDAI

The global population is expected to grow to 9.9 billion by 2050. There will be rapid urbanisation in this period, and urban areas will account for 70% of the world population in the same period.

A rise in income is expected multiple times. Western diets today consume protein levels that exceed the daily requirements and are rich in dairy and meat. (1) The rising incomes and population growth will lead to more consumption of proteins globally from both

high-income and low-income countries. Presently, this protein comes from conventional sources, plants and livestock that both require land and water. Even to meet the current dietary needs, global food systems are overexploiting the limited supply of fresh water, disrupting fertile lands, and destroying forests. Unsustainable methods of livestock production are among the main drivers of environmental damage, climate change, and biodiversity loss. Therefore, there is a need for a food system to meet future food and protein demands sustainably. Global food security can be ensured by changing the way we produce and eat food. One solution could be to increase the consumption of

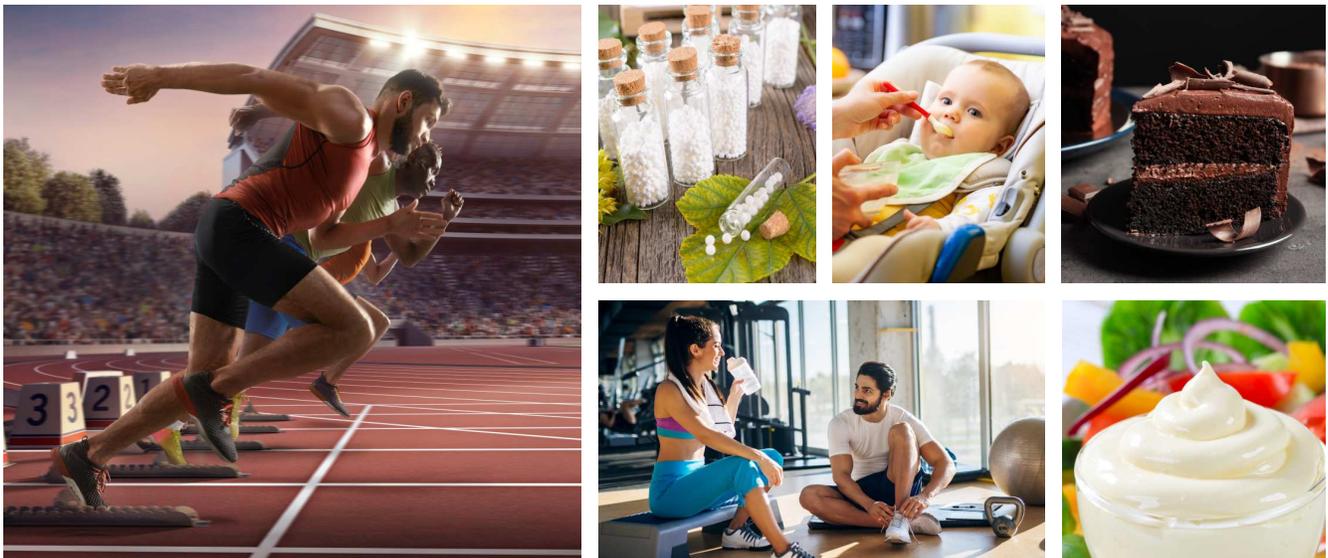
plant-based proteins, as their production is more sustainable and causes less environmental damage than meat and dairy. There is a rising trend of people switching to vegan diets. To meet the increasing demand for protein, many new sources of protein are being explored.

Finding new sources of protein in isolation is not a complete solution to the problem. These new protein ingredients must be formulated into products acceptable to consumers. The new source of protein should be of good nutritional value and functional properties. Complete proteins contain all the essential amino acids in the right proportion. They support good health and balanced growth.



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These sources of proteins are getting unprecedented attention that reduces environmental impact and will provide nutritious food options for

25%) along with healthy fat, fibre, vitamins, polyphenols, and minerals. They are hypoglycemic and give satiety. They have excellent functional properties such as solubility, emulsifying, and gelling ability.

PDCAAS and DIAAS are the preferred methods to measure protein quality. They should be one or near one. Generally, animal and dairy proteins have PDCAAS values near 1 and DIAAS values of 1 or more than 1. Good functional properties are useful to formulate products by using a protein ingredient. They include emulsification, foaming, gelling, water binding capacity, solubility and dispersibility. The formulation of new products has many other challenges, such as consumer acceptance, regulations, etc.

Newer sources of proteins: (2), (3)

In the present scenario, the most widely used commercial proteins are soy proteins, whey proteins, and wheat proteins. We heavily depend upon them as a source of good proteins. In the given context of increasing need for new sources to meet the growing population demands, it is worthwhile to look at diversified sources of plant proteins and other novel sources of proteins.

the growing world population.

Legume proteins:

Legumes are a rich source of proteins with 20 - 25% proteins.

a) **Pea proteins:** They are an excellent source of proteins with protein content of 20 - 25% with, high in essential amino acids like threonine and lysine. They are popular because of cost-effectiveness, nutritional value and health benefits. They have a low glycemic index, give satiety, antioxidant and cholesterol lowering effect. They are used to substitute cereal flour and animal proteins.

b) **Mung bean protein:** This is becoming popular because of its high protein, sustainability, and applications in food processing. This has 25 - 28% proteins with high DIAAS. Mung beans have anti-diabetic and antioxidant properties, and are well tolerated by infants because of low phytic acid content.

c) **Chick Pea protein:** Chick pea is a good source of protein (19 -

d) **Oilseeds:** Whole oilseeds and meal are emerging as a good source of protein in the industry. They have antioxidant, antihypertensive, and neuroprotective properties. Soybean is most exploited for their protein after oil extraction as an ingredient in the food industry. Other oil seeds that can be a source of proteins are sunflower, safflower, rapeseed, peanut, sesame, hemp, evening primrose, chia seeds, flaxseeds, cottonseeds, pumpkin, etc., and are being explored. They have excellent whipping emulsifying properties. The low allergenicity of hemp, evening primrose, and chia seeds is an advantage. The antinutritional factors like glucosinolates, sinapin, and phytic acid should be removed during processing.



Cereals and pseudo

cereals: Wheat gluten is already industrially used in food applications. Other cereals and pseudocereals can be alternative sources of proteins.

a) Rice bran protein: Rice bran, a byproduct of rice milling, is emerging as a source of protein. Full-fat rice bran contains 11 -15% protein, and defatted bran contains 15 -18% protein. The protein contains most of the essential amino acids and has a digestibility of 70 - 85%. Hypoallergenic nature. Rice bran is rich in essential fatty acids and vitamin B, making it an ingredient for the nutraceutical industry.

b) Oats protein: Oats contain about 20% protein with a well-balanced amino acid profile. They are gluten-free and devoid of allergens. Their neutral taste and easy digestibility make them a preferred food for the processing industry.

c) Millets or pseudocereals: Millets are drought-resistant, therefore a sustainable crop. They grow in arid conditions. Therefore, can be a source of food in future. Amaranth and quinoa contain 14% and 8% protein, respectively. Both are high in essential amino acids like lysine, tryptophan, arginine, and sulfur-containing amino acids. Both of these are potential sources of novel

proteins. There is a need of removal of antinutritional factors while processing.

Microalgae proteins:

Spirulina and Chlorella have been increasingly used in the food industry. Because of their essential amino acid content, they are comparable in quality to casein. They are a sustainable source as the requirement of land and water is less. They are a powerhouse of bioactive compounds. They have antioxidant, anticoagulant, anti-inflammatory, anti-microbial, anti-cancer, and neuro-protective effects because of these compounds. Poor digestibility due to anti-nutritional factors, greenish colour, and a typical fishy odour are among the challenges in product formulation. They are used in all forms: Concentrates (about 50% protein) used in pasta, snacks, and bakery items. Isolates (more than 90% protein used clean label formulations. Hydrolysate (35 - 70% protein) exhibit excellent functional property (foaming, solubility) and are used high value sport drinks.

Edible Fungus (Mushroom)

Proteins: They are gaining popularity because of their reasonably high protein content (8.5 - 36.9). They



are a cheap and sustainable source of protein. They are considered healthy because of low fat, high fibre, and phenolics.

Cultured meat: It is meat produced from in vitro-grown muscle cells that are harvested from animals. Cultured meat should mimic the characteristics and nutritional value of conventional meat. It is possible to replace unhealthy saturated fats with the healthy omega-3 fatty acids and their content by altering culture conditions. This will make them a healthy replacement for the meat. Muscle cells are grown in the bioreactors by using specific media. Fetal bovine serum (FBS) derived from the slaughtered cows is rich in hormones, growth factors, amino acids, and antibodies, and is a popular choice of growth factor for cultured meat production. It contributes 95% of the cost of the culture media.





There is a need to have a sustainable serum to produce the cultured meat at mass scale. Cultivating cultured meat in an algal cell medium will reduce the further environmental impact. Cultured meat does not use antibiotics in the cell culture process. There is no genetic modification in the process; therefore, there are no consumer health concerns. Consumers who don't trust biotechnology and who are neophobic may not like to consume it. The major drawback is the high cost of mass-scale production. There is a need to expedite the food safety certification and regulatory clearance.

Edible insects: People have been consuming insects for more than 7000 years. The practice of eating insects is prevalent mainly in Africa, Asia, and Latin America. Insects require less land to grow than conventional livestock. The biomass conversion and growth rates are high, making them a potential source of staple food for the growing population. Insects are high in protein content (more than 50%), fat content, and fats are rich in unsaturated fatty acids.

Chitin, which is in the exoskeleton, is removed as a first step in protein extraction. The extraction process includes degreasing (using a nonpolar solvent), sonication, alkali extraction, followed by isoelectric precipitation and enzymatic hydrolysis. The protein can be used in a variety of food applications like snacks, burgers, energy bars, salads, bread, biscuits, etc. It can be used as feed. The oil can be used in medicine. This use is increasing globally. It has the potential to be used in health supplements.

Plant-based meat

analogues: Plant-based meat is prepared by using plant proteins to form a meat-like form, taste, and texture. Such products will help reduce the consumption of meat and the use of plant proteins, which are a sustainable source. Generally, soy and gluten are commonly used plant proteins in the manufacturing of meat analogues. Fungi and legumes are also used in the manufacturing of these products. Various kinds of plant-based meat analogues, such as sausages, steaks, nuggets, and patties that mimic the taste and texture, are manufactured. In addition to plant proteins, additives such as emulsifiers,

binders, fats, and flavours are added to manufacture these kinds of products. Soy proteins are an excellent source of protein. Wheat gluten helps to make the analogue clearer and improve the elasticity. Extrusion, shear cell technology, and ohmic heating are the technologies used to manufacture meat analogues. Low moisture extrusion processing (LMEP) uses a single screw extruder and forms moisture below 30%. The product exhibits a spongy texture. High moisture extrusion process (HEMP) uses a long cooling die to form moisture above 50%, and the product produced has chewability, cohesion, and elasticity. Shear cell technology produces a product that is fibrous in nature. Ohmic heating, also called electro-conductive heating, is an electromagnetic-based technology where the electric current is passed to achieve uniform heating. Various plant-based meat analogues are succeeding in the market and becoming popular among consumers who do not want to consume meat due to ethical and religious beliefs.





Precision fermentation:

(4) This is emerging as the latest approach utilising microbial cells as biological factories to produce a desired compound by altering genes and metabolic pathways. This genetic code could be an exact copy of the DNA sequence found in the digitised database of the desired animal or plant DNA sequence. Generally, GRAS organisms are used to produce protein ingredients to streamline the regulatory process. During the fermentation process, an optimal culture medium that provides essential elements like carbon, nitrogen, minerals, and water is used. After the fermentation, cells are separated and are spray-dried or freeze-dried. Factors such as heat transfer, oxygenation, and nutrient distribution in large bioreactors affect the strain efficiency and stability. Some of the proteins that are produced by precision fermentation are myoglobin, ovalbumen, soy legumin, lactoferrin, beta-lactoglobulin, casein, and zein, which find applications in food products. The cost of operation in scale-up is prohibitive. Apart from scale-up issues, downstream processing like filtration, freeze drying add to cost and has environmental concerns. Advancements in bioreactor design, automation, and

metabolic engineering are required to address these issues.

Agricultural waste:

(5) Food and agriculture sectors produce a significant amount of waste during growing, harvesting, storing, transporting, and processing. They have a good quantity of protein. These can be sustainable sources of protein. Wheat gluten (75 - 80% protein) or corn gluten (55 - 70% protein) are byproducts of starch or bioethanol plants. Potato proteins can be extracted from potato starch production or the wastewater. Casein and beta-lactoglobulin can be extracted from dairy waste. Fish biowaste contains protein, amino acids, enzymes, bioactive peptides, collagen, and gelatin. Meat industry biowaste, like animal skin, bovine hide, pork and cattle bones can be used to extract collagen. Tea residue, (6) which is a major agricultural waste after tea extraction contain about 21 - 28% protein. Because of good gelling properties, tea proteins are used in dairy products, jellies, bread, etc. These agricultural wastes are potential alternative sources of proteins.

Challenges: (7) Long-term success and acceptance of innovative products using novel sources is a

challenging task. There is a need to ensure the safety of alternative sources of protein to protect consumer health, building trust and acceptance of emerging technologies.

a) Consumer acceptance and perception: The products based on the new sources of protein face several challenges, like consumer perception and dietary preferences, sensory attributes (taste and texture), awareness about the products' impact on health and the environment. A typical example is consumer acceptance is of insect-based food products.

b) Food safety and allergenicity: The occurrence of natural toxicants, chemical or microbial contamination, and allergens are major food safety challenge. These novel sources might have allergenic substances, and there is a need to understand the allergenicity of new sources of proteins.





c) Technological challenges:

Processing technologies and scientific advancements are still in a developmental stage for many new sources of proteins. Scale-up of products like cultured meat or precision fermentation needs substantial investment. Technical breakthroughs in bioreactor design and cell growth to reduce the cost are being developed.

d) Regulatory hurdles:

Significant regulatory discrepancies exist between different regions, and there is a need for harmonisation of regulations across the globe. In India, these new protein ingredients will be classified under “Non-specified Foods” and are covered under the Food Safety Standards (Approval for Non-Specified Food and Food Ingredients) Regulations 2017. Obtaining regulatory approval under these regulations require submitting a dossier with scientific information, which includes data on scientific information, data on safety, risk assessment, clinical trials etc. This is a lengthy process and is challenge for introducing

new sources of proteins.

e) **Cost:** The cost of the extracted protein from the alternative source is a key challenge.

All alternative sources are to be processed to extract the protein, which includes several steps such as fat extraction, alkalisation, acid precipitation, and sometimes sonication. The cost of purifying the protein will depend on the scale of operation and will be reduced as the scale of manufacturing goes up.

Market trends: (8) The global alternative protein market size was estimated at USD 35.6 billion in 2024. The market is expected to grow from USD 40.4 billion in 2025 to USD 130.1 billion in 2034, at a CAGR of 13.9%. The market growth is supported by various factors. They include changing consumer preferences, the need for sustainability, and fast biotechnological innovation. Good regulatory support, growing investments, and rising retail presence will support the future growth. The plant-based proteins sector contributed 40% of market share in 2024. The use of new legumes, algae, and fermentation of feed stocks is creating more possibilities. Plant-based meat and dairy alternatives are leading in consumer availability. Dairy proteins

produced by precision fermentation and cultivated seafood are getting regulatory approval.

The alternative proteins will play a major role in the global food system by feeding the population sustainably. This progress in resilient food systems requires joint efforts from all the stakeholders, which include food safety authorities, industry, and research.

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WHOLE GRAINS: WHY INDIA SHOULD CARE AGAIN PART 2

AUTHORS



Nutritional Benefits of Wheat

Wheat is an excellent energy source due to its high complex carbohydrate content and also provides significant amounts of proteins, dietary fibre, and essential micronutrients including, vitamins, minerals, and phytochemicals. When consumed in its whole grain form such as whole wheat flour, it offers notable nutritional advantages over refined cereals commonly consumed in the Indian diet such as polished rice. For instance, the consumption of three chapatis prepared from 90 g of whole wheat flour can provide about 34% of the recommended daily allowance (RDA) for dietary fibre and 17% of the RDA for protein. In contrast, an equivalent serving of 100 g of cooked polished rice (sonamasuri) contributes only about 2% of the RDA for fibre and 3% of the RDA for

Ms Sreyashi Moitra,
Assistant Manager

&

Ms Vandana Rajiv,
Executive

Nutrition Sciences, ITC Foods

protein. This comparative nutritional profile highlights the role of whole wheat flour in supporting digestive health, promoting satiety, and enhancing protein and fibre intake, particularly in cereal-based diet.

Wheat grains are also important sources of B vitamins, especially thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), and folates (B9). Whole-grain flours have considerably higher vitamin contents than white flours because vitamins are predominantly found in the

bran and germ. In fact, all B vitamins are also concentrated in the bran and/or germ. These vitamins play essential role in energy metabolism and cellular processes. Wheat grains also contain small amounts of phytochemicals that are known to promote well-being. The two major classes of phytochemicals found in wheat are phenolic compounds and terpenoids.

^{1,2}

The ICMR NIN Dietary Guidelines for Indians, 2024 recommends that at least 50% of daily cereal intake (about 120g) should come



come from whole grains which must include the bran, germ, and endosperm in the same ratio as the original grain³. This recommendation is aimed at improving the overall density of the diet. Incorporation of Whole wheat flour in daily meals therefore plays a critical role in meeting the dietary guidelines and may contribute to better digestive health and micronutrient adequacy amongst the Indian Population.

Dietary Fibre in Whole Wheat

The total dietary fibre content of wheat ranges from 9 to about 20% on a dry weight basis, and includes both insoluble and soluble fractions. The cell walls of the starchy endosperm cells in wheat are primarily composed of arabinoxylan (AX) and β -d-glucan,⁴ along with cellulose. Lignin is mainly

presented in the bran and aleurone layers. Smaller proportions of soluble fibre in the wheat play an important role modulating viscosity and fermentation processes in the gut.

Wheat fibre or bran is the hard outer layers of the wheat kernel. Wheat bran is a concentrated source of insoluble fibre, and also contains appreciable quantities of starch, protein, vitamins, and dietary minerals. A large systematic review revealed that even relatively low wheat fibre intake during a single meal can maintain a prebiotic effect, despite the presence of a mixed habitual diet.⁵

Insoluble fibre, which constitutes the major fraction of wheat bran, is resistant to degradation by gastrointestinal microflora and contributes to increased faecal bulk, thereby reducing colonic transit time, while Soluble fibre dissolves in water to form a viscous gel and can be fermented by colonic bacteria, resulting in the production of short chain fatty acids (SCFA) that serve as an energy source for gut microbiota and help modulate the composition and activity of the gut environment, supporting immunity and long-term health benefits^{6,7}

The arabinoxylan (AX) in wheat fiber, the

polyunsaturated fatty acids (PUFAs) and phytosterols in wheat bran oil are known to have an inhibitory effect on the body's cholesterol synthesis and blood lipid level. Numerous studies have also reported that arabinoxylan (AX) can regulate the postprandial blood glucose level of the human body and can significantly improve blood glucose control in patients with type II diabetes.⁸

Evidence on Health Consequences of Refined Grains and Benefits of Whole Grains

Chronic Disease Risk

Research suggests that higher whole grain consumption is consistently linked to lower incidence of major chronic diseases:

- A meta-analysis of prospective studies found significant associations between whole grain intake and reduced risk of coronary heart disease, CVD, total and all-cause mortality. No strong protective associations were seen with refined grains in the same studies.⁹
- In a large systematic review, each incremental daily intake of whole grains was linked to lower risk of stroke, CHD, heart failure, CVD overall, and death, whereas refined grain intake did not show protective effects.¹⁰



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Metabolic Control

Controlled trials where refined grains were replaced with whole grains reported improvements in cardiovascular risk factors: lower total cholesterol, LDL (“bad”) cholesterol, HbA1c (a marker of long-term glucose control), and C-reactive protein (an inflammation marker).¹¹

Inflammation and Biomarkers

Observational evidence shows that higher whole grain intake is associated with lower inflammation (e.g., lower hs-CRP), while higher refined grain intake may be linked to increased inflammation — even after adjusting for lifestyle factors.¹²

India’s Metabolic Risks and Refined Carb Load

The ICMR-INDIAB survey further confirms that high carbohydrate intake from low-quality sources like white rice and refined cereals is associated with higher odds of T2D,

prediabetes, overweight and obesity in Indian adults. These associations persisted even when adjusting for various demographics and health behaviours, underscoring the public health importance of carbohydrate quality not just quantity.¹³

Balancing Whole Grains, Total Carbohydrates, and Broader Diet Quality

It’s crucial to note that some national research indicates that only swapping refined grains with whole grain flour, on its own may not significantly reduce metabolic disease risk, emphasizing that overall diet quality matters. Balanced diets with controlled carbohydrates, adequate protein (especially from pulses, legumes, dairy or lean animal sources), and healthier fats may be most protective. Therefore, dietary recommendations increasingly focus on reducing total intake of low-quality carbs, alongside increasing intact whole grains, pulses, proteins, vegetables, and fruits.¹⁴

Milling & Processing of Whole Grains

[Grain](#) milling is among the oldest manufacturing processes and a wide range of milling techniques are currently used in the food industry. Milling refers to

the process of grinding, and reducing grains into flour or meal. Broadly Milling process can be classified into two approaches, (1) where the whole grain is converted into flour without separating the components and another, (2) it could undergo differential milling to separate the grain into individual parts. For instance, wheat could be milled as whole wheat flour or undergo roller milling to yield multiple products as refined wheat flour, bran, germ, semolina, etc.

Traditional methods like stone milling are considered as the simplest, easiest and quickest method, with the main benefit being that the endosperm, bran, and germ fractions remain in their natural proportions in whole wheat flour¹⁵. Beyond conventional milling systems, newer controlled physical treatments like micronization or ultrafine milling, steam explosion, and other such technologies can modify the bran particle size and improve technological and sensory qualities without removing the bran itself. These emerging technologies are increasingly recognised for their ability to enhance not only the nutritional profile of wholegrain flours but also to improve their functional properties, including solubility, bioavailability, and ease of incorporation into food products.¹⁶



Stamp, and the Basic Stamp.

- If a product bears the 100% Stamp, then all its grain ingredients are whole grain. There is a minimum requirement of 16g - a full serving - of whole grain per labelled serving, for products using the 100% Stamp.
- If a product bears the 50%+ Stamp, then at least half of its grain ingredients are whole grain. There is a minimum requirement of 8g - a half serving - of whole grain per labelled serving, for products using the 50%+ Stamp.
- If a product bears the Basic Stamp, it contains at least 8g- a half serving - of whole grain, but may contain more refined grain than whole.¹⁹

Simple household methods like Soaking, popping, puffing, sprouting/germinating, malting and fermenting can also be adopted to significantly enhance the digestibility and absorption of nutrients from whole grains. Sprouted whole grains contains the bran, endosperm and germ, along with the bioavailability of nutrients intact.³

Whole Grain Labelling Practices in Different Countries

Whole grain labelling is guided by national regulations in many countries, with specific criteria's defining the amount of whole grain required in foods, particularly for staple products like bread and flour. Within the European Union, whole grain foods are defined differently across the member states.

For instance, in Denmark and Sweden, for a food to be characterized as whole grain, it is required to consist of at least 50% of dry matter from whole grain ingredients. In the Netherlands, 100% of the flour must be whole grain for bread to be labelled as 100% whole grain.

In Germany, whole grain bread must be at least 90% whole grain. In the United Kingdom and the USA whole

grain foods must contain $\geq 51\%$ whole grain ingredients by weight¹⁷. In India, FSSAI regulates whole grain labelling through specific rules, notably for bread, requiring whole wheat bread to have $\geq 75\%$ whole wheat flour and brown bread $\geq 50\%$, while multi-grain bread products must meet minimum grain percentages (Minimum 20% should be grains other than wheat).

These Key regulations mandate clear ingredient lists by weight, and accurate claims to prevent misleading consumers, ensuring transparency for products labelled as "whole" or "multi-grain".¹⁸

The Whole Grains Council (WGC), also issues a Whole Grain Stamp, which is a front of pack voluntary labelling symbol that helps customers quickly identify foods containing whole grains and understand how much of whole grain, a product provides. There are three different varieties of the Whole Grain Stamp: *the 100% Stamp, the 50%+*





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Bringing It Back to Whole Grains

Whole grains therefore offer scientifically supported benefits for metabolic health and chronic disease risk reduction, due to fibre, micronutrients, and phytochemicals. India's rich traditional palette of millets and intact grains provides an evidence-backed foundation for healthier diets, yet decades of refining and modern food preferences have shifted consumption patterns.

Rebalancing diets through increased whole grain intake, diversification with whole wheat, millets, and broader diet quality improvements aligns with both research evidence and national nutrition priorities.

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A HEALTHY GUT IS POWERHOUSE OF IMMUNITY

SOME FACTS OF THE BENEFICIAL PROBIOTIC BACTERIA FROM FOOD TO HUMAN HEALTH

AUTHORS



Mr Gokulakrishnan SS,
B Sc(DT), M Sc (DT), NET (DT),
Head (QA and R & D),
Amul Dairy, Gujarat



Dr N Dinakaran,
MBBS, MD, DM
(Gastroenterology), Professor
Emeritus, Chennai



& G Sakthisri Bharathi,
B Tech (FPT)
(ADIT College, CVM),
VV Nagar, Gujarat

Introduction

In contemporary discussions on nutrition and preventive health, the gut has emerged as a central player in determining overall well-being. At the heart of gut health lies the concept of probiotics, defined as live microorganisms which, when consumed in adequate amounts, confer a measurable health benefit on the host. These beneficial microbes, primarily belonging to lactic

acid bacteria and select yeast groups, function as silent regulators of digestion, immunity and metabolic balance.

The human gastrointestinal tract hosts a remarkably dense and diverse microbial ecosystem, often described as a "forgotten organ" due to its profound physiological influence. This microbiota assists in nutrient metabolism, protects against invading pathogens,

educates the immune system, and maintains the integrity of the intestinal barrier. Disruptions to this microbial harmony commonly referred to as dysbiosis are increasingly associated with digestive disorders, compromised immunity and chronic inflammatory conditions. Probiotics offer a food-based, non-invasive strategy to restore and sustain this microbial equilibrium.

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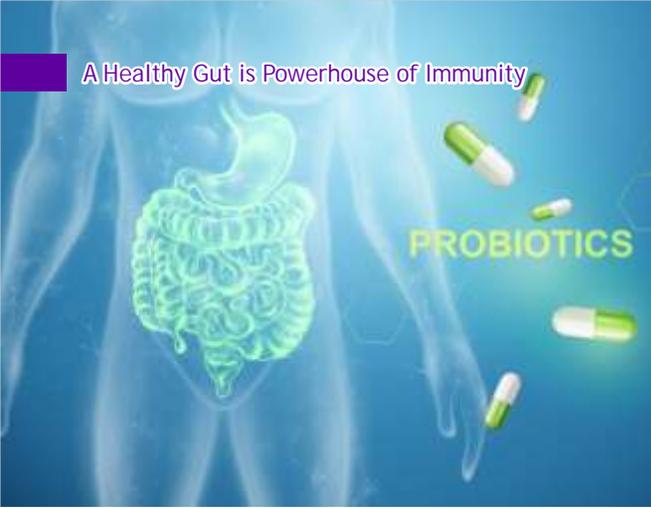


Vasta Biotech Pvt. Ltd.

M: +91 98416 03903

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vasta@vastabiotech.com • www.vastabiotech.com



momentum in the early twentieth century when researchers proposed that beneficial microbes from fermented milk could suppress harmful intestinal bacteria and promote longevity.

This marked a paradigm shift from viewing microbes solely as agents of disease to recognizing their symbiotic role in human health. Over time, advances in microbiology enabled the isolation, characterization and controlled application of specific probiotic strains, transforming traditional fermentation into a precise and reproducible science.

The FAO (Food and Agriculture Organization), in a joint effort with the WHO, defines probiotics as "live microorganisms which when administered in adequate amounts confer a health benefit on the host".

FSSAI says "food with added probiotic ingredients" means food with live microorganisms beneficial to human health, which when ingested in adequate numbers as a single strain or as a combination of cultures confer one or more specified or demonstrated health benefits in human beings and **Minimum Viable Count** of Probiotic foods must contain a minimum viable number of added

probiotic microorganisms of $\geq 10^8$ CFU (Colony Forming Units) per gram or in the recommended serving size per day. Furthermore, the Shelf Life Requirement is that This minimum count of $\geq 10^8$ CFU/g must be maintained throughout the shelf life of the product.

FSSAI-Approved Probiotic Microorganisms (Schedule VII)

According to the FSSAI amendment, which is effective from September 6, 2021, the following live microorganisms are officially recognised as probiotics in India under Schedule VII of the FSSAI regulations and these organisms may be used alone or in combination in your product and must also be clearly labelled with full declaration on the product label. All strains must also be non-GMO.

Probiotic Microorganisms Approved by FSSAI (Schedule VII):

1. *Lactobacillus acidophilus*
2. *Lactiplantibacillus plantarum* ,
3. *Limosilactobacillus reuteri* ,
4. *Lactocaseibacillus rhamnosus*,
5. *Ligilactobacillus salivarius*,
6. *Lactocaseibacillus casei*,
7. *Levilactobacillus brevis*,
8. *Lactobacillus johnsonii*,
9. *Lactobacillus delbrueckii sub- sp. Bulgaricus*

Long before scientific terminology existed, traditional food cultures intuitively embraced probiotic-rich fermented foods such as curd, buttermilk, kefir and fermented vegetables. Today, modern food science has refined this age-old wisdom by identifying specific strains, understanding their mechanisms, and incorporating them purposefully into everyday foods, particularly dairy products to support human health in a structured and evidence-driven manner.

Historical Perspective

Fermentation is among humanity's oldest food-processing practices, valued initially for preservation and palatability and later recognized for its health-promoting attributes. Across civilizations, fermented milk and plant-based foods were consumed not merely as sustenance but as remedies for digestive discomfort and general weakness.

Scientific inquiry into probiotics gained

10. *Bacillus coagulans* ,
11. *Limosilactobacillus fermentum* ,
12. *Lactobacillus caucasicus*,13. *Lactobacillus helveticus* ,
14. *Lactobacillus lactis* ,
15. *Lactobacillus amylovorus* ,
16. *Lactobacillus gallinarum* ,
17. *Lactobacillus delbrueckii* (*Lactobacillus delbrueckii* subsp. *delbrueckii*) ,
18. *Bifidobacterium bifidum* ,
19. *Bifidobacterium lactis* (*Bifidobacterium animalis* subsp. *lactis*)
20. *Bifidobacterium breve*,
21. *Bifidobacterium longum* (*Bifidobacterium longum* subsp. *longum*)
22. *Bifidobacterium animalis* (*Bifidobacterium animalis* subsp. *animalis*),
23. *Bifidobacterium infantis* (*Bifidobacterium longum* subsp. *infantis*),
24. *Streptococcus thermophilus* (*Streptococcus salivarius* subsp. *thermophilus*),
25. *Saccharomyces boulardii* (*Saccharomyces cerevisiae* subsp. *boulardii*)
26. *Saccharomyces cerevisiae* (*Saccharomyces cerevisiae* subsp. *cerevisiae*),
27. *Lacticaseibacillus paracasei*
28. *Lactobacillus gasseri*,
29. *Bacillus clausii*,
30. Established probiotic strains of *Bacillus subtilis*,
31. *Bacillus indicus*

Note 1 - These organisms may be used either singly or in combination but shall be

declared on the label with full information and has to be Non-GMO.

Note 2 - The Food Authority may add any new strain of microorganism, possessing probiotic properties, after proper scientific evaluation and include in this Schedule."

Types of Probiotic Microorganisms

Probiotics are not a generic group; their benefits are strain-specific and depend on functional attributes such as metabolic activity, adhesion capacity and resilience within the gastrointestinal environment.

Lactobacillus species

These lactic acid bacteria are widely used due to their ability to ferment carbohydrates into organic acids, thereby creating an environment hostile to pathogenic microbes. They are naturally present in fermented foods and the human gut.

Bifidobacterium species

Predominantly colonizing the large intestine, these bacteria play a crucial role in maintaining microbial balance, supporting immune development and metabolizing complex



carbohydrates.

Streptococcus thermophilus

Commonly employed in dairy fermentation, this organism enhances lactose digestion and contributes to desirable sensory attributes in fermented products.

Probiotic yeasts

Certain yeast strains offer unique advantages, particularly their resistance to antibiotics and effectiveness in managing antibiotic-associated gastrointestinal disturbances.

Ongoing research is also exploring next-generation probiotic candidates with potential applications in metabolic regulation, inflammation control and immune modulation.



Criteria for Selection of Probiotic Strains

The designation of a microorganism as a probiotic is based on rigorous scientific evaluation rather than tradition alone. Key selection criteria include:

1. Safety and Regulatory Acceptance

Probiotic strains must have a proven history of safe use in foods, be non-pathogenic and lack transferable antibiotic resistance traits.

2. Gastrointestinal Robustness

Survival through acidic gastric conditions and bile exposure is essential for functional efficacy.

3. Adhesion and Functional Persistence

The ability to adhere to intestinal epithelial cells enhances colonization, competitive exclusion of pathogens and immune interaction.

4. Demonstrated Physiological Benefit

Health claims must be substantiated through controlled laboratory studies and human clinical evidence.

5. Technological Compatibility

From a food-processing perspective, strains must remain viable throughout manufacturing, storage and shelf life without compromising product quality.

Applications in the Dairy Industry

Among all food matrices, dairy products remain the most effective and widely accepted carriers of probiotics. Milk offers a nutritionally rich and protective environment that supports microbial survival during processing and digestion.

Probiotic dairy formats include fermented milk, yogurt, curd, buttermilk, drinking fermented beverages, cheeses and frozen desserts. These products integrate seamlessly into daily diets, making them practical vehicles for consistent probiotic intake.

Critical formulation considerations include maintaining adequate viable cell counts, managing oxygen sensitivity, ensuring sensory acceptability and preserving product stability throughout refrigerated storage.

Mechanism of Action of Probiotics

The health-promoting

effects of probiotics are mediated through multiple, interrelated mechanisms:

Microbial Competition

Probiotics compete with harmful microorganisms for nutrients and attachment sites, thereby limiting pathogen colonization.

Antimicrobial Metabolite Production

Organic acids, bacteriocins, and other bioactive compounds suppress undesirable microbes.

Reinforcement of Intestinal Barrier Function

Probiotics strengthen epithelial tight junctions, reduce intestinal permeability and enhance mucosal defense.

Immune Regulation

Interaction with gut-associated immune tissues stimulates protective immune responses while preventing excessive inflammation.

Metabolic Contributions

Fermentation of dietary fibers yields short-chain fatty acids that nourish colon cells, regulate inflammation and support metabolic health.



Health Benefits of Probiotics

Digestive Health:

Probiotics improve lactose digestion, reduce bloating and shorten the duration of various forms of diarrhea. They are also beneficial in managing functional gastrointestinal disorders.

Immune Enhancement:

Regular intake supports immune surveillance, increases mucosal antibody production and reduces susceptibility to common infections.

Metabolic and Cardiovascular Support:

Certain strains contribute to improved lipid metabolism, better glycemic control and overall metabolic resilience.

Gut-Brain Interaction:

Emerging evidence highlights the role of probiotics in influencing mood, stress responses and cognitive well-being through the gut-brain axis.

Age-Specific Benefits: In early life, probiotics support immune maturation, while in older adults they help counteract age-related microbial decline and immune vulnerability.

Challenges in Probiotic Food Development

Despite their promise, probiotic products face notable challenges, including maintaining

microbial viability, ensuring strain stability, meeting regulatory requirements and preserving sensory quality. Temperature sensitivity, oxygen exposure and cold-chain dependence remain critical constraints, particularly in large-scale distribution.

Advances and Innovations

Technological progress has significantly enhanced probiotic delivery:

1. Microencapsulation to improve stability and gastrointestinal survival
2. Synbiotic formulations combining probiotics with supportive prebiotics
3. Non-dairy alternatives to expand accessibility
4. Genomic tools for precise strain identification and performance optimization

These innovations are redefining probiotics as sophisticated functional ingredients rather than supplementary additives.

Conclusion and Future Scope

Probiotics exemplify the convergence of traditional dietary practices and modern nutritional science. By modulating the gut microbiota, they exert far-reaching effects on digestion, immunity, metabolism and overall vitality. As scientific understanding deepens, probiotics are increasingly positioned as integral

components of preventive nutrition rather than niche health products. The future of probiotic foods lies in targeted, evidence-based applications delivered through familiar dietary formats. When developed responsibly and communicated clearly, probiotics hold immense potential to enhance public health through simple, everyday foods demonstrating that profound biological impact often begins at the microscopic level.

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CHANGING LIFESTYLES AND THEIR IMPACT ON TRADITIONAL DIETS IN INDIA:



AUTHOR

Ms Simran Vichare,
Nutritionist, PFNDAI

Introduction

The lifestyles of people have undergone many changes since the Palaeolithic age of hunter-gatherers to industrialisation in today's world. This has also brought about changes in dietary patterns. Earlier, people used to eat traditional diets that were region-specific. A traditional diet refers to food patterns that have evolved over generations within a specific region or culture. These diets are typically based on locally available, seasonal, minimally processed foods and are deeply rooted in cultural practices, religious beliefs, and ecological conditions. Traditional diets emphasize staple grains,

pulses, vegetables, fruits, nuts, seeds, fermented foods, and region-specific cooking methods that enhance taste, digestibility, and nutrient absorption.

In today's fast-paced, urbanized world, lifestyles have changed dramatically due to technology, globalization, changing work patterns, and urban migration. These shifts have significantly influenced food choices, cooking practices, and meal patterns, leading to a gradual departure from traditional diets.

Drivers of Lifestyle Change

In recent years, changing lifestyles have led to significant transformations in food habits and dietary behaviour. These changes have been influenced by liberalization, urbanization, globalization, foreign direct investment, expansion of supermarkets and fast-food

chains, rising incomes, digitalization, and increased access to global media (1).

One of the most profound changes has been the impact of rural-to-urban migration on food access and practices. In rural India, diets are traditionally linked to local agriculture, including kitchen gardens, seasonal produce, and even foraging, fishing, or community-based food collection in certain regions. Food preparation is predominantly home-based, with many items, such as pickles and papads, made in large quantities to last for months. However, urban living often limits access to fresh, local produce and traditional ingredients. Migrants may find it challenging to source region-specific grains, leafy vegetables, or fermented foods, leading to a greater reliance on convenience foods that save time.

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Nutrition Facts

	Qty Per 100g	Qty Per 50g	%DV**
Energy (kcal)	250	125	10
Protein (g)	25.0	12.5	25.0
Carbohydrate (g)	65.0	32.5	-
Total Sugar (g)	0	0	-
Added Sugars (g)	0	0	-
Fiber (g)	6.0	3.0	12.0
Total Fat (g)	1.0	0.5	2.0
Saturated Fat (g)	0.4	0.2	0.8
Trans Fat (g)	0	0	-
Sodium (mg)	0	0	-
Total Iron (mg)	0.4	0.2	1.6

13g
Natural Protein

Goodness
of Millets





While rising incomes have improved food purchasing power, this does not always imply better dietary quality. Changes in family dynamics and social environments have also significantly influenced children's lifestyles and eating habits. Factors such as the increasing number of working members and a shift from joint to nuclear families have contributed to these changes.

Globalization has further affected the Indian food culture. With the country's expanding economy, many people work sedentary jobs, have long working hours, and manage irregular schedules. These have made home cooking less feasible and increased dependence on instant foods, ready-to-eat meals, and food delivery apps. Also, increased access to healthcare and improved educational facilities, coupled with the strong influence of social media, have directly impacted dietary habits (2).

This shift from traditional rural food practices to urban convenience has resulted in new eating behaviours. Eating while working or in front of screens, and late-night eating have become common, disrupting traditional meal times and family dining practices. As exposure to international cuisines and processed foods rises, socioeconomic factors and higher incomes have made fast food more accessible, further contributing to a decline in home cooking. Overall, these changes indicate a significant transformation in dietary patterns and lifestyle choices and hence a shift from traditional cooking.

Impact on Traditional Diet in India

One of the most significant transformations in dietary habits across India is the notable decline in the consumption of millets and whole grains, which were

once foundational components of diets in various regions. Traditional staples such as jowar (sorghum), bajra (pearl millet), ragi (finger millet), and little millet have largely been replaced by polished rice, wheat flour, and refined wheat flour. This shift can be attributed to several factors, including government public distribution policies that prioritize these more commercially popular grains, the convenience associated with their preparation, and changes in taste preferences among consumers.

Pulses and legumes have historically been vital sources of protein in Indian vegetarian diets; however, their consumption has declined significantly. Several factors have contributed to this downturn, including rising pulse prices, less availability, a lack of awareness, a cultural shift towards non-vegetarian diets, and the lengthy preparation times often required. Additionally, some people experience negative digestive side effects and gastric discomfort when pulses are not prepared or consumed properly (9). Despite these challenges, pulses and legumes are nutrient-rich foods that provide not only protein but also dietary fibre, essential vitamins, and minerals.

National-level consumption data reflect a clear decline in traditional coarse grains and overall cereal intake. Despite a steady increase in India's overall food grain production over the past few decades, there has been a contrasting trend in per capita monthly cereal consumption. The decline is marked by rising incomes and people spending less on staple foods and more on diverse foods such as meat, dairy, fruits, and vegetables (4).

Also, urbanization, intensive preparation times of traditional foods, and a busy lifestyle are the reasons for this decline. According to recent data, the consumption of cereals has dramatically decreased, dropping from 13.4 kilograms per person in rural areas and 10.6 kilograms in urban centres during the 1993-94 period. By 2023-24, this figure has further reduced to 9.4

kilograms in rural regions and 8 kilograms in urban areas (3).

This shift not only highlights changing dietary preferences but also raises concerns about the nutritional implications and long-term sustainability of local agricultural practices and food security in India.

Loss of Cooking Traditions and Its Nutritional Consequences

Cooking is a practice that holds cultural and emotional significance. In India, traditional cooking methods such as soaking, sprouting, fermenting, roasting, and slow cooking play a crucial role in enhancing the bioavailability of essential nutrients like iron and zinc. These valuable techniques have historically been passed down orally from elders to younger generations. However, with the rise of convenience foods, many of these time-honoured practices are being lost, leaving younger adults unfamiliar with regional recipes and lacking the confidence to prepare traditional meals.

Traditional Indian diets are typically rich in dietary fibre, high-quality protein, phytochemicals, and essential micronutrients,

due to a diverse array of cereals, pulses, vegetables, and spices considered superfoods. Unfortunately, the increasing consumption of refined carbohydrates, fried foods, sugars, and excess salt beyond recommended levels has contributed to a decline in fibre intake and overall micronutrient density (5). The reduced consumption of fermented foods such as buttermilk, curd, yoghurt, kanji, etc., may adversely affect gut microbiota, which plays a role in immunity and metabolic health. Along with this, there is a growing disconnection from natural, seasonal eating patterns than there was before.

Research conducted in Taipei further highlights the importance of family cooking. The study demonstrates that shared cooking routines not only promote psychological well-being but also serve as a mediator for healthier eating habits. Basically, cooking together fosters immediate nutritional benefits and cultivates long-term behavioural resilience, ultimately supporting better dietary choices (6).





researchers, policymakers, and public health advocates who recognize that traditional Indian foods hold not only cultural significance

seen in Indian kitchens, can significantly improve digestibility and mineral absorption. Teaching these recipes in simplified versions through social media, cooking demonstrations, and practical diet counselling can help reconnect urban populations with their traditional, nutrient-rich food heritage.

Positive adaptations and Revival strategies

Despite the decline in traditional diets, India is witnessing a revival of its culinary heritage. This resurgence is driven by renewed interest in millets, organic farming, local food movements, and the Slow Food movement. As nutrition awareness rises in schools, colleges and the general public, and digital platforms proliferate, younger generations are increasingly reconnecting with indigenous food practices. Because of these positive adaptations, traditional diets are preserved, upgraded, and mainstreamed in ways that promote both health and sustainability.

The combination of modernization and globalization offers opportunities to adapt traditional food systems to modern formats.

The revival of traditional diets is driven by various stakeholders, consumers, farmers, chefs, startups,

but also nutritional superiority and environmental sustainability (7).

For instance, millets were a staple in Indian diets earlier, but to tackle the rising hunger problems, high-yielding crops like rice and wheat were favoured. Overtime a decline in millet base diet was observed. Today, an important challenge in the revival of traditional diets is to bring back the lost nutritionally packed recipes. However, expecting to go back to a completely millet-based diet is difficult, as unfortunately, many households are slowly losing the skills to prepare millet-based staples such as bajra and jowar roti. Unlike wheat chapati, these rotis require different techniques, water ratios, and cooking methods. There are anti-nutritional factors present in whole grains and pulses, and the traditional methods of cooking can reduce them. Soaking, sprouting, fermenting, and slow cooking, commonly

Even the food industry is making an attempt to launch these millets through innovative millet-based products, including ragi pasta, jowar tortillas, bajra cookies, millet noodles, and ready-to-cook millet mixes, which can be used to make idlis, dosa, pongal, khichdi, etc. These products contain a minimum of 10% to a maximum of 60% of millets; one must read the food product label before making a decision. Traditional snacks are also being reinvented, with options that are baked or air-fried and often lower in sodium.



Fermented foods have also been adapted for modern convenience. While some people favour only fresh and home-cooked ingredients, this can be unrealistic for many households now due to the difficulty in making these products and the long preparation time. Instead, people should be educated to use products, such as millet flours, fermented batters, and ready-to-cook traditional mixes, to retain cultural foods in convenient formats. Today, easily accessible products such as bottled kanji, probiotic buttermilk drinks, and packaged idli-dosa batter make these healthy foods more relatable to busy lifestyles. Also, there are now premix and frozen products available for Indian gravies, rotis, and chopped vegetables, offering practical and readily available meal solutions. Many restaurants are embracing this trend as well, incorporating Thalīs inspired by traditional diets into their menus.

Advancements in food technology have revolutionized our access to various food items, allowing us to enjoy them year-round. In the past, many fruits and vegetables were only available during specific seasons, limiting our diets. However, techniques



like controlled atmosphere storage and improved transportation have made it possible to keep perishable foods fresh for longer periods.

Additionally, global trade allows seasonal delicacies to be shipped from different regions, ensuring availability regardless of local harvests. Innovations such as hydroponics and vertical farming enable year-round cultivation of crops, enhancing food security and variety. This ensures that the consumers can savour seasonal flavours throughout the year.

Urban consumers are increasingly leaning towards

organic products, seeking chemical-free produce, heirloom grains, and traditional varieties of rice, lentils, and vegetables (8). Numerous government initiatives and community-supported programs encourage the movement towards local, traditional, and sustainable eating, developing a sense of connection with food. The growing recognition that many traditional Indian practices are rooted in sound scientific principles contributes to this interest. Consumers trust in the health benefits of fermented foods for gut health, the nutritional power of spices, nuts, and oilseeds, and the antioxidant properties of fruits and vegetables.

The shift from traditional to modern diets has been associated with rising rates of obesity, diabetes, cardiovascular diseases, and micronutrient deficiencies in India. Reintegrating traditional, minimally processed foods can play a crucial role in improving public health outcomes.



Conclusion

Preserving traditional diets requires coordinated action from policymakers, educators, communities, and the food industry. Government policies should promote millets, local foods, and sustainable agriculture, while schools and universities must integrate traditional nutrition education into their curricula. The food industry needs to cater to the consumer needs and make traditional foods affordable, accessible, and convenient through innovative product development. It is also very important that the authorities and educational institutes highlight the importance of the food industry, as it is the link between nutrition and convenience. Community initiatives such as food festivals, culinary tourism, and local markets can help sustain cultural food

heritage while providing economic benefits. With the support of digital technology, e-commerce, and personalized nutrition tools, traditional diets can be successfully adapted to modern lifestyles without losing their cultural and nutritional essence.

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FERMENTATION EFFECT ON NUTRITIONAL & SENSORY PROPERTIES OF FOOD PRODUCTS



AUTHORS



Ms. Sanyukta Telange, & Ms. Samreen Shaikh, Jr. Food Technologist, PFNDAI

Around 5000 B.C., nomadic herdsmen stored milk in animal skin bags. Due to natural enzymes and warm weather, the milk transformed into a thicker, longer-lasting sour product. The process led to the discovery of what we now know as yoghurt. This natural process by which microorganisms convert carbohydrates into acids or alcohol is called fermentation.

It serves various functions such as preservation, enhancement of sensory attributes like flavour and texture, improved

nutritional quality, and the promotion of probiotics. While many fermentation types, including lactic acid and alcoholic fermentation, occur anaerobically, some, such as acetic acid fermentation, require oxygen. Key bacteria involved in fermentation include Lactobacillus, Lactococcus, Leuconostoc, and Pediococcus, and common examples of fermented foods are pickles, cheese, yoghurt,

curd, kefir, kombucha, sauerkraut, and kimchi.

Various fermentation types exist, lactic acid fermentation, driven by Lactobacillus bacteria that convert sugars into lactic acid; acetic acid fermentation, involving acetic acid bacteria such as Acetobacter that oxidize ethanol to create vinegar; and alcoholic fermentation, primarily facilitated by yeasts like Saccharomyces cerevisiae, transforming



enrichment makes fermented plant foods especially beneficial for vegetarian and vegan diets (1).

sugars into alcohol and carbondioxide.

Importantly, yeasts also play a significant role in fermentation; for instance, in cocoa fermentation, they convert sugars such as glucose into ethanol and produce volatile compounds that contribute to chocolate's flavour development(1).

Nutritional Effects of Fermentation

During fermentation, many changes occur in the nutritional profile of the food products. A key advantage of fermentation is microbial vitamin synthesis. For instance, microorganisms such as *Bacillus subtilis*, used in natto fermentation, produce significant amounts of vitamin K2, known for its role in bone and cardiovascular health. Research shows that fermentation can also enhance levels of B vitamins, including B2, B9, and B12. Fermented legumes often contain higher amounts of riboflavin and thiamine than their unfermented forms, as these vitamins are generated during microbial metabolism. This natural

Fermentation breaks down carbohydrates and proteins into simpler forms, improving their digestibility and absorption. For example, lactose fermentation in milk reduces lactose levels in products like yoghurt, making them easier to digest for lactose-intolerant individuals. Similarly, the conversion of proteins into peptides and amino acids enhances protein absorption, which is especially beneficial for plant-based foods (3).

Raw plant foods contain antinutritional compounds such as phytates, tannins, and enzyme inhibitors that can bind to minerals such as iron and zinc, making them less available for absorption. During fermentation, microbes can break down these antinutrients, thus improving the bioavailability of minerals and other nutrients. In legumes like chickpeas and lentils, phytic acid levels can decrease by 30-60%, enhancing mineral absorption, while reduced tannins improve protein digestibility and mineral availability (1,2).

Fermented foods are high in

probiotics like *Lactobacillus* and *Bifidobacterium*, which help balance the gut microbiome for better digestion and nutrient absorption. They support gastrointestinal health, enhance gut motility, and improve nutrient breakdown. Additionally, probiotics and bioactive peptides in these foods boost intestinal barrier function, reduce inflammation, and support the immune system, promoting overall digestive and immune health (3).

Sensory Effects of Fermentation

Fermentation is used not only to enhance the nutritional quality of foods but also to preserve them and improve their sensory appeal. Bacteria, yeasts, and molds convert carbohydrates, proteins, and lipids into a wide range of metabolites such as organic acids, alcohols, gases, and volatile compounds, which extend shelf life while generating characteristic flavours, aromas, and textures that define fermented foods.

Flavour compound formation during fermentation

Microbial diversity significantly influences the sensory attributes of fermented foods, as different microorganisms offer unique metabolic functions.

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 *Refers to outcome of a clinical study amongst 800 children over 12 months, published in Ind. J. Nutr. Dietet., (2008), 45, 449, 495 comparing kids who consume usual daily diet vs. kids who consume usual daily diet plus 2 recommended serves (2x33g) of complan. Protein in Complan is sourced from milk.



Yeasts add fruity and floral aromas through ethanol and carbon dioxide production, while non-Saccharomyces yeasts enhance complexity with esters and terpenes, particularly in beverages like wine and beer. Lactic acid bacteria (LAB) produce lactic acid, imparting a sour taste and compounds like diacetyl and acetic acid, contributing buttery and vinegar-like notes. Molds such as Aspergillus and Penicillium produce enzymes that break down macromolecules, helping flavour development in products like soy sauce and certain cheeses. (5).

- **Flavour development:** A wide range of compounds contribute to the sensory profiles of fermented foods. Esters such as ethyl acetate and isoamyl acetate impart fruity and floral aromas, while phenolic compounds like vanillin and eugenol provide spicy and woody notes. Ketones, particularly diacetyl (2,3-butanedione), are responsible for buttery flavours commonly associated with fermented

dairy products. Organic acids, including lactic, acetic, and citric acids, contribute sourness, enhance preservation, and influence overall flavour balance.

- **Texture modification:** Fermentation induces significant changes in texture. In plant-based and protein-rich foods, microbial metabolism leads to structural and functional modifications that directly affect mouthfeel and physical properties. During fermentation, acidification leads to casein coagulation, resulting in a denser texture. These are most apparent in yoghurt and sour cream. Fermentation conditions and the choice of bacterial cultures can influence this final texture (6).

Studies show that LAB fermentation of pea protein isolate emulsions can create gel-like textures similar to fresh cheese during refrigeration, influenced by different starter cultures that affect gel firmness and protein network structures. Fermentation with *Bacillus subtilis* can decrease hardness and chewiness in texturized vegetable proteins due to proteolytic changes, but excessive proteolysis may compromise protein matrices, emphasizing the need for process optimization for desirable textures. (7).

- **Aroma complexity:** Aroma complexity in fermented foods arises from the formation of numerous volatile compounds produced through microbial fermentation, enzymatic activity, and, in some cases, heat-induced reactions. These processes generate characteristic sensory notes.

In coffee, microbial fermentation of cherries creates esters and alcohols that provide fruity and floral aromas, while roasting leads to Maillard reactions and caramelization, producing compounds like furans and pyrazines that add caramel-like, nutty, and roasted notes. The aroma profile differs based on bean variety, processing method, and roast level. In wine, aroma arises from grape composition, fermentation, and aging. Yeasts produce esters and higher alcohols that give fruity and floral notes, with terpenes like linalool adding aromas in specific wines.

In cheese, aroma develops mainly during ripening through proteolysis and lipolysis. Protein and fat breakdown generate aldehydes, methyl ketones, sulphur compounds, and other volatiles that contribute creamy, nutty, savoury, and pungent notes, with flavour intensity increasing as ripening progresses.

In Swiss cheese, propionic acid bacteria ferment lactic acid to produce propionic acid, acetic acid, and carbon dioxide. The carbon dioxide forms the characteristic holes or "eyes," while the organic acids contribute to the nutty, slightly sweet flavour. In blue cheeses, molds grow within the cheese and produce enzymes that break down fats. This leads to the formation of compounds responsible for the sharp flavour, distinctive aroma, and the typical blue-green veining.

- **Colour changes:**

Fermentation can induce notable colour changes in foods through enzymatic and non-enzymatic reactions as well as through pigment transformation. Enzymatic browning may occur due to the activity of polyphenol oxidases, particularly in plant-based substrates, leading to the formation of brown pigments that influence visual quality. Conversely, fermentation can also promote pigment stabilization, as organic acid production lowers pH and limits oxidative reactions, helping preserve natural colours such as anthocyanins in fermented fruits and vegetables. In some cases, microbial metabolism results in pigment degradation, where chlorophylls, carotenoids, or betalains are altered or

broken down, causing colour fading or shifts. These colour changes play an important role in consumer perception, as visual appearance strongly influences expectations of flavour and product quality in fermented foods.

Examples of commonly consumed fermented foods:

Yoghurt

Yoghurt contains over 100 volatile compounds from milkfat lipolysis and microbial transformations of lactose and citrate. Its aroma and flavour are primarily due to acetaldehyde, diacetyl, acetoin, and lactic acid, influenced by the starter culture and milk composition. In yoghurt production, bacteriophage infections can hinder fermentation by attacking lactic acid bacteria, leading to inferior products with uneven texture. To tackle this, the industry rotates starter cultures of different strains to reduce phage-related failures.

Home-made yoghurt uses a portion of previous curd as a starter culture, which can vary in microbial composition, unlike industrial production that uses pure starter cultures for consistent quality. Fermentation enhances both flavour and nutritional quality, aiding lactose digestion, improving protein digestibility, increasing



mineral bioavailability and live lactic acid bacteria in yoghurt provide probiotic benefits for gut health.

Idli

During fermentation of idli batter, naturally occurring microorganisms produce lactic acid and carbon dioxide, which acidify and leaven the batter. The composition of the batter also plays an important functional role. Urad dal (black gram) releases soluble polysaccharides and mucilage during soaking and grinding, which help stabilize gas bubbles and contribute to the characteristic porous, honeycomb texture of steamed idli. Fermentation causes important biochemical and nutritional changes, leading to increases in free sugars, non-protein nitrogen, and certain vitamins, while reducing antinutritional factors like trypsin inhibitors.



gluten development and can lead to a denser crumb.

Fermentation also produces higher alcohols, esters, aldehydes, and organic acids that contribute fruity, malty notes. Lipid oxidation reactions form compounds such as hexanal. These fermentation-derived compounds act as important aroma precursors, which are further transformed during baking through Maillard reactions, caramelization forming key crust aroma compounds such as pyrazines, furans, and 2-acetyl-1-pyrroline. These reactions together determine the characteristic flavour, aroma, texture, and colour of bread. In sourdough, it lowers the glycaemic response by modifying starch. These biochemical changes contribute to improved nutritional value as well as better digestibility of fermented breads (9).

Pickles

Indian pickles (achaar) feature complex flavours that are tangy, spicy, and savoury, developed through spices, salt, and oil and limited fermentation. Organic acids, esters, and phenolic compounds from spices enhance aroma and taste. Practices like sun-drying intensify flavour, with preservation relying more

on salt, oil, or vinegar than fermentation.

In contrast, many pickles consumed in Western countries, such as fermented cucumbers and sauerkraut, depend primarily on lactic acid bacteria. These bacteria lower the pH, inhibit spoilage microorganisms, and influence texture by modifying pectic substances in the vegetable cell walls. This process leads to a softer, tender texture, although excessive fermentation can cause undesirable mushiness. Salt concentration helps regulate microbial activity and pectin breakdown, thereby maintaining firmness.

Studies on fermented cucumbers have also shown that fermentation produces a wide range of aroma compounds. Around 75 volatile organic compounds have been identified in naturally fermented cucumbers, and about 60 in samples fermented with added bacteria, including esters, aldehydes, acids, alcohols, and ketones, all of which contribute to flavour.

Meat

Fermented meat products like dry and semi-dry sausages undergo controlled fermentation involving lactic acid bacteria, staphylococci, and sometimes yeasts.

Nutritional quality improves with higher levels of methionine and choline, along with increased B vitamins and vitamin C. For example, fermented idli batter contains riboflavin, thiamine, and folic acid (8).

Bread

During dough fermentation, yeast converts sugars into carbon dioxide and ethanol. This step is crucial for bread texture. For example, naan, which is fermented, is soft and fluffy, while unleavened paratha is denser. Inadequate fermentation results in a low-volume loaf with a dense or tough texture. Fermentation also enhances dough handling, allowing it to better trap the carbon dioxide, which causes the dough to rise. Longer fermentation results in a more open crumb with larger air cells, while shorter fermentation can lead to a tighter, coarse texture. Flour type also plays an important role. Refined flour supports the formation of a stronger gluten network, allowing better gas retention. Whole wheat flour, however, contains bran that disrupts

This process enhances tenderness, sliceability, and flavour intensity through the breakdown of muscle proteins into peptides and amino acids. Additionally, microbial metabolism and lipolytic reactions create volatile compounds that contribute to the aroma.

Fermentation also increases nutrients and digestibility, potentially boosting certain vitamins like thiamine and B12. It reduces undesirable components and produces antimicrobial metabolites, such as bacteriocin, improving safety and extending shelf life. Ultimately, acidification, proteolysis, dehydration, and microbial activity shape the sensory qualities and stability of these products (10).

Challenges and Considerations

Fermented food production presents several important challenges due to its reliance on complex microbial ecosystems and dynamic biochemical processes. A primary concern is the control of microbial contamination and spoilage, as unwanted microorganisms can enter through raw materials, equipment, or the processing environment and persist throughout fermentation, leading to off-flavours, gas formation, toxin production, or safety hazards.

At the same time, fermentation itself is inherently variable because differences in microbial strains, environmental conditions, and raw material composition strongly influence metabolic activity. Even closely related strains of bacteria or yeasts can produce different amounts of acids, flavour compounds, vitamins, and other bioactive metabolites, resulting in inconsistencies in taste, texture, and nutritional quality.

Maintaining consistent fermentation, therefore, requires precise control of critical parameters such as temperature, pH, oxygen availability, salt concentration, and time, especially at larger scales. Regulatory compliance and food safety impose complexities in fermentation, necessitating validation, microbiological testing, and thorough documentation to align with legal standards.

Operational challenges include increased production costs and the requirement for advanced monitoring technologies,



which can restrict scalability and reproducibility. To tackle these issues, modern fermentation employs integrated process control, stringent hygiene practices, standardisation of starter cultures, and innovative tools like predictive modelling and meta-omics to enhance microbial management, safety, consistency, and overall product quality(4).

Conclusion

Fermentation enhances the sensory qualities and nutritional value of foods by improving flavour, aroma, texture, digestibility, and nutrient bioavailability, while also aiding preservation and food safety. Emerging research on microbiome-tailored fermentation focuses on designing fermented foods based on individual gut microbiota to deliver targeted probiotic and prebiotic effects, potentially improving glycaemic control and overall health.



Fermentation promotes sustainability by converting food waste into useful products like organic acids and animal feed, supporting a circular bioeconomy. Fermentation is also becoming a key technology in the development of alternative proteins. By using microorganisms to transform plant-based ingredients, fermentation can improve digestibility, reduce off-flavours, enhance texture, and increase certain nutrients, making plant-based foods more acceptable and nutritionally balanced.

This reflect show fermentation, rooted in

traditional practices, remains highly relevant in modern food systems.

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ULTRA-PROCESSED FOODS AND NCDS IN INDIA - PART 3

EFFECT OF PROCESSING ON NUTRIENTS

AUTHOR

Dr. Malathy Venkatesan,
Project Coordinator, PFNDAI



Introduction

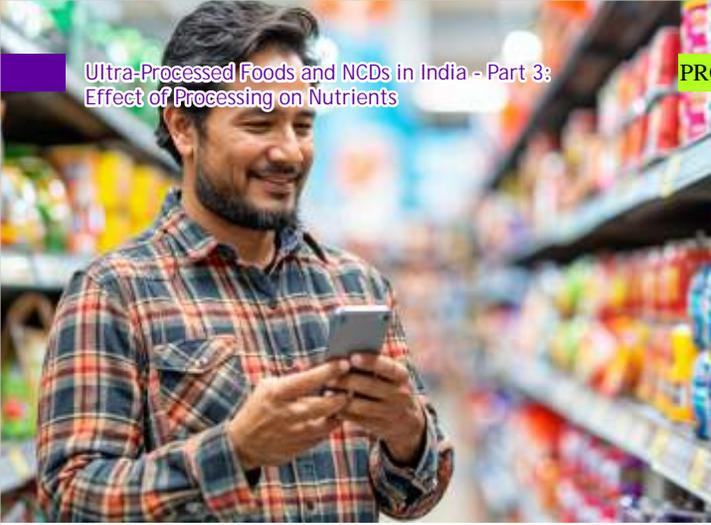
Food processing has played a crucial role in human progress; from basic preservation methods to complex industrial processes. To increase food's shelf life and guarantee survival amid a shortage, early techniques including drying, salting, and fermenting were developed. With the advent of mass manufacturing and mechanization during the Industrial Revolution, food preparation, distribution, and storage underwent a radical change. In order to satisfy the needs of an expanding population, wholesome, secure, and practical products have been made possible by developments in food science and technology. Food processing is essential for increasing food safety, reducing waste, and boosting nutritional content. It also boosts the economy by creating jobs

and expanding the market. Despite recent concerns about "Ultra-processing", food processing remains crucial in ensuring global food security, reducing post-harvest losses, and adapting to changing consumer preferences. Considering scientific data on the impact of processing on nutrient content is essential for improving consumer knowledge and informed decision-making.

Processing of liquid food products

Pasteurization is the practice of heating liquids (such as milk or fruit juice) to a specified temperature for a given amount of time in order to destroy or inactivate dangerous microorganisms such as bacteria and parasites. This can help lower the likelihood of these organisms causing food-borne diseases. Ultra-high-temperature sterilization

(UHT) is a revolutionary sterilization technique that enables the processing of liquids at 138°C for 2-3 seconds effectively inactivating pathogenic and most spoilage causing microorganisms. Among the primary advantages of UHT include the fact that it causes fewer losses in functional and fruit juice's nutritional qualities, such as its antioxidant capacity, phenolic composition, provitamin (A) concentration and vitamin C content. Vitamin C commonly referred to as the antioxidant ascorbic acid is a water-soluble vitamin that is susceptible to a variety of processing methods such as heat, light and air leading to its degradation, reducing the vitamin's nutritional



value in food products. Vitamin C is known to improve the uptake of iron and strengthen the immune system. In traditional processes such as canning or candy formation (called murabba) the vitamin C is significantly degraded. The heat sensitive B group vitamins are similarly stable and available in milk. Homogenization of milk during UHT process improves the bioavailability as well as bio-absorption of fat as well as proteins in milk(1).

Effects of processing on macro nutrients

Extrusion technology is an efficient alternative to thermal cooking including frying. Grains and legumes are subjected to high pressure and temperature for few seconds to result in a cooked product with improved protein as well as fiber functionality and nutritional value. The process breaks down complex, insoluble cell wall structures, significantly raising the soluble dietary fiber content and increasing water-binding capacity,

which can improve gut health. Examples are pasta and extruded ready to eat snacks including breakfast cereals.

Dietary fats are a broad range of

lipids that perform vital functions in the body such as storing energy, insulating material and formation of cell membrane.

Hydrogenation of oil is the industrial process of adding hydrogen to liquid vegetable oils in the presence of a catalyst (usually nickel) to convert them into solid or semi-solid fats. The primary reasons are to increase product shelf life, improve texture/consistency, raise the melting point, and create cost-effective alternatives to butter. Interesterification using enzymes, modifies fats by rearranging fatty acids on the glycerol backbone to modify fats into solid or semi solid products without creating trans fats.

The most common techniques of food preservation is drying since it is the easiest way to reduce a products water content especially in India which is blessed with hot summers. Traditional drying is frequently done in sun light during summer. A multi-layer tray drier which

utilizes heated air in an enclosed room is an invention with the most simple and easy technique. Drum drying and spray drying are processing equipments that effectively reduce drying time while preserving heat labile nutrients(1).

High fat high salt high sugar in traditional Indian food

Processed foods are generally thought to be inferior to unprocessed foods. The term may suggest that a packaged food item contains many ingredients, perhaps even artificial colors, flavors, or other chemical additives, and high in fats, salt and sugar.

Traditional Indian foods, including many traditional snacks and sweets are often high in fat, sugar, and sodium (HFSS). Popular items include deep-fried snacks (samosas, pakoras), savory snacks (namkeen, chips), sugary sweets (milk sweets, besan based sweets). It is customary among Indian households to consume snacks either at breakfast time and definitely in the evening. A snack is a food, usually smaller than a meal, and consumed in-between meals. There are both traditional and modern snack foods either prepared out of the home or at home.

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Creative Visualization. *Oats are rich in dietary fibre. Dietary fibre helps sustain energy, keeps fuller for longer & aids in managing weight Lattimer J.M.et al, 2010, Dietary Guidelines for Indians,2011 & Nutrient requirement for Indians, (ICMR,2020). Saffola* encourages you to follow a healthy lifestyle, and a diet low in saturated fat & cholesterol to keep you fit.



The snacking behavior and preferences were studied as a survey conducted in 8762 adults from North(Sonepat) and South India Vizag. Participants were asked to report multiple factors, preferences, and reasons for snacking in general. The preferred reported timing for snacking was evening for participants from Sonipat and was morning for Vizag. Savory snacks were the most preferred; 50% of the participants consumed them 3-5 times/wk. Participants preferred to purchase out-of-home prepared snacks and eat them at home (86.6%)while watching television (69.4%) or with family/friends (49.3%). Most of the participants purchased snacks from street vendors (84% of Sonepat participants and 64% of Vizag participants). The reasons for snacking were hunger, craving, liking, and availability. Snack consumption was higher in Vizag (56.6%) than in Sonipat (43.4%).(2)

In a study, few processed ready-to-eat snack foods were purchased from the market and analyzed for their salt and fat content. The categories of products chosen were commercial salt biscuits (four varieties), packaged commercial fried snacks (nine varieties) and non-packaged commercial fried snacks. For non-packaged fried snacks six varieties of products were

chosen which were sourced from three different shops.

This was done to understand the variation in products as these are locally prepared and sold. All these products were analyzed for their salt and fat content using standard techniques. Results indicate that biscuits contained an average of 2% salt and around 20% fat. The packaged commercial fried snacks contained similar salt concentrations but higher fat content in the range between 30-42%. The non - packaged (i.e. loose packed) snacks had a similar or higher salt content with higher fat content. Table 1 (3)

Pickles and papads are consumed regularly in Indian cuisine for main meals. Papads are consumed as a snack between meals in addition. Indian pickles (achaar) are typically very high in salt, often containing over 800 mg of sodium per serving, acting as a primary preservative to prevent bacterial growth. While many traditional

pickles are savory with minimal sugar, others—especially sweet, fermented varieties—can contain added sugars. Indian papad is generally high in sodium and fat, particularly when fried. A single piece contains roughly 200 -265 mg of sodium (over 10% of daily value) and can have 3-5 g of fat.

The nutritive value of popular snacks in Punjab was reported (4). The energy values of different snacks i.e. samosa, vada, bread pakora, paneer pakora, cutlets, potato chips, noodles, burger, hot dog, pizza, patty and pastry was in the range of 466 to 631 kcal/ 100 g dry matter, respectively. The corresponding range for protein was 9.2 to 22.6 g/ 100 g while that for fat was 12.7 to 32.5 g/ 100 g, respectively. Further, it was observed that calcium, iron and zinc content of above-mentioned snacks ranged between 2.1 to 6.2, 1.3 to 5.4 and 1.8 to 7.2 mg/ 100 g

Table 1: Salt and Fat Content of Commercial Non-packaged Products (3)

Product	Salt content g/100g	Fat content g/100g
Chakli	1.85 -2.07	31.7- 42.2
Koduballe	1.66 -1.79	33.3 - 42.5
Nipattu	2.25 -2.47	23.9 - 36
Boti	1.89 -1.92	28.9 - 32.6
Ribbon Chips	1.92 -2.34	33.0 - 34.8
Friums	1.62 -1.83	30.0 - 34.8

Summary

Generally, to date, foods have been ranked according to their nutrient content, e.g., foods rich in protein such as fish, meat, dairy and legumes and foods rich in sugars, salt and fat (as in many dietary pyramids worldwide), or their botanical and animal origins, e.g., white and red meats, fruits, vegetables, cereals, legumes, nuts, fish, dairy and eggs.

The concept of ultra-processed foods (UPFs) is new and lacks clear definition. The UPF concept has been consistently criticized for being an overly heterogeneous concept, and the NOVA classification has been criticized for being qualitative only and too imprecise. There is no scientific evidence for correlation between processing of food and NCDs. On the other hand, small scale processing contains high levels of salt sugar and fat which could

lead to health concerns when consumed in larger quantities.

Globally, the need for a wider understanding of how the modern food system shapes dietary patterns and eating behavior is important. A blanket criticism of food processing as the the major contributor to NCDs and other health issues has no scientific basis.

There is a need to improve the quality of food consumed by creation of awareness among consumers for ensuring healthier food options and associated metabolic risk.

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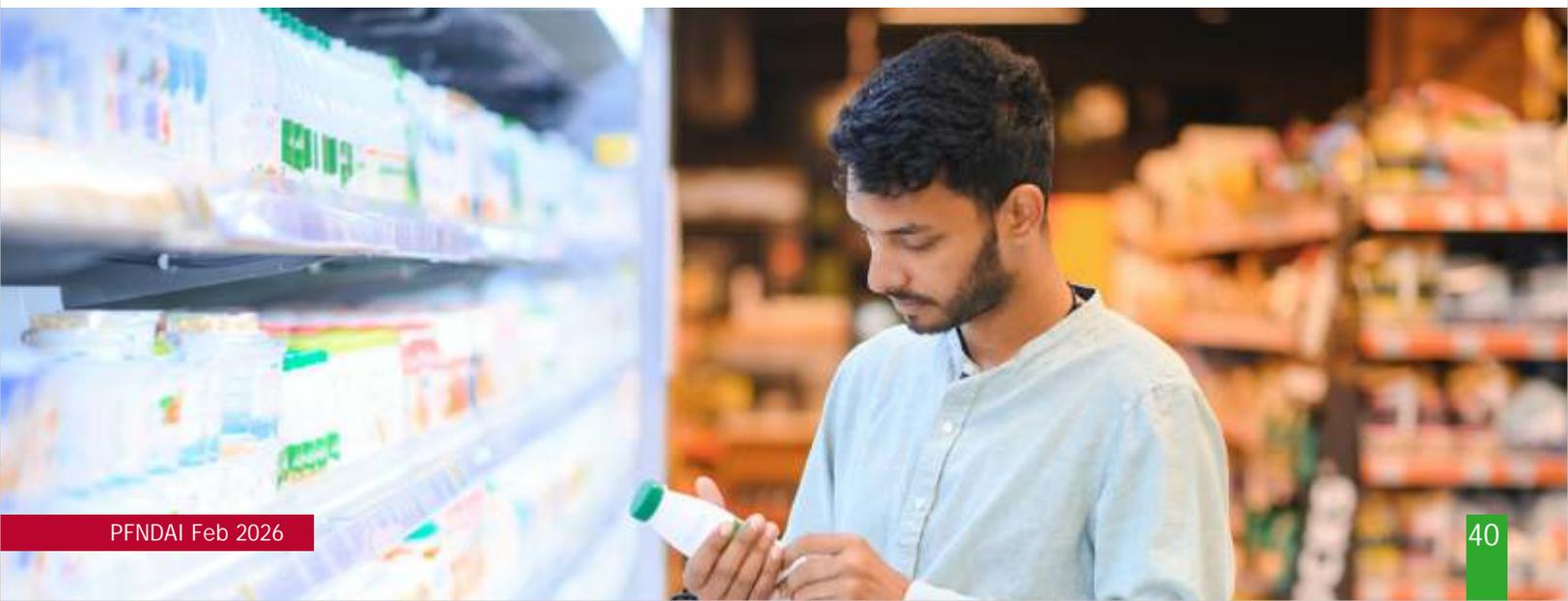


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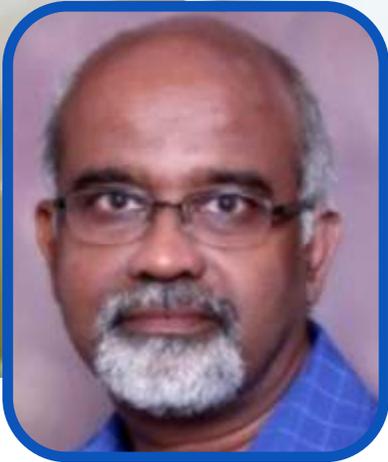
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BIOHACKING: FROM SELF-EXPERIMENTATION TO THE SCIENCE OF HUMAN OPTIMIZATION



AUTHOR

Mr Vilas Ramrao Shirhatti,
Principal Advisor, Zydus Wellness Products Limited
R&D Consultant, Seven Turns Private Limited
Visiting Faculty Institute of Chemical Technology (ICT)
PAC Member, Rajiv Gandhi Science and
Technology Commission

In an era defined by precision medicine, data-driven decision making, and unprecedented access to biological information, a new paradigm of personal health optimization has emerged—biohacking.

Once relegated to fringe communities and Silicon Valley subcultures, biohacking is increasingly intersecting with mainstream science, preventive medicine, and public health discourse. For a growing number of individuals, biohacking is not a wellness trend but an applied philosophy: the systematic attempt to understand, measure, and optimize human biology. At its core, biohacking reflects a shift from

reactive healthcare to proactive health engineering. Instead of waiting for disease onset, biohackers seek to modify upstream determinants of health—metabolism, circadian rhythm, inflammation, cognition, and cellular resilience—using tools drawn from nutrition science, physiology, neuroscience, biotechnology, and behavioural science. The ambition is not merely longevity, but an extension of health span: the period of life spent in good physical and cognitive function (Kirkland & Tchkonja, 2017). Yet biohacking occupies a complex space between rigorous science and speculative experimentation. To assess its true potential—and limitations—it is essential to distinguish evidence-based

practices from emerging hypotheses and ethically contentious interventions.

Defining Biohacking: A Systems Biology Perspective

Biohacking, sometimes referred to as DIY biology or self-quantification, encompasses intentional interventions aimed at improving biological performance. Unlike conventional medical approaches that focus on disease diagnosis and treatment, biohacking emphasizes continuous optimization through feedback loops.

Measurement is central to this philosophy: sleep metrics, glucose variability, heart rate variability (HRV), inflammatory markers, and cognitive performance are routinely tracked to guide interventions.



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- Infant substitute
- Skim Milk Powder

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- Mycotoxins
- Naturally occurring toxins(NOT,s)
- Heavy metals and minerals
- Minerals & Toxic heavy metals
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- Antibiotics / Residues
- Food Adulteration tests
- Food additives, preservatives and artificial sweeteners
- Synthetic food colour
- Antioxidants
- Packaged Drinking analysis as per IS 14543
- Drinking water as per IS 10500
- Process water IS 4251
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fasting can improve cardiometabolic markers, enhance insulin signalling, and activate autophagy-related pathways associated with cellular

such as caffeine and omega-3 fatty acids to prescription agents like modafinil.

While stimulants can reliably enhance vigilance and attention, evidence for sustained improvements in higher-order cognition remains mixed (Battleday & Brem, 2015). Moreover, neuroenhancement does not equate to neuroplasticity. Contemporary neuroscience emphasizes that long-term cognitive resilience depends more on sleep quality, stress regulation, and learning environments than on neurotransmitter manipulation alone (McEwen & Morrison, 2013).

Non-pharmacological approaches—including mindfulness meditation and breath-based interventions—have demonstrated reproducible effects on attentional control, emotional regulation, and stress-related biomarkers, with minimal risk profiles (Tang, Hölzel & Posner, 2015).

3. Lifestyle and Circadian Biohacking

Circadian rhythm regulation represents one of the most evidence-supported domains of biohacking. Disruption of circadian biology is now implicated in metabolic syndrome, mood disorders, immune dysregulation, and increased mortality risk (Bass & Lazar, 2016).

maintenance and aging (de Cabo & Mattson, 2019). However, outcomes vary widely depending on age, sex, baseline metabolic health, and genetic background (Anton et al., 2018). These findings underscore a key principle of biohacking: **biological responses are context dependent**.

The increasing use of continuous glucose monitoring (CGM) has further personalized nutritional strategies. Large-scale studies demonstrate that postprandial glycaemic responses vary significantly between individuals consuming identical meals, influenced by microbiome composition, lifestyle, and genetics (Zeevi et al., 2015).

2. Cognitive and Neurochemical Optimization

Cognitive biohacking often centres on **nootropics**—substances claimed to enhance memory, focus, or executive function. These range from well-characterized compounds

This approach aligns closely with **systems biology**, which conceptualizes the human organism as an interconnected, adaptive network rather than a collection of isolated organs (Kitano, 2002). Small perturbations—dietary timing, micronutrient intake, light exposure—can produce nonlinear and individual-specific effects. Consequently, biohacking places strong emphasis on personalization, a principle increasingly validated by precision medicine initiatives (Collins & Varmus, 2015).

Categories of Biohacking

1. Nutritional and Metabolic Biohacking

Nutritional interventions are the most accessible and scientifically grounded form of biohacking. Practices such as intermittent fasting, time-restricted eating, ketogenic diets, and elimination diets aim to improve metabolic flexibility, insulin sensitivity, and mitochondrial efficiency.

A growing body of evidence suggests that intermittent

Interventions such as timed light exposure, sleep regularity, meal timing, and temperature modulation aim to restore synchrony between internal clocks and environmental cues. Experimental and epidemiological studies link circadian alignment with improved glucose metabolism, hormonal balance, and inflammatory control (Panda, 2016).

Sleep optimization has received scientific attention. Chronic sleep deprivation is associated with impaired immune function, cognitive decline, and increased risk of cardiometabolic disease (Walker, 2017). While consumer-grade wearables lack clinical diagnostic accuracy, longitudinal tracking can reveal meaningful trends in sleep duration, variability, and recovery patterns.

4. Technology-Driven and Experimental Biohacking

At the frontier of biohacking lie implantable devices, neuromodulation technologies, hormone manipulation, microbiome engineering, and genetic interventions. While these areas overlap with legitimate biomedical research, unsupervised self-experimentation introduces substantial risks.

For example, CRISPR-based gene editing has

transformed molecular biology and holds immense therapeutic promise yet remains ethically and clinically inappropriate for human enhancement outside controlled trials (Doudna & Charpentier, 2014). Similarly, hormone optimization protocols conducted without medical supervision may disrupt endocrine feedback systems with long-term consequences.

These practices highlight the widening gap between laboratory science and consumer experimentation, reinforcing the need for regulatory oversight and ethical guardrails.

Preventive Health, Resilience, and the COVID-19 Effect

The COVID-19 pandemic catalysed renewed public awareness of immune resilience, metabolic health, and preventive strategies. It also underscored a fundamental limitation of modern medicine: not all health threats can be rapidly cured. This realization strengthened interest in lifestyle-based risk reduction and biological preparedness.

Many reported benefits of responsible biohacking—improved energy regulation, enhanced



sleep quality, reduced inflammation, and better stress resilience—align with established principles of preventive medicine (Katz et al., 2020). Importantly, biohacking encourages biological literacy, empowering individuals to engage actively with their health data.

Risks, Ethics, and the Limits of Control

Despite its promise, biohacking carries meaningful risks. Dietary extremes can induce micronutrient deficiencies, excessive supplementation may cause toxicity, and over-interpretation of biometric data can foster anxiety or false certainty.

Ethical concerns extend beyond individual risk. If enhancement technologies become effective, unequal access could exacerbate health and performance disparities. Scholars have also questioned whether enhancement-oriented biohacking blurs the boundary between therapy and augmentation in ways that challenge social norms (Savulescu et al., 2011).



Finally, there is the risk of biological reductionism—the belief that complex adaptive systems can be optimized through isolated variables. Human physiology evolved under constraints that resist linear optimization.

The Future of Biohacking: Integration, Not Extremes

Biohacking is gradually converging with institutional science. Personalized nutrition, digital therapeutics, AI-driven health coaching, and systems medicine increasingly incorporate principles once considered fringe. The concept of a “digital health twin,” integrating genomic, metabolic, and behavioural data, is already under development in research settings (Viceconti et al., 2021).

The most sustainable future for biohacking lies not in radical enhancement, but in disciplined application of fundamentals: sleep, movement, nutrition, stress regulation, and social connection—areas with the strongest evidence base.

Conclusion: Optimization with Scientific Humility

Biohacking represents a cultural and scientific shift toward agency, prevention, and personalization in health. When grounded in evidence and guided by caution, it offers a powerful complement to conventional healthcare systems.

However, biology is not software, and humans are not machines to be endlessly upgraded. The central challenge is not how far human performance can be pushed, but how intelligently resilience, adaptability, and long-term well-being can be supported.

In that sense, biohacking is less about becoming superhuman—and more about understanding what it truly means to be healthy human, informed by science.

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REGULATORY ROUND UP



AUTHOR
Dr Shashank Bhalkar,
 Executive Director, PFNDAI
executivedirector@pfndai.org

Dear Readers,

Please find below new notifications, orders, etc. since the last round-up

[Decision taken in 48th Food Authority meeting related to 'Policy regarding timeline for the compliance of FSS Regulation](#) : This is about the decision taken by the Food Authorities regarding the timeline of compliance in FSS regulations. According to this decision, amendments relating to FSS (L&D) Regulations or any other changes in the labelling requirements specified in other Food Standards and Regulations, shall come into force from 1st July, subject to a minimum transition of 365 days from the date of notification. This decision clearly gives a minimum of 365 days for compliance, which would be helpful to manage the packaging material inventory. The

enforcement may be changed from case-to-case basis in emergencies.

[Validity Order of FSSAI notified Food Testing laboratories as on 14th January 2026](#) : This order provides the latest list of FSSAI-approved laboratories with validity of their accreditation as on 14.01.2026.

[Direction under Section 16\(5\) of Food Safety and Standards Act, 2006 regarding enforcement of the new standards for Meat Sausages notified under FSS \(Food Products Standards and Food Additives\) First Amendment Regulations, 2025](#) : New standards for meat sausages that were notified and to be implemented from 01.02.2026, are now extended by three months on request by the industry representatives.

[Draft Food Safety and Standards \(Licensing and](#)

[Registration of Food Business\) Amendment Regulations, 2026 relating to Maintain daily records of production and storage of rawmaterials, ingredients, work-in-progress and processed /cooked or packaged food products](#) :

These draft regulations propose the following two amendments.

- i) The requirement of maintenance of daily records of production and storage of raw material utilisation separately, as stated in Schedule 2, Annexure 3, serial number 8, does not apply to non-manufacturing food business operators.
- ii) The requirement of subjecting raw material storage, ingredients, work in progress and processed/ cooked or packaged products to FIFO, FEFO as stated in schedule 4, part 2, section 5.2.5, is not applicable to Retailers.

Any objections or suggestions should be sent in the prescribed format within thirty days from 23.01.2026.

RESEARCH IN HEALTH & NUTRITION

The Lancet slams “corporate power” driving UPFs, nutritionists reject processing-based dietary advice

The Lancet has published a three-part series calling for aggressive government action to reduce the consumption of ultra-processed foods (UPFs), framing corporate power as the central barrier to healthier diets.

The series argues that education and consumer behaviour shifts alone are insufficient, and that coordinated policies are needed to regulate UPFs, improve access to fresh foods, and restructure food systems. The authors liken the necessary

measures to historical tobacco control efforts, emphasizing the need to confront corporate lobbying, political influence, and profit-driven strategies that perpetuate poor diets.

However, the series has drawn criticism from medical and nutrition experts for its reliance on the Nova classification system, which categorizes foods by their level of processing. Critics argue that this framework is scientifically flawed and oversimplified, as it can misclassify foods and fails to account for their actual metabolic impact. They contend that refined carbohydrates and added sugars are the true drivers of obesity, diabetes, and other chronic diseases, and that policy should focus on these rather than processing levels alone. Experts suggest front-of-package warnings and updated dietary

guidelines targeting refined carbs as more effective interventions.

Industry representatives also challenge the Lancet’s approach, warning that labelling affordable and nutritious foods as “ultra-processed” risks confusing consumers and undermining public health goals. They advocate for collaboration with the food industry to achieve sustainable improvements. Meanwhile, organizations like the American Heart Association stress the importance of discouraging nutrient-poor UPFs rather than imposing blanket restrictions.

In summary, the Lancet series highlights the urgent need for systemic change to reduce UPF consumption and corporate influence, but its reliance on the Nova system has sparked debate. Critics call for a more evidence-based focus on refined carbohydrates and sugars, while industry voices caution against oversimplification that could stigmatize beneficial foods.

<https://www.nutritioninsight.com/news/ultra-processed-foods-upfs-the-lancet-diet.html>

The big UPF myth: Why consumers say one thing and eat another

The article explores consumer perceptions of ultra-processed foods (UPFs), highlighting both scepticism and nuanced acceptance.

It begins by noting that UPFs

are increasingly scrutinized for their links to health concerns such as obesity, diabetes, and cardiovascular disease. Despite this, many consumers continue to rely on them due to convenience, affordability, and taste.

The piece emphasizes that awareness of the term “ultra-processed” varies widely. In some markets, consumers are unfamiliar with the classification, while in others,

they associate it strongly with negative health outcomes. The article points out that definitions of UPFs can be complex, often including everyday items like bread, breakfast cereals, and plant-based meat alternatives, which complicates consumer understanding.

A key theme is the tension between health consciousness and practicality.

While consumers express concern about additives, preservatives, and artificial ingredients, they also acknowledge the role UPFs play in modern lifestyles. The article highlights that many people balance their diets by mixing minimally processed foods with UPFs, rather than eliminating them entirely. It also discusses how marketing and labelling influence perceptions. Terms such as

“natural,” “organic,” or “clean label” can mitigate consumer worries, even when products technically fall under the UPF category. This reflects a broader trend where transparency and trust in brands shape acceptance.

Finally, the article situates the debate within global food trends. As wellness and sustainability gain traction, there is growing demand for

reformulated UPFs that reduce salt, sugar, and fat while maintaining convenience. The narrative underscores that consumer attitudes are not uniformly negative but shaped by cultural context, personal priorities, and evolving definitions of what constitutes healthy eating.

<https://www.foodnavigator-asia.com/Article/2025/09/24/what-consumers-really-think-about-ultra-processed-food/>

Next in omega-3s: Algae-based sources ride wave of new delivery tech

Algae-based omega-3s are emerging as a powerful and sustainable alternative to traditional fish oil, offering identical health benefits in terms of EPA and DHA without the environmental drawbacks associated with marine sourcing.

Industry leaders such as dsm-firmenich, Aker BioMarine, GC Rieber VivoMega, and Gelita highlight that algae-derived oils are not only bioequivalent to fish-based sources but also cleaner, more sustainable, and increasingly consumer-friendly thanks to advances in delivery technologies. The industry acknowledges that while algae-based solutions are promising, cost and technology developments are needed to scale them for mass-market adoption.

Scientific research is broadening the recognized benefits of omega-3s beyond heart health to include cognitive performance, sports recovery, muscle preservation,

mental well-being, vision, inflammation, and healthy aging. Gelita points to breakthroughs linking omega-3s to slowing biological aging, cancer prevention support, and improved athletic performance. Emerging evidence also suggests omega-3s may help preserve muscle mass during weight loss, particularly relevant in the context of GLP-1 drugs like Ozempic. This expansion of health applications reinforces the relevance of omega-3s in modern nutrition and supports continued demand across diverse markets.

Technological innovation is playing a central role in advancing supplement efficacy and stability. Aker BioMarine's PL+ Technology leverages marine phospholipids to enhance cellular uptake of omega-3s by up to 25 times, with clinical trials showing dramatically improved absorption compared to concentrated fish oil, especially under low-fat diets. Gelita has developed Easyseal, a specialized gelatin solution that improves softgel capsule resilience and reduces leakage, addressing formulation challenges with krill oil.

GC Rieber VivoMega stresses the importance of advanced technology and data-driven production to optimize raw material use, improve efficiency, and enhance sustainability, with industrial AI increasingly applied to operations. dsm-firmenich highlights refining techniques that eliminate pollutants and controlled fermentation processes that avoid contamination risks, alongside powder technologies that enable higher omega-3 loading in gummies while overcoming stability and palatability issues.

Overall, the omega-3 industry is undergoing a transformation driven by sustainability, scientific validation, and technological innovation. Algae-based sources are positioned as the future of omega-3 supplementation, offering potent, environmentally responsible alternatives to fish oil, while new delivery platforms and formulation technologies are expanding both the effectiveness and accessibility of these essential nutrients.

<https://www.nutritioninsight.com/news/omega-3-algae-fish-oil-heart-health.html>

Anti-Obesity Medication (AOM) users reveals nutrition innovation potential

Research highlights significant opportunities for nutrition innovation tailored to users of anti-obesity medications (AOMs), particularly GLP-1 therapies.

The study shows that most current users are highly motivated to adopt complementary food, beverage, and supplement solutions that align with their treatment, with 80% willing to pay more for products offering added health attributes and 67% prioritizing GLP-1-friendly formulations. Satisfaction levels are high, with 91% of users reporting positive weight management progress and over a third planning to continue GLP-1 use long term.

These consumers emphasize

portion control, gut health, hydration, and muscle maintenance, creating demand for proteins, biotics, and low-sugar options. Many have also increased their intake of pre- and probiotics, reflecting concerns about gastrointestinal discomfort associated with medication use.

For those discontinuing AOMs, the research identifies a different set of needs. While many stop after achieving target weight or health goals, others cite side effects such as digestive discomfort, hydration issues, or weakness, as well as cost. After discontinuation, consumers seek solutions that help maintain weight, control appetite, promote satiety, preserve muscle mass, and support digestive comfort. ADM points to prebiotic fibres, resistant tapioca starch, plant-based proteins, and biotics as key ingredients to meet these demands.

Despite efforts to sustain

healthy habits such as eating more fruits and vegetables, practicing portion control, cooking at home, and increasing protein and fibre intake, 76% of former users report regaining at least some of the weight lost. A notable challenge is the return of “food noise,” or intrusive thoughts about food, which affects 60% of former users and drives two-thirds to consider restarting GLP-1 therapy.

The findings underscore that both current and former AOM users represent distinct but overlapping markets for functional nutrition innovation. Current users require products that complement medication effects by supporting muscle health, digestion, and hydration, while former users need solutions that help sustain weight management and appetite control.

<https://www.nutritioninsight.com/news/adm-glp-1-medication-nutrition-innovation-biotics.html>

CRN confirms vitamin K2 safety at high intake level

The Council for Responsible Nutrition Foundation (CRN) has issued updated safety guidance for vitamin K2, specifically in the MK-7 form, establishing a highest observed intake (HOI) level of 375 µg per day for adults.

This marks a departure from earlier editions of CRN's Vitamin & Mineral Safety, which provided a single safety limit for vitamin K encompassing

both K1 and K2. The distinction reflects the rapid growth in consumer use of vitamin K2 supplements and the need for more precise evaluation. CRN explains that while an Upper Limit (UL) is set when adverse effects are observed at high intake levels, an HOI represents the highest intake level at which no adverse effects have been documented.

The updated guidance draws on more than 40 human clinical trials conducted over the past decade, covering doses between 58 and 462 µg per day for up to two years. Across these studies, no serious adverse effects were reported,

and there was no clinically meaningful impact on blood coagulation in healthy adults not taking vitamin K antagonist medications such as warfarin. Based on this evidence, CRN concluded that 375 µg/day is a safe intake level for MK-7 supplementation in adults, though individuals on anticoagulants should consult healthcare providers before using vitamin K-containing products.

Vitamin K2, particularly MK-7, is supported by scientific evidence for its role in bone and cardiovascular health, which has fuelled growing consumer interest.

CRN's updated chapter in the fourth edition of Vitamin & Mineral Safety incorporates modern methodologies, expanded clinical data, and global regulatory perspectives to ensure transparency and rigor in its evaluation. Beyond bone and heart health,

emerging research suggests additional potential benefits of vitamin K2, including alleviation of long COVID symptoms, support for kidney function, and improvements in women's health during menopause. This updated HOI guidance is positioned as an

important step in advancing scientific understanding and supporting responsible product development in the dietary supplement sector.

<https://www.nutritioninsight.com/news/vitamin-k2-menaquinone-7-mk7-supplements.html>

Experts contest link between UPFs and early-onset women's colorectal cancer

A recent women's health study has linked high consumption of ultra-processed foods (UPFs) to a significantly increased risk of developing early-onset colorectal adenomas, precursors to cancer, before the age of 50.

The research, based on data from 29,105 female nurses in the Nurses' Health Study II, found that women with the highest UPF intake had a 45% greater likelihood of developing conventional adenomas compared to those with the lowest intake. On average, UPFs accounted for more than a third of participants' daily caloric intake.

Importantly, the elevated risk was specific to conventional adenomas and not observed for serrated lesions. The association remained consistent even after adjusting for factors such as BMI, diabetes, fibre, folate, calcium, vitamin D intake, and overall diet quality. Researchers noted that the risk increased steadily with higher UPF consumption, suggesting that any reduction in intake could lower risk.

Experts outside the study have raised concerns about the findings, emphasizing that the research demonstrates correlation rather than causation. Marco Gerlinger, a gastrointestinal cancer specialist, pointed out that while the association between UPFs and bowel cancer risk is already recognized, this study's novelty lies in linking UPFs to early-onset polyps.

However, he cautioned that the retrospective nature of the study means other environmental or lifestyle factors may have influenced the results. He acknowledged that reducing UPF intake appears sensible but stressed that more mechanistic research is needed before firm dietary recommendations can be made.

A major challenge highlighted by nutrition experts is the ambiguity of UPF classification. The study relied on food-frequency questionnaires and the Nova system to categorize foods, but this approach can misrepresent actual intake.

Gunter Kuhnle of the University of Reading explained that many foods listed in questionnaires can be either ultra-processed or minimally processed, making it difficult to determine what participants truly consumed.

For example, "bread" could refer to homemade sourdough

or industrially produced white bread, yet both would be recorded the same way. This lack of precision complicates efforts to establish reliable associations between UPFs and disease risk. Kuhnle concluded that the data may reflect associations with specific food groups rather than UPFs as a whole.

The findings add to growing evidence linking UPFs to adverse health outcomes, but they also underscore the complexity of defining and measuring UPF intake.

Policymakers face difficulties in advising the public due to the wide range of processed foods, some of which are nutrient-poor while others may provide health benefits.

Recent statements from organizations such as the American Heart Association and the Physicians Committee for Responsible Medicine highlight the need for more nuanced dietary guidance, focusing on nutrient-poor UPFs rather than blanket restrictions, and improving consumer understanding of what constitutes healthy versus unhealthy processed foods.

<https://www.nutritioninsight.com/news/experts-contest-link-between-upfs-and-early-onset-womens-colorectal-cancer.html>



Unsalted skin-roasted peanuts boost brain vascular function and memory

A new Dutch study has found that daily consumption of unsalted, skin-roasted peanuts can improve brain vascular function and memory in older adults.

Conducted at Maastricht University Medical Center's NUTRIM institute, the randomized, controlled crossover trial involved 31 healthy participants aged 60–75. Over a 16-week period, consuming 60 grams of peanuts per day led to a 3.6% increase in global cerebral blood flow and a 5.8% improvement in verbal memory. Participants also experienced reductions in systolic blood pressure and pulse pressure, alongside enhanced blood flow in the

frontal and temporal lobes, regions critical for memory and cognition.

The researchers attribute these benefits to peanuts' nutrient profile, which includes plant-based protein, unsaturated fats, L-arginine, and polyphenols. L-arginine is particularly important for vascular health, while polyphenols and antioxidants in peanut skins may further support vascular and cognitive function. The study combined dietary intervention with MRI scans and cognitive testing using the Cambridge Neuropsychological Test Automated Battery, providing mechanistic insight into how peanuts may enhance brain health.

Participants consumed premeasured packets of peanuts daily, either all at once, spread throughout the day, or incorporated into meals. After 16 weeks, the groups

switched conditions to confirm the effects. The findings, published in *Clinical Nutrition*, mark the first demonstration that peanut intake can improve brain vascular function in healthy older adults, suggesting a potential dietary strategy for supporting cognitive health and memory. The study was funded by The Peanut Institute Foundation, which did not influence the design or analysis.

These results build on previous research linking peanuts to broader health benefits, including allergy protection when consumed early in life or during breastfeeding. Together, the evidence positions peanuts not only as a nutrient-rich snack but also as a functional food with promising applications in vascular and cognitive health.

<https://www.nutritioninsight.com/news/peanuts-brain-health-cardiovascular-memory.html>



Microencapsulated iron ingredient outperforms conventional options

This study on microencapsulated iron is quite striking because it highlights how formulation science can dramatically change the effectiveness and tolerability of a nutrient that has historically been problematic for consumers.

Conventional iron salts like ferrous sulphate are effective but often cause gastrointestinal irritation and metallic

aftertastes, which reduce adherence.

Microencapsulation matrix seems to solve both issues by controlling release, improving bioavailability, and masking unpleasant sensory qualities.

A few aspects stand out:

- **Rapid efficacy:** Reversal of anemia in just 14 days in vivo is unusually fast compared to conventional iron therapies, which often take weeks to months to show measurable improvements.
- **Tolerability:** The absence of gastrointestinal irritation, even after prolonged administration,

is a major differentiator. This is critical because GI side effects are the leading cause of poor compliance in iron supplementation.

- **Sensory appeal:** The taste test results suggest that consumer acceptance could be much higher than with traditional iron supplements, which often suffer from metallic notes.
- **Versatility:** Being water-dispersible and suitable for pills, powders, gummies, and functional foods makes Lipofer adaptable to diverse delivery formats, which is important for global public health strategies.

From a regulatory and market perspective, this positions Lubrizol alongside other advanced iron delivery systems, which already has WHO recognition. This development also underscores a broader

trend: **nutrient delivery systems are becoming as important as the nutrients themselves.** Encapsulation, stabilization, and sensory engineering are now central to bridging the gap between

efficacy and consumer adherence.

<https://www.nutritioninsight.com/news/lubrizol-lipofer-microencapsulated-iron-supplement.html>

Oleic acid strengthens antitumor cellular immunity

This Hong Kong study adds a fascinating nutritional dimension to cancer immunotherapy.

The researchers found that **oleic acid**, the omega 9 fatty acid abundant in olive oil, avocados, and nuts, can enhance the activity of **γδ T cells**—a subset of immune cells with strong antitumor properties. By contrast, **palmitic acid**, common in palm oil and fatty meats, appears to impair these cells' tumour fighting ability.

The mechanism is tied to

IFNγ signalling. Palmitic acid overstimulates IFNγ secretion, which paradoxically leads to immune cell death and reduced antitumor activity. Oleic acid tempers this response, restoring **γδ T cell** function and improving immunosurveillance. In metabolomics analyses, patients with higher oleic acid levels showed better outcomes in **γδ T cell** therapy.

What makes this study notable is its **clinical relevance:**

- It suggests that **dietary fatty acid composition directly influences cancer immunotherapy outcomes**, a link rarely demonstrated so clearly.
- It highlights a **simple, actionable intervention**—increasing oleic acid intake while reducing palmitic acid—that could complement

advanced therapies.

- It opens the door to **drug development targeting fatty acid-related pathways**, potentially amplifying the benefits of **γδ T cell** therapy.

This aligns with a broader movement in oncology toward **integrative strategies**, where nutrition, microbiome modulation, and lifestyle factors are combined with cutting edge treatments to improve patient outcomes.

It also echoes findings in other areas, such as the role of the oral microbiome in pancreatic cancer risk and microplastics' impact on colorectal cancer via gut microbiome disruption.

<https://www.nutritioninsight.com/news/cancer-prevention-diet-oleic-palmitic-acid-fats.html>

From bacteria to seaweed: New gels support ethical, animal-free nutrition research

This development in animal free scaffolds is a major milestone for nutrition and biomedical research.

Traditionally, materials like **Matrigel** or collagen—derived from mouse tumours or animal tissues—have been the backbone of organoid and cell

culture systems. But they come with ethical concerns, batch variability, and reproducibility issues. The new approaches from the Netherlands and the US address all of these challenges in different but complementary ways:

- **Synthetic PIC Invasin gel (Netherlands):**
 - Built from polyisocyanopeptide (PIC), a fully synthetic and chemically defined hydrogel.
 - Invasin, a bacterial protein, is added to provide cell binding functionality.
 - Enables long term, reproducible organoid growth without animal inputs.

- Offers both 2D and 3D formats, giving researchers access to the apical and basal sides of intestinal epithelial cells—critical for studying nutrient uptake, gut barrier function, and microbiome interactions.

- **Seaweed based scaffolds (US):**
 - Derived from red seaweed (Pacific dulse), processed into biocompatible gels.
 - Sustainable and vegan, with a low carbon footprint compared to animal derived collagens.
 - Polysaccharides like alginate, carrageenan, and agarose

provide tunable stiffness and porosity.

- Suitable for applications in **cellular agriculture** (e.g., cultivated meat) and nutrient absorption studies.
- Avoids risks of immune reactions or pathogen transfer associated with animal materials.

Together, these innovations represent a **shift toward ethical, reproducible, and**

human relevant nutrition research models. They not only reduce reliance on animal studies but also improve physiological relevance, making it easier to study digestion, metabolism, and nutrient transport in vitro. The sustainability angle—especially with seaweed—adds another layer of impact, aligning with global goals to reduce the environmental footprint of research and food production.

This is part of a broader movement toward **organ on chip systems, vegan biomaterials, and precision organoid platforms**, all converging to make nutrition science more ethical, scalable, and accurate.

<https://www.nutritioninsight.com/news/animal-free-scaffolds-nutrition-research.html>

Scientists uncover that babies' gut bacteria may influence future emotional health

Researchers at UCLA Health have uncovered evidence that the composition of gut bacteria in early childhood may shape emotional health later on.

The study, published in Nature Communications, analysed data from the Singapore-based GUSTO cohort, focusing on stool samples collected at age two, brain scans at age six, and caregiver reports of behavioural symptoms at age 7.5. Children with higher levels of bacteria from the Clostridiales order and Lachnospiraceae family were more likely to show

internalizing symptoms such as anxiety and depression. The link was not direct but mediated through differences in connectivity across emotion-related brain networks, suggesting that the microbiome influences how these circuits develop and function.

The findings highlight a "cascading effect" in which early gut microbial profiles program brain circuits that later affect emotional outcomes. This connection mirrors patterns observed in adult microbiome research, where the same bacterial groups have been associated with stress responses and depression. The study emphasizes that if left unaddressed, early symptoms of anxiety and depression can

persist into adolescence and adulthood, underscoring the importance of early interventions.

Senior author Dr. Bridget Callaghan explained that identifying specific microbial species responsible for these effects could open pathways for targeted strategies such as probiotics or dietary modifications. While the study was observational and based on a relatively small sample of 55 participants, it provides compelling evidence that the gut-brain axis plays a role in shaping mental health during critical school-age years.

<https://www.nutritioninsight.com/news/infant-babies-gut-bacteria-microbiome-psychiatry.html>

"Good science is good business": AG1 and IIFH partnership to advance metabolic health

AG1 has entered into a strategic partnership with the Innovation Institute for Food

and Health (IIFH) at UC Davis to accelerate the commercialization of nutrition research focused on metabolic health.

The collaboration is designed to bridge the gap between academia and industry by combining UC Davis' scientific expertise in advanced omics and clinical research with AG1's

market reach and consumer platform. The aim is to translate rigorous science into accessible products that address issues such as inflammation, gut health, obesity, and broader metabolic dysfunction.

Kat Cole, CEO of AG1, emphasizes that the partnership is built on maintaining

high scientific standards, with UC Davis retaining the right to publish all findings, whether positive or negative. She notes that AG1's role is not only to apply research but also to amplify and communicate the science to consumers, ensuring that innovations are both scientifically credible and commercially viable. Dr. Justin Siegel, faculty director of IIFH, underscores the principle that "good science is good business," highlighting the importance of aligning research integrity with product development.

The collaboration is expected to explore nutrient-metabolism interactions and identify focus areas through forums and expert engagement. One area

of particular interest is the impact of GLP 1 medications, which are reshaping the food system by addressing metabolic dysfunction at its root. Siegel suggests that this shift could lead to new categories of food and supplements tailored to GLP 1 users, similar to how gluten-free products became mainstream. AG1 is cautious about entering this space but acknowledges growing consumer feedback that its products support individuals using these medications, reinforcing the need for clinical trials to substantiate such claims.

Beyond supplements, the partnership envisions new food and beverage innovations that merge nutrient density with

consumer adherence, building on AG1's strength in creating daily rituals. This approach could extend into snack bars, drinks, or other functional formats that integrate AG1's ingredients. The collaboration reflects a broader transition in nutrition science from preventing illness to enabling people to thrive, with metabolic health as the central focus. By combining UC Davis' research depth with AG1's commercial insight, the partnership seeks to accelerate the development of science-backed products that can meaningfully improve consumer health outcomes.

<https://www.nutritioninsight.com/news/ag1-iif-metabolic-health-glp-1-uc-davis.html>

BCAAs: From gym staple to everyday performance enhancer

The article explores how branched-chain amino acids (BCAAs) are evolving from their traditional role as a gym-focused supplement into a broader wellness ingredient appealing to everyday consumers.

Once primarily associated with muscle recovery and energy metabolism for athletes, BCAAs are now being positioned as functional enhancers for busy professionals, students, and even gamers, thanks to their potential benefits in reducing mental fatigue and supporting cognitive resilience. Market interest is particularly strong in regions like China, where nearly a third of consumers express interest in amino acids or peptides in sports nutrition

drinks, and in the US, where demand for added functional benefits in hydration and performance beverages is rising.

This shift is driving innovation in formats beyond powders and capsules, with BCAAs appearing in ready-to-drink beverages, snack bars, functional dairy, and even indulgent formats like puddings and cookies. The appeal lies in their dual role of replenishment and recovery, aligning with consumer demand for multifunctional products that combine hydration, energy, and mental clarity. Emerging formulations pair BCAAs with vitamins, minerals, caffeine, taurine, or adaptogens to create products that address both physical stamina and cognitive performance.

Despite this momentum, BCAAs remain relatively niche, featuring in fewer than 1% of

global food and supplement launches over the past five years. Analysts suggest that brands can unlock growth by targeting different life stages—supporting muscle development in younger consumers, aiding mobility and bone health in seniors, and contributing to longevity when combined with nutrients like omega-3s, vitamin D, and calcium.

Looking ahead, the future of BCAAs is expected to lie in multifunctional formats that integrate them into mainstream categories, positioning them as "mind and muscle" solutions for a wide spectrum of consumers seeking endurance, focus, and everyday wellness.

<https://www.vitafoodsinsights.com/proteins-peptides-amino-acids/bcaas-from-gym-staple-to-everyday-performance-enhancer>

How Much Vitamin D Is Too Much?

The article explores the growing ubiquity of vitamin D fortification and supplementation, raising the question of how much is too much.

Vitamin D is essential for bone health, muscle function, and immunity, but it must be activated in the body through hydroxylation in the liver and kidneys before it becomes biologically active. Current dietary guidelines recommend 600 IU per day for most adults and 800 IU for those over 70, with an upper safe limit of 4000 IU. Toxicity risks emerge when intake exceeds this threshold,

leading to hypercalcemia, which can cause symptoms ranging from thirst and frequent urination to seizures, arrhythmias, and even death.

Deficiency remains a serious issue, linked to rickets in children and osteomalacia in adults, making supplementation critical for at risk groups such as pregnant women or those with limited sun exposure. However, evidence does not support claims that vitamin D reduces risks of cardiovascular disease or cancer, nor does supplementation in vitamin D replete individuals lower fracture or fall risk.

Importantly, toxicity almost always results from high dose supplements rather than fortified foods or sun exposure, since the body regulates

vitamin D production from sunlight.

For the food industry, this creates both a challenge and an opportunity. Fortified products like milk, juice, and cereals typically contain safe, modest amounts of vitamin D, helping consumers meet daily needs without approaching toxic levels. Manufacturers are encouraged to emphasize fortification as a safer alternative to high dose supplements, while also communicating clearly about recommended intake and the limits of vitamin D's benefits.

<https://www.ift.org/news-and-publications/food-technology-magazine/issues/2025/october/columns/diet-and-nutrition-how-much-vitamin-d-is-too-much>

The next frontier for animal-free dairy? 'Slow-release' mineral delivery

Eden Brew's latest pivot highlights how precision fermented dairy proteins can move beyond simply replicating milk to deliver added nutritional functionality.

The company has discovered that casein micelles—the spherical structures naturally formed in cow's milk—act as “slow release delivery systems.” In traditional dairy,

they gradually release calcium over several hours in the stomach.

Eden Brew is now engineering these micelles to carry other minerals such as iron, magnesium, and zinc, creating a protein base that can improve bioavailability and reduce side effects often associated with supplements, like nausea from iron.

This shift marks a strategic move away from consumer facing milk products toward a B2B model focused on supplements, sports nutrition, and food fortification.

The company argues that sustainability messaging alone is not enough to win consumers or investors; instead, health outcomes and nutrient density provide stronger value.

By positioning its fortified caseinates as ingredients for GLP 1 companion foods, longevity products, and functional nutrition, Eden Brew aims to capture high value markets while scaling toward cost parity with dairy by 2031.

<https://agfundernews.com/the-next-frontier-for-animal-free-dairy-slow-release-mineral-delivery-says-eden-brew>

Active lifestyles demand personalized Ingredients in snackable formats

The sports and active nutrition sector is undergoing a transformation as it moves beyond traditional products aimed at athletes to embrace mainstream consumers seeking convenient, enjoyable, and personalized solutions.

Industry leaders highlight that active nutrition is now about integrating supplements into everyday lifestyles through “snackable” formats such as bars, gummies, sachets, and even popcorn. This shift reflects changing demographics and consumer expectations, where taste, texture, and presentation are valued as much as scientific efficacy. Companies are driving innovation by combining personalization, credible science, and appealing delivery formats.

Personalization is becoming central to the future of active nutrition, with wearable data, AI-driven insights, and metabolic tracking enabling tailored supplement solutions. OmniActive emphasizes the importance of science-backed ingredients adaptable to personalized wellness platforms, while FrieslandCampina envisions predictive models that adjust supplement subscriptions in real time based on health

metrics such as sleep and stress. Real-world, condition-of-use research is also gaining importance, with companies like OmniActive and Bioiberica conducting clinical studies that reflect how consumers actually use supplements. Bioiberica’s all-female clinical trial on Collavant n2 collagen demonstrated significant improvements in joint health, underscoring the value of targeted research for diverse populations.

Quality and transparency remain critical as consumers demand verified, trustworthy products. Balchem stresses that ingredients used by elite athletes carry credibility that resonates with everyday users, and highlights its TRAACS system for ensuring mineral quality. Bioiberica points to the challenges of maintaining transparency in the collagen market, where inconsistent standards risk undermining consumer confidence, and has secured NutraStrong Collagen Verification to validate its offerings. Certification and rigorous testing are increasingly seen as essential to building trust in a crowded marketplace.

At the same time, innovation in delivery formats is reshaping consumer experiences. Balchem

notes that snackable supplements such as hydration gels and pre-workout gummies must withstand complex processing to deliver promised efficacy, citing issues with creatine gummies that failed to meet label claims. Its Creatine MagnaPower ingredient leverages chelated magnesium bisglycinate to enhance stability and bioavailability, improving muscle power beyond conventional creatine. TSI Group’s OptiCreatine portfolio expands creatine into diverse, consumer-friendly formats like effervescent and “candyceuticals,” reflecting how flavour, convenience, and lifestyle fit are now as important as performance outcomes.

Overall, active nutrition is evolving into a mainstream wellness category defined by personalization, scientific validation, quality assurance, and enjoyable formats. The convergence of technology, real-world research, and innovative delivery systems is creating a new generation of supplements that are not only effective but also engaging and seamlessly integrated into daily life.

<https://www.nutritioninsight.com/news/active-sports-personalized-nutrition-supplements-creatine.html>

Micronized mineral salts for better gummy formulations

PFNDAI Feb 2026

Jungbunzlauer is spotlighting its portfolio of micronized citrate mineral salts as a solution to one of the biggest challenges in gummy supplement formulation: achieving smooth texture and

high bioavailability at higher mineral doses.

The company emphasizes that traditional mineral salts often leave a gritty, sandy mouthfeel,

which compromises consumer experience. By micronizing calcium citrate and trimagnesium citrate, Jungbunzlauer ensures better dispersion, improved mouthfeel, and enhanced absorption, allowing gummies to deliver both sensory appeal and nutritional efficacy. Emily Orr, senior food scientist in application development, explains that minerals such as citrates, gluconates, and glycinates are generally preferred for their superior bioavailability compared to options like magnesium oxide, making ingredient selection critical for health outcomes.

Magnesium gummies are highlighted as a standout trend in the rapidly expanding gummy supplement market, which has been the fastest-growing format in Europe and North America between 2020 and 2024. Orr notes that magnesium-based formulations are accelerating across functional confectionery, and Jungbunzlauer's technology is designed to help brands meet clean label expectations while balancing taste, texture, and efficacy. The company has also introduced fully reacted magnesium bisglycinate, showcased at major industry events in Las Vegas and Frankfurt, underscoring its

commitment to next-generation mineral combinations. These chelated salts offer stability and compatibility with gummy formats, making them ideal for innovation in functional supplements.

Looking ahead, Jungbunzlauer sees the convergence of pleasure, efficacy, and science in bite-sized formats as the defining direction for the gummy supplement category, with recipe cards for specific formulations available through its sales team.

<https://www.nutritioninsight.com/news/jungbunzlauer-bioavailable-micronized-citrate-mineral-gummies.html>

Precision technologies enable clean label, sugar reduction & plant-based adoption

The article explores how precision taste technologies are reshaping food and beverage innovation by addressing consumer demands for health, naturalness, and sustainability without compromising flavour.

It highlights the convergence of three major pressures: the adoption of plant-based proteins, the push for sugar reduction, and the insistence on clean label formulations.

Consumers increasingly prioritize ingredient quality and reduced sugar intake, but taste remains the decisive factor for repeat purchases and market success.

To meet these expectations, companies are deploying

advanced solutions. dsm-firmenich's ModulaSense applies receptor-based molecular masking to eliminate specific off-notes in plant proteins, enhancing flavour perception and purchase intent.

Sensient's BioSymphony uses biotransformation to create complex, natural flavour compounds that mimic slow, authentic cooking processes, enriching taste profiles and reducing the lingering bitterness of high-intensity sweeteners.

HTBA's OptiTaste platform leverages citrus flavonoids from upcycled fruits to balance sweetness, maintain mouthfeel, and support sugar reduction without sacrificing sensory satisfaction.

These innovations are tightly linked to clean label strategies, emphasizing natural origins, solvent-free processes, and ingredient transparency.

The integration of upcycled materials such as rapeseed meal

and immature citrus fruits reflects a circular economy approach, reducing waste while adding commercial value.

Technical challenges remain, particularly around the stability of flavonoids under varying conditions, and regulatory frameworks differ across regions, requiring globally adaptable solutions.

Looking ahead, taste and texture will continue to dominate consumer expectations in healthier products, with sustainability only scaling when products succeed in the marketplace.

Investments in receptor biology, predictive sensory science, and expanded biotransformation platforms signal that clean label and sustainable taste enhancement are evolving from niche differentiators into industry standards.

<https://www.foodingredientsfirst.com/news/precision-taste-technologies-clean-label.html>

How ingredient innovators are solving the salt reduction challenge

Sodium reduction has progressed from being a regulatory requirement to a mainstream consumer demand, driven by heightened awareness of the health risks associated with high salt intake.

Global initiatives, such as the WHO's 2023 report and the European Commission's Farm to Fork Strategy, have set ambitious targets to cut population-level sodium consumption, while national HFSS regulations are tightening restrictions on high-salt foods.

The challenge lies in salt's multifunctional role: it not only enhances flavour but also contributes to preservation, texture, and shelf life.

Ingredient innovators are responding with tailored solutions that balance health goals with sensory quality. Corbion's PuraQ Arome and Purasal HiPure P Plus reduce sodium while maintaining microbial stability and shelf life, avoiding the bitterness often associated with potassium chloride substitutes.

Lionel Hitchen focuses on flavor-led approaches, using umami-rich ingredients like Miso Flavour to preserve salt perception and mouthfeel, ensuring reduced-sodium products still feel "complete" and satisfying. Levapan's Biolev yeast-based extracts provide clean label alternatives that naturally boost umami and salt perception without artificial enhancers, aligning with consumer demand for natural, additive-free products.

Success stories highlight practical applications: Biolev

helped a snack manufacturer achieve a 30% sodium reduction while maintaining flavour intensity, and supported an organic soup producer in meeting clean label and certification standards. Lionel Hitchen's Miso Flavour has consistently demonstrated its ability to preserve flavour richness in reduced-salt formulations, impressing clients with its sensory balance.

Overall, the industry is moving toward flavour-led, clean label solutions that integrate health, taste, and functionality. Sodium reduction is no longer just about compliance; it has become a pathway to consumer trust, competitive differentiation, and sustainable innovation in food formulation.

<https://www.foodingredientsfirst.com/news/salt-reduction-innovation-food-industry.html>

Precision fermentation dairy gains ground

The Future of Protein Production summit in Amsterdam spotlighted precision fermentation as a transformative force in dairy innovation.

The event gathered over a thousand delegates and emphasized how this technology can deliver bio-identical proteins while supporting sustainability and circular economy models.

France-based Standing Ovation announced a breakthrough in converting acid whey, a low-value byproduct of cheese

production, into high-quality proteins at industrial scale. This achievement, validated with dairy multinational Bel, demonstrates how side streams can be repurposed into functional proteins, enhancing both sustainability and product performance. Casein's importance lies in its role in texture, nutrition, and taste, particularly in cheese-making and protein-rich formulations.

Netherlands-based Vivici is targeting sports nutrition and wellness markets with precision-fermented dairy-identical proteins. Its beta-lactoglobulin is already available in the US, and the company is preparing to launch lactoferrin, a bioactive protein linked to recovery, gut health,

and fatigue reduction. Vivici's strategy emphasizes functional and nutritional benefits, reflecting strong demand in specialized nutrition sectors.

Regulation remains a central challenge. Both companies are pursuing approvals across multiple regions, with the US offering a more straightforward path compared to Europe's Novel Foods process. Standing Ovation has applied for GRAS status in the US and plans to seek EU approval, while Vivici is advancing dossiers in Canada, Singapore, the UK, and the UAE.

Scaling production capacity is another bottleneck, as industrial fermentation facilities are limited.

Precision fermentation, long used in pharmaceuticals, is now positioned as a mainstream enabler of sustainable,

functional dairy proteins, with the potential to redefine traditional fermentation and reshape the protein landscape.

<https://www.foodingredientsfirst.com/news/precision-fermentation-dairy-protein-production-future-summit.html>

Formulators target plant-based, clean label & alt-dairy innovation

Emulsifier innovation is evolving to meet consumer demands for clean label, plant-based, and sustainable food solutions.

Manufacturers are moving beyond traditional emulsifiers like lecithin to explore hybrid blends, co-emulsifiers, and protein-based alternatives that enhance texture, stability, and mouthfeel in products such as plant-based milks, yogurts, and bakery goods. Sternchemie emphasizes synergies between plant proteins and lecithin to improve creaminess and shelf stability in dairy substitutes, while Palsgaard develops specialized blends like

MilkFoam 204 for frothy plant milks and AcidMilk 310 for smooth, stable plant yogurts.

The push for “cleaner and leaner” labels is reshaping formulations, with companies reducing reliance on multiple additives and E-numbers. Palsgaard’s solutions simplify labels while maintaining performance, and its Emulpals range supports healthier cakes by replacing saturated fats. In chocolate, lecithin alternatives such as ammonium phosphatides (AMP) are gaining traction, offering cost savings and eliminating off-tastes, while lecithin replacements in margarine improve efficiency and stability.

Sustainability is central to this evolution, with Sternchemie sourcing botanical alternatives like sunflower lecithin and using mild processes to reduce environmental impact, and

Palsgaard investing in renewable energy and RSPO-certified palm oil while developing non-palm options. These innovations also help minimize food waste by improving raw material efficiency. Looking ahead, fermented emulsifiers and blended solutions combining lecithin, plant proteins, and hydrocolloids are expected to drive further progress, though cost pressures and regulatory hurdles remain.

Overall, emulsifier development is shifting toward natural, trusted, and sustainable systems that balance technical performance with consumer expectations for transparency and environmental responsibility.

<https://www.foodingredientsfirst.com/news/emulsifier-evolution-formulators-target-plant-based-clean-label-alt-dairy-innovation.html>

How weight management medication is reshaping F&B

The rise of GLP-1 weight management medications such as Ozempic, Mounjaro, and Wegovy is reshaping the food and beverage industry by shifting consumer priorities toward nutrient-dense, portion-controlled, and protein-forward products.

Users of these medications,

who often experience reduced appetite, are seeking foods that deliver satiety, muscle support, and energy in smaller servings. This has prompted brands to reformulate offerings with high protein, fibre, and functional ingredients, while also introducing fortified snacks and beverages that combine multiple nutritional benefits.

Companies like Chobani and Danone are leading with protein-rich yogurt drinks designed to help maintain muscle mass and energy, while Nestlé has launched Vital Pursuit, the first brand explicitly marketed to GLP-1

users, offering portion-controlled, high-protein meals. Other packaged food innovations include Lean Cuisine Balance Bowls and Evol Mini Meals, which emphasize calorie control alongside flavour and nutrition.

In foodservice, restaurants are adapting menus with lighter entrées, half portions, and protein-centric dishes, while quick-service outlets experiment with functional add-ons like chia, flaxseed, and adaptogens. Mocktails and nutrient-focused beverages are also gaining traction as part of this shift.

Looking ahead, the GLP-1 movement is expected to accelerate demand for protein-enhanced products that deliver more than one functional benefit, reinforcing the trend toward holistic nutrition. This

transformation is not only influencing product development and marketing strategies but also reshaping dining experiences, signalling a broader change in the food economy as weight

management medications become mainstream.

<https://www.foodingredientsfirst.com/news/glp1-food-beverage-trends-weight-management.html>



Cultivated meat breakthrough: Scientists overcome cost and technical barriers

Scientists in Israel have achieved a major breakthrough in cultivated beef by discovering a way to naturally immortalize cow cells without genetic modification.

This overturns long-held assumptions that bovine cells could only be renewed through gene editing, which raised safety and regulatory concerns. The process, published in Nature, relies on the activation of telomerase and PGC1a, enabling cells to reset their biological clocks and regenerate mitochondria. This creates stable, self-renewing bovine cell lines that can be scaled for cultivated meat

production.

Traditionally, cattle cells enter senescence after a limited number of divisions, but the team at the Hebrew University of Jerusalem and Believer Meats cultured cells from Holstein and Simmental cows for over 500 days, eventually observing spontaneous renewal after 240 generations. Molecular analysis confirmed that the cells retained normal growth regulation and DNA repair capabilities, demonstrating a natural, controlled pathway of renewal.

The findings remove a significant technical and regulatory barrier, since non-GM immortalized cells provide a cleaner starting point for approval and consumer acceptance. Cultivated beef has faced challenges around cost and scalability, but this discovery offers a safer and more sustainable foundation. Beef production is one of the

most resource-intensive forms of agriculture, linked to deforestation, water depletion, and greenhouse gas emissions, so cultivated alternatives could dramatically reduce environmental impact.

Believer Meats has secured exclusive rights to the technology and USDA approval for a large-scale facility in North Carolina, positioning it to bring this innovation to market. Looking ahead, researchers plan to explore whether similar natural renewal pathways exist in other mammals and whether these cells can be developed into muscle and fat tissues suitable for cultivated meat.

This breakthrough could accelerate the commercialization of cultivated beef and reshape the future of sustainable protein production.

<https://www.foodingredientsfirst.com/news/cultivated-beef-cell-renewal.html>



Consumers favour functional and natural ingredients

APAC IngredienTracker 2025 reveals that Asian consumers are increasingly attentive to ingredient choices, with more than 70% checking labels before purchase and showing strong preferences for natural,

familiar, and plant-based options that deliver functional health benefits.

The study, conducted across China, Indonesia, Australia, and Japan, assessed perceptions of 91 ingredients in categories such as dairy, beverages, bakery, snacks, and infant formula.

Consumers are particularly drawn to reduced-sugar and

functional sweeteners, with sugar-free and low-sugar claims rising in product launches, especially in beverages.

Traditional sugars are declining, while additive sweeteners in drinks have grown from 18% to 29%. Ingredients perceived as "natural," such as monk fruit, brown sugar, and cane sugar, are favoured over those with artificial or scientific names.

Fats and oils with health-supporting properties are also gaining traction, with sunflower, canola, and coconut oils, along with vitamin E, performing well. There is a growing interest in locally produced fats, reflecting both sustainability and health priorities. Consumers are willing to pay more for premium, nutrient-fortified

ingredients, and many actively share their knowledge of food quality with peers and online communities.

Cargill has responded with innovations tailored to these preferences, including high-cocoa aerated chocolate, cocoa almond milk, and a zero-calorie vanilla latte syrup for milk-based drinks. The findings

underscore how ingredient perception now shapes purchasing decisions as much as taste, with functional and natural qualities driving reformulation strategies across the region.

<https://www.foodingredientsfirst.com/news/asia-functional-natural-ingredient-trends-2025.html>

Gut health goes mainstream: The new growth engine for functional F&B

viewing gut health as essential for overall well-being, and many associating improvements in digestion with benefits such as energy, immunity, and skin health.

Gut health has moved firmly into the mainstream as a driver of holistic wellness, reshaping food and beverage innovation worldwide.

Innova Market Insights reports a 42% rise in product launches carrying digestive health claims, reflecting consumer demand for clean label, low-additive formulations and expanded offerings of probiotics, prebiotics, and fibre-rich foods beyond traditional dairy. T

he trend is increasingly linked to broader health outcomes, with nearly 60% of consumers

Weight management and stress relief are now central to gut health's appeal. Consumers identify gut health as a key factor in controlling weight and alleviating stress, prompting brands to develop science-backed, personalized nutrition solutions. Examples include Adday Wellness's super porridge, which combines oats, soy protein isolate, and fibre for weight control and digestive support, and Humm's probiotic kombucha shots, marketed for focus, immunity, and stress relief.

Functional beverages are a particularly strong growth area,

with gut health emerging as the most sought-after benefit. Synergy Flavors' research shows consumer interest in flavours like mango, ginger, and turmeric far exceeds their current representation in product launches, highlighting opportunities for innovation. Nestlé's kefir products exemplify the trend, offering clear digestive and immunity claims that resonate with consumers.

Overall, gut health has become a gateway to holistic wellness, driving rapid innovation across categories and positioning microbiome-focused products as premium, transparent, and science-based solutions for modern health needs.

<https://www.foodingredientsfirst.com/news/gut-health-holistic-wellness-trends.html>

Sunflower protein for plant-based functional beverages

Tetra Pak has expanded its ingredient portfolio with the launch of sunflower protein, aimed at supporting the fast-growing plant-based and functional beverage markets.

The ingredient contains up to 50% protein, along with fibre, vitamins, and antioxidants, and offers a neutral, slightly nutty flavour with off-white colouring. Its dosing range of 2% to 7% provides flexibility for formulators to enhance protein content, texture, and overall nutrition in applications such as plant-based iced coffee, yogurt, and ready-to-drink protein beverages.

The company emphasizes that sunflower protein can be integrated into existing production processes with minimal adjustments, making it a cost-effective option for producers seeking to expand product portfolios. Positioned as renewable and adaptable, it aligns with consumer demand for health-focused products, with 74% of consumers actively seeking items that carry health claims.

Market forecasts underscore the opportunity: the plant-based food and beverage sector is expected to triple to US\$35.9 billion by 2033, while the global protein market is projected to surpass US\$27.48 billion. Europe's meal replacement

segment alone is set to nearly double in value over the same period. Sunflower protein's high digestibility and suitable amino acid profile further strengthen its potential as a versatile ingredient for plant-based formulations, supporting both

nutritional and functional innovation in the evolving protein economy.

<https://www.foodingredientsfirst.com/news/tetra-pak-sunflower-protein-launch.html>

Inside the next wave of sugar reduction & healthier snacking innovation

Fi Europe 2025 is set to showcase how the food and beverage industry is reinventing sweetness and snacking in response to consumer demand, regulatory pressures, and health priorities.

The event will highlight sugar reduction strategies and healthier snack innovations, with companies like Givaudan, ADM, and Biolev presenting new tools and approaches.

Sugar reduction is increasingly tied to EU regulations on HFSS foods and Nutri-Score labelling, pushing brands to reformulate without sacrificing taste. Givaudan emphasizes synergy

between natural ingredients, botanicals, and flavours to deliver indulgence alongside functionality, while ADM introduces sweetening solutions such as Reduced Sugar Glucose Syrup and Stevia Edgility, enabling up to 30% sugar reduction.

Biolev focuses on holistic sensory quality, moving beyond high-intensity sweeteners toward stacked solutions that combine sweetness with flavour modulators. Its Flavormax yeast extract leverages umami to enhance flavour balance and achieve modest sugar reductions in beverages.

Healthy snacking is also evolving toward multifunctionality, combining reduced sugar with added fibre, postbiotics, upcycled ingredients, and botanicals. ADM highlights prebiotic fibre Fibersol and postbiotic innovations like Lactobacillus

gasseri CP2305, while Givaudan showcases prototypes such as protein bars with acerola, puffs made from upcycled green banana powder, and oat beta-glucan snacks. These concepts aim to deliver gut health, balanced energy, and indulgent sensory experiences.

Looking ahead, the boundary between functional and feel-good foods is expected to blur further. Reformulation will increasingly integrate science-backed botanicals, precision fermentation, and sustainable sourcing, aligning sweetness reduction with broader wellness benefits such as stress relief, cognitive support, and digestive health. Fi Europe 2025 positions these innovations as the next wave of holistic, consumer-driven snacking solutions.

<https://www.foodingredientsfirst.com/news/fie-2025-sugar-reduction-preview.html>

Alternative materials market strengthens as sustainability declines

Market for alternative materials is gaining strength even as sustainability declines as a central investment narrative.

Rising costs of raw commodities

like cocoa and coffee, driven by climate pressures, pests, and regulatory burdens such as the European Deforestation Regulation, are pushing companies and investors to explore substitutes. While sustainability once dominated food tech investment, the focus has shifted toward resilience, clean-label health, and functional ingredients. This change reflects investor priorities: rather than planet-friendly branding, they now

demand sharper commercial fundamentals and proof of scalability before funding.

Alternative materials are being developed across categories, from cocoa and coffee to eggs, often as B2B solutions rather than consumer-facing brands. Large companies like Barry Callebaut are adopting cultivated cocoa to de-risk supply chains, while partnerships between start-ups

and established players are helping scale innovations. Yet investors are more cautious, raising the bar for funding and requiring stronger business cases beyond R&D.

Consumer acceptance remains a challenge. Strategies include rebranding alternatives as superior versions of originals or stealth inclusion, where substitutes are incorporated without explicit labelling. The

latter is gaining traction as consumers increasingly prioritize health and authenticity but may resist unfamiliar or reformulated products.

Looking ahead, the future of alternatives depends on whether current commodity price pressures persist. If prices normalize, companies relying on alternatives may struggle to justify their relevance, though

some may remain viable due to their resilience and functional positioning. The sector is moving toward realism, with higher expectations from investors and a more pragmatic narrative that emphasizes commercial strength over sustainability rhetoric.

<https://www.foodnavigator-asia.com/Article/2025/09/16/alternative-materials-strengthens-as-sustainability-declines/>

Sparkling brain drinks target fatigue and mental performance

New Zealand-based Arepa is carving out a distinctive niche in the functional food and beverage space by focusing exclusively on brain health rather than the more crowded areas of gut health or energy.

Its latest launch introduces sparkling versions of its Brain Drinks in Yuzu Lemon & Vanilla and Spiced Orange, expanding beyond earlier flavours like Ginger Peach and Blackcurrant. These new options are designed to be natural, low-calorie, and sweetened with monk fruit,

offering consumers a more approachable taste profile while retaining the same active ingredients.

The Uplift formulation combines American ginseng, L-theanine, and vitamin B6 to support steady mental energy, memory, and alertness without the drawbacks of caffeine. Calm and Clarity, on the other hand, blends L-theanine with magnesium to promote relaxation, reduce fatigue, and improve sleep quality. The company has also introduced Brain Capsules for Sleep, formulated with L-theanine, saffron, and magnesium bisglycinate, reflecting consumer demand for non-sedative sleep solutions backed

by clinical evidence.

Arepa's strategy is to build credibility through science while diversifying formats. Beyond drinks, it is preparing powders, gummies, bars, and yoghurts, and is exploring partnerships with food and beverage companies and ingredient suppliers. This positions the brand to expand its reach and reinforce its identity as a specialist in brain health. The broader implication is that functional beverages are evolving toward more targeted benefits, with brain performance emerging as a compelling frontier alongside energy and gut health.

<https://www.foodnavigator-asia.com/Article/2025/09/25/sparkling-brain-drinks-arepa-targets-fatigue-and-mental-performance/>

Mycoprotein-Based Crispy Range in Germany and Austria

Planted has introduced its first mycoprotein-based product line, the "Crispy" range, in Germany and Austria, marking a significant expansion of its plant-based portfolio.

The lineup includes schnitzel, burger patties, and nuggets, all designed to replicate familiar comfort foods with a crispy exterior and juicy texture inside. This is the company's first use of mycoprotein, cultivated via natural fermentation, which requires minimal resources and offers high protein and fibre content.

The products are positioned as convenient, family-friendly

meals that combine indulgence with health benefits. Co-founder Pascal Bieri emphasized that breaded products are among the strongest categories in the convenience segment, and the Crispy range demonstrates how enjoyment and innovation can align. Planted describes the items as "golden on the outside, juicy on the inside," highlighting their natural ingredients and sustainable profile.

Currently available in Germany through REWE and EDEKA, and in Austria via Interspar, Eurospar, and MPREIS, the Crispy range is set to expand into Switzerland and other European markets. Planted sees

this launch as a way to enrich everyday life with contemporary plant-based choices while reinforcing its commitment to sustainability and nutrition.

<https://vegconomist.com/retail-e-commerce/planted-launches-first-mycoprotein-based-crispy-range-germany-austria/>

Demand for functional and plant-based foods fuel APAC dairy growth

Asia Pacific dairy market is expanding rapidly, driven by both functional dairy products and the rise of plant-based alternatives.

Traditional dairy consumption is increasing in large markets such as China, India, and Indonesia, supported by a growing middle class, Western dietary influences, and health-conscious consumers seeking probiotic, fortified, and nutrient-rich options. Analysts project the market will nearly double in value by 2033, reaching over US\$616 billion, with a strong CAGR of 7.1%.

Health and functionality are central to this growth. Consumers are drawn to claims

such as high protein, immune support, and natural ingredients, while dairy snacking is evolving into a wellness-oriented space. Brands are innovating with portion-controlled formats and multisensory experiences to fit modern routines. Examples include Bel Group's Laughing Cow adapting to Chinese breakfast habits and new launches like Outside's matcha oat latte and Oatbedient's oat milk powder, which target stress relief, clean-label preferences, and younger demographics.

Plant-based dairy is also gaining traction, driven by health, sustainability, and animal welfare concerns. Global growth is expected to outpace historic rates, supported by more sophisticated and functional product portfolios. High protein content is making plant-based options more

competitive, though challenges remain around reducing preservatives and unfamiliar ingredients that can undermine perceptions of naturalness. Non-dairy ice cream remains niche, with limited innovation and quality issues, but local flavours and limited editions are sustaining consumer interest.

Overall, the APAC dairy sector is entering a new phase where functional benefits and plant-based innovation are reshaping consumer expectations. To sustain momentum, brands will need to move beyond simple alternatives and invest in added value, functionality, and culturally relevant formats that balance indulgence with health.

<https://www.foodnavigator-asia.com/Article/2025/09/25/demand-for-functional-and-plant-based-foods-fuel-apac-dairy-growth/>

How Gen Z made Free From the flavour of modern wellness

Gen Z has transformed the "Free From" category—foods without gluten, dairy, or sugar—from a niche, compromise-driven segment into a mainstream expression of

wellness and identity.

Once associated with bland, inferior substitutes, Free From products are now celebrated for taste parity, creativity, and cultural relevance, thanks in part to social media platforms like TikTok and Instagram that have turned them into lifestyle aesthetics.

Gen Z's embrace of Free From is not only about health but also about inclusion, belonging,

and self-expression. Nearly two-thirds of Gen Z in the US buy Free From products weekly, often without any diagnosed allergy, while Millennials and Boomers contribute to demand for different reasons—Millennials as parents seeking safer options for children, and Boomers for practical health needs like diabetes or lactose intolerance.

The category's evolution reflects broader consumer expectations.

Taste is now non-negotiable, with sugar-free leading reformulation trends through ingredients like monk fruit, stevia, and allulose. Functionality is also key, as consumers expect protein, fibre, and gut health benefits alongside allergen-free claims. The rise of GLP-1 medications, which reduce appetite, is reshaping demand toward portion-controlled, nutrient-dense snacks where every bite must deliver value.

Transparency and affordability have become baseline

expectations, with private-label Free From products proving that consumers will no longer pay a premium for safety and wellness.

Safety remains central, as food allergies affect millions globally and undeclared allergens drive a significant share of recalls. This makes trust and rigorous allergen management critical for brands. For Gen Z, Free From is empowerment and identity, a way to enjoy indulgence without guilt while linking personal wellness to sustainability.

The future points to Free From becoming the default rather than the alternative. With global growth near 13% annually and retailers dedicating entire aisles to these products, the category is no longer fringe. What began as a marginal offering has become a \$100 billion reinvention of how health, indulgence, and identity intersect at the table.

<https://www.nutraingredients.com/Article/2025/09/25/gen-z-drives-100bn-free-from-boom-in-bakery-and-snacks/>

GLP-1-friendly snacks: protein-packed NPD

The rise of GLP-1 weight loss medications is reshaping consumer snacking habits and driving innovation in protein-packed products.

With appetite suppression and a stronger focus on satiety, protein has become the centrepiece of the snack aisle, offering sustained energy and muscle support compared to quick sugar hits.

This shift has pushed brands to reimagine traditional favourites and create new formats that balance indulgence with functionality.

Major launches include Quaker's protein granola bars

and oatmeal, Eggo's protein waffles and pancakes, and Catalina Crunch's plant-based protein granola, all designed to fit seamlessly into everyday routines.

Indulgent yet functional products are also emerging, such as Ghost's nostalgic Count Chocula protein powder, Junkless candy-like protein bars, and Wild Fox Foods' clean-label snacks.

In Europe and North America, Luker Chocolate is introducing protein-enriched couvertures, while savoury options like Higgidy's protein-rich frittata bites, Nichols Farms' pistachios, and The New Primal's beef mini sticks highlight how protein is being integrated into diverse categories.

Beyond snacking, protein is expanding into staples, with Brami's lupin bean pasta, Fly By Jing's soy noodles, and Natural Grocers' organic yogurt offering nutrient-dense alternatives to everyday foods.

Brands are also leveraging social impact and convenience, as seen with Oikos' university nutrition program and Sunnie's portion-controlled snack boxes.

Overall, the trend reflects a broader consumer demand for foods that deliver satiety, flavour, and functionality, positioning protein as the defining ingredient of modern wellness in the GLP-1 era.

<https://www.foodnavigator-usa.com/Article/2025/10/03/gl-p-1-friendly-snacks-protein-packed-npd/>

India regulates Ayurveda Aahara, aligns with food wellness trends:



India Regulates Ayurveda Aahara India has introduced a new regulatory framework for Ayurvedic foods, known as Ayurveda Aahara, aligning with the country's growing focus on traditional and personalized wellness.

Beginning September 1, 2025, food businesses producing and marketing Ayurvedic foods must obtain licenses through the Food Safety Compliance System (FoSCoS) portal.

The Food Safety and Standards Authority of India (FSSAI) defines Ayurveda Aahara as foods prepared according to recipes, ingredients, or processes described in authoritative Ayurvedic texts.

This regulation creates a new Kind of Business (KoB) category specifically for Ayurvedic food manufacturers. Firms with nationwide or overseas operations must apply for a Central License from New Delhi, at an annual fee of Rs7,500. Other businesses, such as traders, retailers, or exporters, can apply under existing registration or licensing rules.

On July 25, 2025, FSSAI published instructions for license applications along with

an approved list of 91 Ayurveda Aahara products. If a product is not included, companies must submit references from recognized Ayurvedic texts for approval. Updates to the list will be issued separately. Operating without a license can result in penalties of up to Rs2 lakh or imprisonment of up to six months, according to FSSAI's 2025 Penalty Chart.

The regulation does not apply to Ayurvedic drugs, proprietary herbs, medicinal products, or narcotic/psychotropic substances. It was developed in collaboration with the Ministry of Ayush, reflecting the government's commitment to integrating Ayurveda with modern food safety practices.

The framework is rooted in the Ayurvedic principle of personalized nutrition, tailoring diets to an individual's constitution (prakriti). Standardized recipes provide authenticity and safety, while still allowing practitioners and consumers to adapt them to personal health needs. For example, the preparation of JirakaDadhi (cumin-flavoured curd) is described in detail, including preparation methods, benefits (digestive support, relief for diarrhoea), and cautions (not to be consumed at

night).

The approved list includes citations from Ayurvedic classics, descriptions of food formats (hard eatables, drinkables, lickables), parts used (fruit, root), preparation methods, and health benefits. This ensures authenticity and regulatory compliance while supporting Ayurvedic treatment plans.

The move reflects rising consumer interest in traditional foods and personalized wellness across India and the Asia Pacific. It also highlights the untapped potential of Indian ingredients in global markets. By providing a clear, pre-approved reference for manufacturing, the regulation strengthens industry credibility and consumer trust, while fostering growth in both the food and Ayurveda sectors.

This regulation positions Ayurveda Aahara as a formalized food category, bridging traditional knowledge with modern compliance and opening new opportunities for India's wellness-focused food industry.

<https://www.foodnavigator-asia.com/Article/2025/10/15/india-regulates-ayurveda-aahara/>

Sunflower phytosterols achieve EFSA novel food approval

Kensing has secured European Food Safety Authority (EFSA) novel food authorization for its sunflower-derived Sunvasterol phytosterols, granting the company commercial exclusivity in the EU.

This approval allows Sunvasterol to benefit from EFSA's established health claims for plant sterols, which are recognized for their cholesterol-lowering properties and heart health benefits.

Unlike earlier approvals that covered sterols from sources such as soy and pine, this authorization specifically covers sunflower-derived phytosterols, reflecting growing consumer demand for sustainable, allergen-free, and non-GMO alternatives. Kensing emphasizes that Sunvasterol is fully disconnected from deforestation and traceability challenges, as it is produced from upcycled sunflower oil distillates sourced from Spain, Argentina, and the US.

Phytosterols are naturally occurring lipids found in seeds, grains, and legumes, and they reduce cholesterol absorption in the intestines by competing with dietary and biliary cholesterol. EFSA-approved claims stipulate that a daily intake of at least 0.8 g of plant

sterols or stanols helps maintain normal blood cholesterol levels, while intakes of 1.5–3 g can lower LDL cholesterol by 7–12.5% within two to three weeks.

Sunvasterol contains concentrated beta-sitosterol, stigmasterol, and campesterol in both free sterol and esterified forms, with esterification enhancing fat solubility and enabling incorporation into a wide range of foods beyond supplements. Kensing highlights that the ingredient can be seamlessly integrated into margarines, spreads, yogurts, dairy drinks, milk analogs, condiments, and salad dressings without affecting flavour or colour, allowing manufacturers to market products with heart health claims.

The company underscores that Sunvasterol combines scientific validation with practical formulation advantages, offering cholesterol-lowering efficacy supported by over 140 published studies while minimizing sensory impact on carrier products. Kensing plans to expand production capacity to meet anticipated demand and will showcase Sunvasterol at the Food ingredients Europe trade show in Paris, alongside its Sun E vitamin E product. This approval positions Sunvasterol as a sustainable, scientifically substantiated, and versatile lipid ingredient for functional foods targeting cardiovascular health.

<https://www.nutritioninsight.com/news/kensing-sunvasterol-plant-sterols-heart-efsa.html>

Novel foods: Experts debate regulatory obstacles at Future of Protein Production 2025

At the Future of Protein Production conference in Amsterdam in late October 2025, experts from across the novel protein industry debated the regulatory hurdles facing companies developing cell-based and alternative protein products.

A central theme was the disparity between approval processes in different regions.

Singapore and Australia were highlighted as offering faster regulatory pathways that help build investor confidence and allow proof-of-concept launches, though these markets are relatively small and geographically distant for European firms. By contrast, the European Food Safety Authority (EFSA) was criticized for its slow pace, often taking years to deliver opinions, and for its inability to provide direct guidance on scientific testing. Despite this, EU authorization was recognized as carrying significant global weight and easing entry into the UK market.

Speakers advised companies to

build a single, robust dataset that could be used across multiple jurisdictions to streamline approvals. They also suggested that the pet food segment could serve as an early revenue stream and testing ground, offering insights before entering the human food market. The discussions underscored the tension between the need for rigorous safety assessments and the desire for more agile regulatory systems that can support innovation in sustainable protein production.

<https://www.foodingredientsfirst.com/news/novel-foods-experts-debate-regulatory-obstacles-at-future-of-protein-production-2025.html>

How to define ultra-processed foods? IFT experts renew calls for science-based classification

The debate over how to define ultra-processed foods (UPFs) is intensifying in the US, with the Institute of Food Technologists

(IFT) urging regulators to adopt science-based classifications that emphasize nutritional quality rather than the degree of processing.

Current systems often categorize foods by processing intensity alone, which can misclassify nutrient-dense items like whole-grain bread or yogurt as UPFs. IFT argues that this oversimplification risks stigmatizing safe, beneficial foods and confusing consumers by conflating processing steps with formulation choices.

Earlier in 2025, the FDA and USDA issued a Request for Information to begin shaping a unified national definition, marking the first concrete step toward regulatory clarity. IFT has contributed input from experts across academia, regulatory science, industry,

and public health, stressing that clear, evidence-based terminology is essential for effective communication.

The implications of an official definition are significant. It could reshape labelling requirements, eligibility for federal nutrition programs, advertising claims, reformulation incentives, and consumer perceptions. While some UPFs are clearly linked to junk food, regulators are being urged to avoid blanket categorizations that ignore nutritional context.

Political momentum is also shaping the discussion. Under Health and Human Services, federal agencies are working toward a definition as part of broader health initiatives, though they emphasize there are no plans to ban UPFs

outright. California has already taken a pioneering step, passing legislation to phase out UPFs from school meals by 2029, with a full ban by 2035. Meanwhile, advocacy groups like the Americans for Ingredient Transparency coalition are pushing for a uniform national standard on ingredient transparency and labelling.

Overall, the push for a science-based definition reflects a shift toward balancing public health goals with the complexity of modern food systems, ensuring that regulatory frameworks support both consumer clarity and innovation in food formulation.

<https://www.foodingredientsfirst.com/news/how-to-define-ultra-processed-foods-ift-experts-renew-calls-for-science-based-classification.html>

EU "meaty" label debate looms with plant-based brands in regulatory limbo



The debate over whether plant-based products can use meat-related names such as "burger" or "sausage" has reached a critical stage in Europe.

Following a European Parliament vote to restrict such terminology, the issue is now in trilogue negotiations with the Council and Commission, leaving manufacturers in regulatory limbo. Livestock advocates argue that meat-related terms should be reserved for animal products to protect consumers from confusion and safeguard cultural heritage, while plant-

based industry groups counter that these names help shoppers understand how to cook and consume sustainable alternatives.

The controversy is sharpened by a 2024 European Court of Justice ruling that existing legislation already protects consumers from misleading labels, raising doubts about whether new restrictions are legally defensible. The stakes are high: Europe is the world's largest market for plant-based meat alternatives, projected to grow from US\$108 billion in 2025 to nearly US\$590 billion by 2035. Supporters of plant-based foods warn that restrictions could stifle innovation, disadvantage farmers producing soy and legumes, and contradict EU sustainability and health strategies that encourage

dietary shifts away from processed meat.

Manufacturers face difficult choices, weighing costly rebranding against the risk of rushed compliance if restrictions are enforced quickly. Over 400 organizations have mobilized against the measure, while livestock groups continue to push for stricter terminology rules. The outcome of trilogue negotiations will determine whether Parliament's position holds, but legal challenges appear likely. At its core, the debate reflects unresolved tensions between consumer protection, market competition, and Europe's broader sustainability goals.

<https://www.foodingredientsfirst.com/news/eu-meat-names-debate-continues.html>

UPFs are not the devil to clean-label's angel

The article challenges the widespread perception that ultra-processed foods (UPFs) are inherently harmful, arguing instead for a more nuanced understanding.

While 65% of European consumers believe UPFs damage long-term health, new research from the University of Leeds suggests that overeating is driven more by perceptions and sensory qualities than by processing levels alone. In studies involving over 3,000 UK adults and 400 everyday foods, researchers found that nutrient content and consumer beliefs explained most of the variation in overeating, while the Nova classification of processing accounted for less than 4%.

Foods perceived as sweet, fatty, or processed were more likely to trigger cravings, regardless of their actual nutritional profile, whereas those seen as bitter or high in fibre reduced the likelihood of overeating. This highlights the importance of perception: how people think about food influences their eating behaviour as much as what the food contains. The researchers caution that the UPF label is a blunt tool, grouping together very different products such as sugary soft drinks, fortified cereals, protein bars, and vegan meat alternatives. Some may be less healthy, but others can provide valuable nutrition, especially for groups like older adults or those with restricted diets.

The study urges industry and policymakers to rethink their approach. Instead of relying on UPF labels, they should strengthen food literacy, reformulate products to

balance enjoyment with satisfaction, and acknowledge the social and emotional motives behind eating. Warning labels could backfire by discouraging consumption of beneficial foods, while reformulation strategies should aim to preserve pleasure alongside health benefits.

Ultimately, the Leeds findings suggest that the future of UPFs lies in reframing the conversation. By focusing on taste, emotional impact, and perceived health value, brands can meet consumer needs more effectively and avoid oversimplified narratives that demonize processing. The challenge is to translate these insights into action, reshaping both product development and public messaging with greater nuance and transparency.

<https://www.foodnavigator-usa.com/Article/2025/09/26/upfs-new-consumer-insights-offer-strategic-opportunities-for-fb/>

Can This New International Standard Transform Plant-Based Food Labelling?

The new ISO standard for plant based food labelling represents a significant milestone in clarifying what "plant based" means on packaging and in trade.

For the first time, there is a globally recognised guideline that defines criteria for manufactured foods and ingredients, aiming to strengthen consumer trust and

reduce confusion.

The standard distinguishes between two categories. The first covers products entirely free of animal ingredients, including those derived from microbial fermentation such as mycoprotein or mushroom based foods. These can be labelled "plant based." The second allows up to 5% animal ingredients for technological purposes, such as lactose in flavour carriers or egg wash in pastry. These cannot be labelled simply "plant based" but must use qualifiers like "plant based vegetarian" or "plant strong," with clear disclosure of animal content. Cultivated meat can fall into this second category, provided its use is limited and

transparent.

The preference for "plant based" over "vegan" reflects consumer research showing broader appeal of the former term, especially among flexitarians. While "vegan" remains important for certain audiences, ISO's guidance encourages brands to use it more discreetly, such as on back of pack labelling.

Although adherence is voluntary, ISO standards carry weight in shaping national regulations, corporate practices, and retailer policies. This framework could become a reference point for governments considering legislation, while also reducing risks of greenwashing and

inconsistent claims. The compromise between stakeholders—those wanting strict exclusion of animal ingredients and those seeking flexibility—suggests the standard will be widely adopted, even if implementation varies across regions.

In effect, the ISO standard

provides a harmonised language for plant based labelling, enabling companies to market products more credibly and helping consumers make informed choices. It also sets the stage for future regulatory alignment, even as debates continue in Europe over whether terms like “burger” or “milk” can be applied to plant

based alternatives.

This development could reshape how plant based foods are positioned globally, balancing consumer trust with industry innovation.

<https://www.greenqueen.com.hk/international-organisation-for-standardization-plant->



Information is the new must-have in food

The article emphasizes that food information is becoming a critical driver of consumer choice. Shoppers are no longer satisfied with simple front-of-pack claims like “low sugar” or “high protein.”

Instead, they are actively turning packages around to scrutinize ingredients lists and processing methods. Research shows that more than 60% of consumers globally read these lists, but many struggle to fully understand them.

This reflects a growing desire

to connect food choices with health, sustainability, and ethics, alongside rising awareness of ultra-processed foods and additives.

Regional differences are notable. In Asian markets such as China, India, and Malaysia, consumers are particularly attentive to ingredients, influenced by cultural traditions like food-as-medicine and heightened food safety concerns.

This vigilance means long or complex ingredient lists may be

perceived as risky. In Europe and the US, the trend is also growing, but communication strategies need to focus on clarity and accessibility rather than technical jargon.

For brands, the challenge is not just transparency but making information digestible. Linking products to natural or cultural norms, using clear language, and engaging consumers through packaging, websites, and retail media are all effective strategies.

Private labels and challenger brands are already leveraging this by highlighting ingredient sources, sustainability claims, and transparent pricing. In Asia, experiential marketing that taps into consumer curiosity offers another avenue.

Overall, the appetite for food information is reshaping the industry. Success will depend on how well companies can balance openness with simplicity, ensuring that the information provided empowers rather than overwhelms consumers.

<https://www.foodnavigator.com/Article/2025/10/14/consumers-want-more-information-about-food/>



FDA 'no questions' letter for whey proteins unlocks new functionality for high-protein foods

The text refers to the FDA issuing a "no questions" letter to Verley for its precision fermentation whey proteins.

In regulatory terms, this means the FDA has reviewed Verley's Generally Recognized as Safe (GRAS) notification and has no objections to its conclusion that the ingredient is safe for use in food.

This clearance effectively unlocks new opportunities for food and beverage manufacturers to incorporate Verley's whey proteins into high protein products.

The surrounding page content highlights how this decision is significant because precision fermentation dairy proteins can deliver the functionality of traditional whey—such as texture, solubility, and nutritional quality—without relying on animal agriculture.

For brands, it opens the door to innovation in categories like

sports nutrition, baked goods, and dairy alternatives, while also aligning with consumer demand for sustainability and clean label protein sources.

In essence, the FDA's "no questions" letter validates Verley's technology and provides a regulatory green light, which is expected to accelerate adoption of precision fermentation proteins across the high protein food sector.

<https://www.foodnavigator-usa.com/Article/2025/10/10/fda-sends-no-questions-letter-to-verley-for-precision-fermentation-dairy-proteins/>

