



# FOOD, NUTRITION & SAFETY MAGAZINE

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## CLEAN LABEL INGREDIENTS

Dr. Malathy Venkatesan

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MEDICATION STIMULATES  
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**BIOTECHNOLOGY IN THE  
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# NUTRITION DRINK POWDERS: GOOD OR BAD

Many social media posts are critical of some of these products that contain milk products, malt extracts, sugar, a variety of vitamins and minerals and some additives. There are two main grievances about these products that they point out. One is the sugar and second is the health claims.

The actual added sugar in the

recommended scoop of 20-30 g of the product would be 6 or 7 g (or just a little over a teaspoon).

As most of them add either milk solids, which contain a lot of lactose, the milk sugar. This lactose is counted in the total sugar. If one drinks fresh milk, then this sugar is unavoidable.

The second problem that is pointed out is health claims. Although some claims may be slightly exaggerated, most claims are made after proper

verification and are all okayed by FSSAI.

If there is some grievance, then the right place is either ASCI (Advertising Standards Council of India), which has been officially appointed by FSSAI to look into any such problems.

Social media gives a lot of publicity that not only promotes the person posting but also harms the reputation of the company, without giving them a proper opportunity to defend.





We fully understand that we should first give preference to a balanced diet. That would give all the nutrients needed by the body.

However, it is seen that not just urbanisation but the change in lifestyle necessitates at least one or two meals or their equivalent foods, that cannot guarantee balance of nutrients.

Also, many of the foods containing essential nutrients are very expensive, so it is difficult, even if desired, to have the perfect eating habits and diets providing all the

nutrients needed by the body.

Under such conditions, we cannot starve the body of essential nutrients such as protein, vitamins and minerals. It would be nice if some dietary fibre is included in the ingredients.

This becomes not just a very effective means to ensure that people, especially the younger ones, are not deprived of these nutrients.

People certainly would prefer to have acceptable taste and at present the easiest is sugar to

make it sweet. It would be nice if we develop a cultural change to appreciate savoury or spicy beverages.

That would remove the stigma for these beverages. Even the kadha, the traditional Ayurvedic herbal decoction ultimately is given with honey to make it acceptable.

So, this is a traditional practice to make the supplement sweet so people drink it without difficulty.

**Prof Jagadish Pai, Editor,  
PFNDAI**



# FLIPPING THE FOOD PYRAMID.

## HAS THE SCIENCE CHANGED?



**AUTHOR**  
**Dr Joseph I Lewis,**  
Chairman, Scientific Advisory  
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A co-operative grocery store (1970), based on customers' purchasing habits, stocked larger quantities of grains and potatoes, which were cheaper than meat, fish, and eggs.

The behavioural insight, of "a good, healthy diet at a reasonable price", likely inspired the development of the Food Pyramid.

Households would get the recommended daily intake of nutrients by consuming the allotted servings of food groups without the necessity to calculate them.

However, they did not know these amounts, and labelling, which came later, has not helped. National surveys, though, provide policymakers with feedback on the population's nutrient intakes.

The impact of the pyramid on dietary change has been less than expected, considering the rise in NCDs.

Nutrition policies that establish public health goals should set time frames to assess whether measures taken are appropriate and effective. Impact assessments are now necessary before new measures are taken.

The upright pyramid, MyPlate, and now the US 2026 inverted model represent three different nutritional graphics communicated to consumers. The original model, which advised on food groups to consume, has now shifted toward avoiding hyperpalatable processed foods.





Essentially, the focus has moved from recommendations to avoidance. Nutrition science itself has not changed; only the communication approach has shifted. Guidance usually encourages good dietary behaviour: eat more rather than don't eat, or shaming such consumption.

Despite being an educational icon for five decades, insights into why populations fail or falter to follow are required before moving to another graphic.

The grocery store advertisement of 'reasonable price' forewarned policymakers that affordability is the key factor for households to adopt the food pyramid. Turning the Pyramid into MyPlate (US 2011; India 2024) visually emphasises a half-plate of fruit and vegetables over grains, overlooking the price factor, that grains are cheaper.

High-income countries (HICs) spend 6-10% of their total income on food, while Indian households spend between 40-49%. Household Consumption Expenditure Surveys (HCES 23-24) reaffirm that affordability drives current dietary patterns.

While this may be true, HICs are not faring any better in reducing obesity, diabetes and heart disease. Is affordability, therefore, the only factor, or have others been ignored?

The US 2026 guidelines introduce a third graphic. It upends the educative "nutrient-based" model and instead adopts a deterrent approach towards 'hyperpalatable' processing.



Cooking from scratch makes foods recognisable, and food products with long ingredient lists make 'real foods' unrecognisable: the thread of processing is evident. Though 'UPF' is not used, 'highly processed' foods are discouraged.

Recognising full-fat dairy, butter, and meat as 'whole-food fat sources', it reverses decades of "low-fat" messaging.

Saturated fat remains limited to 10% of daily calories.

Wheat flour and roti are presumably recognisable foods, but not bread or biscuits; milk and plain curd are, but not flavoured yoghurt, barfi, or ice cream. Palatability has become the surrogate measure of UPF, undefined, but apparent in product depictions.

The upright pyramid may not have failed solely because of affordability. If all foods became equally affordable, would consumption behaviour pivot towards "real food" and away from processed foods that offer convenience and palatability?

The presumption that diets are a trade-off needs to be thoroughly examined before the optimism of a new graphic leads to policy. There is no data to show that the flipped-over pyramid will sustain a new dietary behaviour.

Programs on developing new eating habits have dropout rates of 40-70% within the first year. Flipping the pyramid, when the science has not changed, could be another communication exercise.



# CLEAN LABEL INGREDIENTS



**AUTHORS**

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**Introduction**

Consumption and purchase of processed food have increased due to factors such as urbanization, the rise of nuclear families, the increasing number of working couples, increased family incomes, and convenience in purchase as well as delivery of products. Consumers are now paying attention to labels resulting in preference for “Clean labels”.

The definition of clean label is presently vague but consumers associate natural, less processed, chemical-free, free from artificial or synthetic as some concepts of clean

labels. Clean label refers to foods that are characterized by simple, recognizable ingredients and minimal processing, aligning with consumers' desire for transparency and healthfulness.

The global clean label ingredients market size was estimated at USD 120.03 billion in 2022 and is projected to reach USD 168.3 billion by 2030, growing at a CAGR of 4.3% from 2023 to 2030. The growth is driven by high consumer demand for natural and sustainably sourced foods.

**Key attributes of clean label products**

Although there is no official regulatory definition for clean label foods, the following attributes are

commonly associated with them:

- Simplicity and familiarity- Fewer or a minimum number of recognizable ingredients that are easy to read on the label
- Natural ingredients- No synthetic flavours, colours, chemical preservatives or artificial food additives should be added in a clean-label food
- Transparency- It is one of the core attributes of clean labelling. Information on sources of ingredients, methods of sourcing, and manufacturing methods on the label gives consumers the confidence that the food will be safe in all aspects
- Less/ Minimal processing- Clean labelled foods should be minimally processed using conventional techniques

Kellogg's



HIGH FIBRE



HIGH IRON



6 VITAMINS



ONLY 2% FAT<sup>^</sup>



Creative Visualization. Suggested Serving. <sup>^</sup>A naturally low fat food.



(pathogenic microorganisms, toxigenic, etc.), chemical (mycotoxins, pesticide residues, metals, etc.) and physical (insect fragments, foreign materials, etc.)

contaminants is the challenge in the production of whole grain products. Various physical, chemical, and biological techniques, as well as processing conditions, can be used to reduce contamination and partially control the production of mycotoxins.

### Plant extracts

To meet the consumers' demand for a healthier and natural diet, plant extracts are revolutionizing the food and beverage industry, which are incorporated into a wide variety of products. Botanical extracts are obtained from plants, roots, flowers, and fruits, and have been used throughout history in various cultures for medicinal and culinary purposes. However, their recent popularity is related to the growing desire to consume more natural food products with health benefits and clean label.

Examples are: natural colours, flavours and preservatives

### Natural colours

Colourings are defined as substances that modify the perceived colour of objects or impart colour to other colourless objects. Colour is present throughout nature in fruits, vegetables, seeds and roots and can be used in the form of pigments; examples are annatto, turmeric, anthocyanins, carotenoids and betalain. Their extraction and purification are costly and yield relatively low quantities, which drives up production expenses.

However, stability of these compounds under food processing conditions is the major challenge in application. This requires more concentrations as compared to synthetic colourants resulting in increased cost to the processor. Several strategies have been developed to protect natural colouring compounds from adverse environmental conditions, which include; micro-/nano-encapsulation to provide a physical barrier that shields the natural colorant, co-pigmentation (in case of anthocyanins), bulking with stable starches or other polysaccharides, natural, antioxidants, and metal ion chelators, to minimize degradation enhancing their stability during storage and processing. (3)

While many consumers associate clean label with "natural" and "organic," there are key differences. For example, some ingredients allowed in natural or organic foods may not be accepted under clean label standards. Compounds such as potassium bicarbonate, ammonium bicarbonate, and calcium hydroxide, which are permitted in organic foods, may not meet clean label expectations. Similarly, natural colorants like carotenoids and anthocyanins are allowed in clean label products but not in foods labelled as "natural". (1)

### Source of Clean Label Ingredients: (2)

#### Naturally functional foods: whole grains, fruits, and vegetables

Cereal grains have unique phytochemicals that complement those of fruit and vegetables when combined in a diet can be clean label ingredients. In addition, grains, fruits, and vegetables are recognized as a source of dietary fibre. Ensuring safety against the presence of biological



## Natural flavourings

Use of plant material as natural flavouring has been popular especially in home-made and artisanal products. Examples are saffron, cardamom and vanilla. These can also give a “clean label” to the food product. However, the availability and cost of these natural materials are challenges in large scale production of food products. The use of different extraction technologies allows for the production of different forms of presentation (liquids and powders), from these natural materials with preservation of the natural aroma. Examples are mint, saffron, fruit flavours.

Yeast extract is another example of a flavouring agent widely used because it is natural and contains aromatic notes suitable for use in vegan products as well as meat products.

## Antioxidants

Natural antioxidants such as rosemary extract, tocopherols (Vitamin E), and ascorbic acid (Vitamin C), are used to prevent oxidation, improve shelf life, and maintain nutritional value. These “clean label” ingredients are often added to oils, snacks, and meat products to curb lipid peroxidation and maintain quality. A list of plant material with the

active antioxidant compounds is given in Table 1. (4)

## Preservatives

Traditional Indian products used preservatives which include salt, sugar, vinegar, oil, microorganisms (through fermentation) which can be called “clean label ingredients”. In recent times, there has been considerable efforts to substitute chemical preservatives in commercial food products with natural products or extracts from natural material. Microorganisms are one of the richest sources of beneficial secondary metabolites, including antimicrobials like bacteriocins which have preservative action. Nisin and pediocin are the two leading examples of commercially available bacteriocins. Further, nisin is an FDA-approved and most widely accepted natural/clean-label preservative in food.

Organic acids produced by microorganisms are effective as preservatives and are suitable for “clean labels” Examples are lactic acids, ascorbic acid, formic acid and fumaric acid. Plant secondary metabolites, namely terpenoids, quinones, alkaloids, thiols and polyphenols, which give

plants odour, pigmentation, and a specific flavour have also been reported to exhibit bioactivity against pathogenic microorganisms. Examples are camphor, menthol and curcumin. The Codex General Standards for Food Additives has enlisted various ‘clean-label’ approaches. Based on their ADI and other relevant safety criteria listed under INS, some of the natural/clean-label preservatives discussed above have already been evaluated by JECFA for use in foods per the provisions of International Food Standards. Some food preservatives assessed and approved are summarized in Table 2. (5)

## Clean label ingredients in Indian food products

Traditionally Indian food products have used natural ingredients as additives, colours and preservatives. Turmeric is the best example. Other natural colours used include beetroot powder, annatto, carotenoids (paprika/ carrot), chlorophyll. Natural Preservatives/Flavour





Enhancer include salt, sugar, Citrus fibres, mustard and fruit concentrates; texturizers & Binders include Guar gum, pectin, and starches.

Cold pressed oils such as mustard, groundnut, coconut and sesame oils were popular in rural areas and have gained consumer preference in urban areas in recent times. Jaggery, mahua syrup, and dates are some of the natural sweeteners used in Indian food products. Plant-based acidulants such as tamarind, kokum, ambadi (leaf and calyx) are known to be used in India from ancient times.

Plant extracts such as saffron, ginger, chamomile, lavender, peppermint, and green tea, provides unique flavours and functional properties have been incorporated into a variety of products, from desserts to yogurts and health products. Examples of clean label ingredients in Indian food products are given in table 3. (6)

### Future prospects

The advantages of emphasizing the integrity of ingredients and the health benefits associated with organic and clean label offerings include enhanced market value and increase in conscientious consumers. This presents a promising opportunity for ingredient suppliers and manufacturers to collaborate in the creation of natural ingredients that not only meet clean label criteria but also offer enhanced nutritional value and functional advantages. For instance, there is increasing interest in ingredients such as plant-based, fibre-rich additives, and natural ingredients that can contribute to improved health outcomes and cater to specific dietary preferences.

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# WEIGHT LOSS AND DIABETES MEDICATION STIMULATES NEW FOOD PRODUCTS

AUTHOR

Prof Jagadish Pai,  
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Obesity and type 2 diabetes have been on the rise, globally.

Various reasons have been attributed to these and similar lifestyle diseases. Besides HFSS foods with high fat, sugar and salt, many other challenges such as modern hectic lifestyle with lack of time and regularity along with very little physical activity and relying on conveniences worsen the situation.

This promotes the above problems that are not only prevalent in western societies, but also in many Asian countries including India, where a large percentage of the urban population has this problem.

Recently, new drugs called GLP-1 drugs are gaining popularity in the US and some of the other western

countries. These are injectable drugs that suppress appetite and reduce the craving for some HFSS foods, so people eat substantially less food. They also feel full and do not feel hungry for quite some time, so the caloric intake is drastically reduced. Besides some side effects of the drugs, other nutritional problems are created, unless proper care is taken to prevent these.

This will create the need for drastic changes in eating habits and formats of foods. Already many companies in the US are marketing GLP-1 foods, specifically designed for those who are on this treatment. As this phenomenon grows globally, including in Asian countries like India and China, there is an enormous opportunity for marketing for such products.

## Benefits & Side Effects of GLP-1 Drugs (1, 2)

GLP-1 (glucagon-like peptide 1) is a hormone that is naturally produced in the gut after eating. It helps regulate blood sugar by stimulating insulin. It also suppresses glucagon and slows digestion. The GLP-1 drugs amplify these effects, reducing appetite and promoting satiety or feeling of fullness. When blood sugar rises after eating, they cause the body to make more insulin, to lower blood sugar. Hence, originally these were developed to control type 2 diabetes.



However, they also help weight loss, by curbing hunger. They also slow the movement of food from the stomach to small intestine, so one feels fuller faster and for a longer time. Thus, satiety lasts longer. This makes one eat less, resulting in dramatic weight loss, about 15 to 20% of body weight, along with the improved blood sugar control.

Besides control of blood sugar and helping weight loss, they seem to have other health benefits. They may lower the risk of kidney and heart disease, heart failure and stroke. Many have experienced improvement in blood pressure. These benefits may be due to drugs or the weight loss.

Gut also has trillions of microbes influencing metabolism. GLP-1 therapies alter the movement of food in the gut along with its fermentation pattern. This changes the makeup of microbiome.

GLP-1 signals to the brain travel from the gut via bloodstream and vagus nerve. These signals reduce

hunger and dampen the cravings for high-calorie foods. It also affects taste perception. Appetite suppression and taste perception also affects food preferences. Patients report reduced desire for sweets and fatty foods.

However, there are some common side effects reported such as nausea, vomiting, diarrhea, and headache. Also, there is a risk of hypoglycemia.

While GLP-1 drugs promote fat loss, rapid weight reduction due to restricted food intake can cause another problem. Since skeletal muscle is the largest site in the body for glucose uptake and a key player in metabolism, rapid weight loss can lead to lean muscle mass loss unless dietary changes are made to prevent it. It is very important for patients on GLP-1 medication to limit muscle wasting through exercise and high-quality protein diet. Rapid weight loss and reduced nutrient intake can also compromise bone density.

While these drugs suppress appetite, they create new nutritional challenges. Just eating less food can also mean missing out on essential nutrients along with calories. This necessitates changes in dietary intake with smaller,

nutrient dense meals rich in high-quality protein. There is a need especially for certain micronutrients such as vitamins B12, D and folate along with magnesium and iron. Thirst may be reduced so hydration is important. Fibre and probiotics support gut health, so they also must be supplied.

Regarding the sweetness, there is still no clarity as to craving for sweet foods, but people may not develop aversion to sweet foods. There is also an effect on thirst, so hydration may be affected.

As people eat the essential nutrients along with the caloric nutrients, if people simply reduced food intake, not only will they be consuming less calories but also less nutrients. This will cause a lot of problems of multiple deficiencies unless these are taken care of. One such problem was seen among seniors, who reduce their food intake because of their inability to eat full meals as before and also because their caloric needs are reduced as they become older. However, many nutrients are still needed to the same extent as when they were younger. One example is protein. Protein requirement remains remarkably constant even when caloric needs are reduced.

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SHURU HOTI HAI  
TAYYARI JEET KI.**



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So many seniors who simply reduce their food intake, become deficient in protein and may develop sarcopenia, wherein there is loss of skeletal muscle mass. This causes loss of strength and function.

Some other nutrients like dietary fibre, vitamins like B12, folate and D and minerals such as magnesium and iron also may have deficiency symptoms. These are also needed to be supplied adequately for the person under treatment to remain healthy. As thirst is not perceived much, there is a need to supply water to body.

These nutrients must be supplied either as supplements or the diet should be modified or fortified so lesser amount of food intake does not deprive the body of some of these essential nutrients. Traditional foods are not rich enough to compensate for the reduction in food intake.

It is very important that persons under this treatment have supervision of a dietician who will ensure that the person does

not become at risk of deficiency and have such problems like wasting of muscles and organs and other problems.

### Developing Diets and Food Products for GLP-1 Treatment

Traditional foods in India have a large proportion of carbohydrates with some protein and fat along with other micronutrients. When we incorporate legumes, fruits and vegetables, we increase the dietary fibre. Non-vegetarian diet may contain slightly higher amounts of protein with slightly less dietary fibre. As is mentioned above, if we try to reduce the intake of this food overall, we are going to reduce our protein, dietary fibre and micronutrients intake.

So, we must compensate for their reduction. We find it difficult increase protein content, without increasing carbohydrates or fats too. There is an opportunity of some high protein ingredients that could be ingeniously used to increase the protein and dietary fibre. One very easily encountered one is soya granules or chunks or badi, that has mostly protein and dietary fibre.

There are some high protein shakes or health food drink mixes marketed which also can be part of the meals. As there is a need for

consuming more of water, beverages may become an important part of the diet. Milk foods like curd, butter milk and Greek yogurt may be very useful, where additional micronutrients may be available.

Non-vegetarians could include eggs and lean meat or fish that could increase protein content without adding much carbohydrates. Frying could add undesirable fat and so should be avoided.

Addition of nuts should be with caution, as nuts have high amounts of fat. Defatted nuts like peanuts would be useful. They may be high in protein and with good proportion of dietary fibre and starch. However, these are not very easily available.

There is an opportunity for market of food products that are either smaller portions with high protein, fibre and micronutrients or some beverages of similar composition. Already some companies in the US are marketing such products that are getting growing demands as many people are now going on GLP-1 medication.

### GLP-1 Treatment Impact Globally

The recent indications show that GLP-1 global market is set to grow at 29.6% through 2030.

Consumers on treatment are showing a shift in behaviour with chips/salty snacks and sweet baked goods being consumed less, as medication curbs cravings for these indulgent, high calorie items. With decrease of fast-food consumption, they tend to seek healthier foods cooked at home. This poses both challenges and opportunities for industry, as demand for foods and beverages lower in sugar, carbs, fat and calories yet satisfying and flavourful increases. Dietary needs of patients promote high-protein, low-calories and portion-controlled options. (3)

Some companies have already developed products that are fibre-rich, with lean proteins and healthy fats. There are GLP-1-friendly meals that emphasise portion control and high protein content to help appetite control and nutrition. Beverages are also developed that not only serve the criteria of portion control and the nutritional needs, but are easy to carry when and where they are needed. They also prevent dehydration, as people tend to drink less while on this medication. Personal nutrition is very important, so patients are advised diet under supervision of dietician. (4, 5)

There are challenges like consumer education and awareness of these new non-traditional products. This needs proper marketing with functional claims that are strictly controlled by regulatory environment.

### Future Developments

Currently, the cost of the GLP-1 drugs is quite high, so consumers may find it a little difficult especially in India and other Asian countries. However, two things are happening. Patents for some drugs are expiring in India and China in 2026, so there may soon be some generic options available at affordable costs. Secondly, some oral options have shown very promising results, so cost will be much lower as well as there will be less resistance in treatment as opposed to current injection. (6, 7)

This will certainly make a lot of Asians to try this easier and faster option of weight reduction and control of diabetes. Consequently, there will be demands for high-protein, high-fibre, nutrient-dense and portion-controlled products as well as some changes in traditional recipes. All these changes will hopefully promote healthier eating but caution

is needed to prevent problems like sarcopenia. Also, it is known that if this treatment is discontinued abruptly, the weight-gain is much faster. Hence, professional help of registered and well-qualified dietician/nutritionist must be sought for healthy weight loss.

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# TRANSFORMING ALTERNATIVE PROTEINS BY EXTRUSION TECHNOLOGY



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With the growing global population, feeding everyone poses a challenge.

Incomes are rising, and so is the demand for protein in the diet. The environmental and ethical issues surrounding traditional animal sources of protein are significant. Problems like greenhouse gas emissions, deforestation, and extensive water and land use are linked to producing more animal-based protein. This has led to the search for alternative protein sources such as plants, microbes, algae, insects, fungi, and cultured cells. These new sources come with their own

challenges, including antinutritional compounds, cost, regulatory hurdles, and consumer acceptance.

The main challenge is to process these sources to remove antinutritional compounds, creating products with good protein quality and functional properties that can be safely consumed or used to develop new products acceptable by consumers. Extrusion is one such technology with great potential for processing these new protein sources. This is successfully used in the case of oilseed-based ingredients and is being tried in other cases. This article will discuss the extrusion technology used to process oilseed-based ingredients in detail and efforts for processing other sources of alternative proteins using this

technology.

## Extrusion of oilseed ingredients as potential protein sources: (1)

Oilseeds are a diverse group of plant seeds rich in oil. Oil is extracted by expeller press, solvent or by both. The nutrient-dense fractions after extracting oil, both cake and meal are excellent sources of protein and are also rich in bioactive compounds.

Common oilseeds such as soybean, peanut, rapeseed, sunflower, sesame, and chia, after the extraction of oil, are significant sources of proteins, with unique nutritional and functional attributes. These byproducts, otherwise used as animal feed and other industrial applications, are emerging as a source of novel protein ingredients.

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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.



A typical twin-screw extruder consists of a feeder, motor, barrel, screws, and die. (long cooling die in case of high moisture meat alternatives). The raw materials added are

exceeding 130 degrees C. The melt is then expelled through a die.

Extrusion offers an efficient means to enhance the nutritional and functional properties of oilseeds and cakes for the utilisation of oilseed protein for human consumption. This technology is used to manufacture a diverse range of products, including puffed snacks, ready-to-eat breakfast cereals, low and high-moisture plant-based meat alternatives, pelletised pet foods etc. Presently, this is extensively used to process soy flour, grits, and protein concentrates.

In low-moisture extrusion, the melt is rapidly exposed to lower temperature and pressure, causing the superheated water to be released quickly.

blended with water in the barrel. The blend undergoes further mixing, shearing, and kneading by rotating screws while being cooked at high temperatures. Low-moisture extrusion cooking results in Texturised Vegetable Proteins (TVPs) having a moisture of 10 - 40% and requires rehydration before consumption. High-moisture extrusion with moisture of 40 - 70% results in moist, fibrous, and/ or layered high-moisture meat alternatives (HMMAs).

Evaporation of water is the sole driver of the structure, resulting in low-moisture extrudates forming puffed snacks, breakfast cereals, and TVPs. In high-moisture extrusion, a long cooling die at the end helps controlled cooling of the end product. The conversion of water to steam at the end of the die is prevented, avoiding the product expansion. This cooling process creates simultaneous velocity and temperature gradients within the die because the velocity and temperature at the centre are higher than the cool die wall. This gradient facilitates fibrous structure formation in HMMAs. The internal layers and core continue to flow at higher speeds. This flow profile enhances the development of the fibrous structure to align the protein molecules.

This technology has the potential to reduce antinutritional factors and off flavours, as proven in its applications like the reduction of phytate and trypsin inhibitors in cereal bars and infant formulas made from corn meal, soy protein concentrate and cassava starch. High temperature and pressure of the process results in Maillard reactions, leading to roasted and meaty flavour to the product. Another advantage of extrusion cooking is the improvement of protein and starch digestibility.

The extrusion process involves different functional zones: the feeding zone, the mixing zone, the melting zone, and the die. The barrel is set to ambient temperature in the feeding zone, and the screw conveys the material to the next zone. In the mixing zone, the screw configuration is equipped with mixing elements to blend the feed material with water, which is directly injected. The melting zone features more kneading elements. Water acts as a plasticiser and transforms the raw materials into a viscoelastic melt at substantially higher temperatures, typically

The physical and functional properties of the extrudates depend upon moisture content, the barrel temperature profile, and specific mechanical energy (SME) input.



These parameters also impact the nutritional and structural properties of the extrudate. Moisture during the extrusion acts as a lubricant, reducing the residence time of the feed in the barrel and the shear forces required to drive the melt through the die.

Elevated temperatures during extrusion cooking promote unfolding and denaturation of proteins, resulting in the association and realignment of proteins in the cooling die.

Denaturation of proteins improves the digestibility and nutritional quality of extrudates. Solubility and water holding capacity are better at mild temperatures, like 130 degrees C. Higher temperatures tend to caramelize the extrudates.

Oilseeds have antinutrient factors such as tannins, phytic acids, alpha-amylase and trypsin inhibitors, and saponins that affect the bioavailability of nutrients. Reports suggest that in the case of soybean, flaxseed, sesame seed meal, reduction of antinutritional factors and improvement in digestibility occur during extrusion. Specific Mechanical Energy (SME) is the work input from the extruder driver motor into the raw materials, generated by friction between the screws, barrel, walls, and the product. Higher SME leads to

dissociation or depolymerisation of protein. SME also affects density, expansion index, colour, and hardness of the final product. Protein solubility and low molecular weight increase with the higher SME. The affordability of oilseed cakes and meals compared to traditional sources of protein makes them an attractive source for their applications.

**Plant-based meat alternatives:** Extruded oilseed-based proteins and meals have emerged as an excellent source for creating meat alternatives. Soy protein concentrate, isolate, cake and meal are extensively being used and have good PDCAAS value. There are reports of using sunflower meal, peanut protein concentrate, and hemp seed protein concentrates for producing HMMAs, which are found to have good textural properties. A blend of oilseed proteins with other plant proteins can enhance the nutritional profile of the HMMAs. The sunflower meal, which is low in lysine and blended soy protein that is rich in lysine, can improve the amino acid profile.

**Extruded Snack Food and Ready-to-Eat Breakfast cereals:** Nutritional benefits and

techno-functional properties of oilseed cakes, meals and proteins make them an important source for making extruded Snack Foods and Ready-to-Eat Breakfast cereals. Enrichment of pea-wheat cereal with extruded flaxseed meal improves the nutritional quality of bars. The ability to customise shapes and forms enables extrusion technology for product innovations as per consumer preferences.

**Enhancement of oilseed-based extruded foods:** Combining oilseed proteins with cereals or millets improves protein quality due to the complementary effect of amino acids. Microbial fermentation of oilseed-based ingredients before extrusion has several advantages. It reduces antinutritional factors and produces umami flavours in the final products, which is desirable in the case of HMMAs. Reduction of pea off-flavour and yeast-like umami flavour was observed in pea protein-based sausages due to LAB fermentation of pea protein.



Enzyme treatment also improves functional and nutritional properties in a wide range of applications. Incorporation of hydrolysed wheat gluten in soy-based HMMAS improved texture, protein digestibility, and amino acid composition. Hydrolysis of soy protein with flavorzyme is reported to produce chicken and beef-like aroma. Controlled oxidation of the vegetable oils used in the products produces meaty flavours. Enzyme interesterification, emulsification, and oleo gelation can obtain better fat mimetics.

### Pulses and the extrusion process to improve their consumption: (2)

Pulses are important alternative protein sources and are gaining popularity as novel food ingredients in the formulation of a variety of food products. They are a source of gluten-free food and an excellent source of protein, dietary fibre, minerals, and vitamins. Processing of pulses by extrusion technology improves nutritional and functional properties, making them acceptable products. The protein

content of pulses varies from 17-30%, which is double that of cereals. High temperature, shear, and stress conditions of extrusion denature proteins and increase solubility. High temperature of the process leads to Maillard reaction, imparting the colour and aroma to the product.

Acrylamide, which is a byproduct of the Maillard reaction, is formed and is reported to be minimised by increasing the feed moisture or injecting carbon dioxide during processing. Extrusion cooking of the pulse-based products has better water solubility, absorption, and digestibility with reduced antinutritional compounds. They can be added as a functional ingredient in powder form to bread, soups and cream. Pulses contain 60 - 65% carbohydrates. Several reports indicate a significant increase in the total available carbohydrates after extrusion cooking. This could be due to an increase in the carbohydrate availability inside the cell generated by diffusion of the water inside the matrix, leading to a subsequent increase in specific surface area through cell rupture and higher cell wall porosity. The increase in

dietary fibres is observed in extrusion cooking. This may be because of the breakdown of polysaccharides into oligosaccharides. Some ready-to-eat products enriched with pulses demonstrated an improvement in dietary fibre. Water-soluble vitamins are more liable to destruction than the oil-soluble vitamins during extrusion.

### Extrusion utilisation of insects: (3) (4)

Edible insects display high nutritional quality, and proteins are among their main components. Insect proteins have a well-balanced amino acid profile and are of high quality. Therefore, they are at an advantage compared to other sources of alternative proteins with respect to protein quality. Insect proteins or flours are already partially replacing conventional ingredients in bakery and meat analogues.

There are reports of insect proteins being utilised through extrusion technology to obtain high moisture extruded products. Inclusion of insect protein instead of routinely used plant protein like soy protein isolate, provides an opportunity to improve the protein profile of the meat analogues to be similar to an animal-derived product.

In one experiment, inclusion of 15 - 40% insect protein concentrate (both *Alphitobius diaperinus* and *Tenebrio molitor*) was used with soy protein concentrate. Optimum meat like texture was obtained when 40% insect protein was included at a high barrel temperature of 170 degrees C. In an experiment of extrusion with high or low-fat Cricket flour (15 - 30%) and soy protein isolate, fibrous meat analogues with high anisotropic indices up to 2.8 were obtained. This can offer an opportunity to partially substitute Soy Protein Isolate for the manufacture of fibrous meat analogues.

### Extrusion of algae for getting meat analogues: (5)

Algae are rich in protein with good amino acid composition and other nutrients like pigments, vitamins and minerals. They require less land and water than animal proteins. This makes them a promising source of alternative proteins. The development of algae-based meat alternatives by extrusion is still in the initial stage. In an experiment to substitute the soy proteins with the *Auxenochlorella protothecoides* microalgae by high moisture extrusion at high concentrations (50%)

fibrillary textured meat analogue was obtained. The microalgae reduced texturisation at high concentrations because of limited access to intracellular proteins during the process, and the lubrication of high fat content in the biomass, which decreased the shear forces affecting negative texturisation. It was possible to overcome this problem by using 30% biomass. The advantage of using biomass was the enrichment of the extrudate with vitamins B1, B2, B3, B6, and vitamin E, which were retained in the process. Use of high moisture extrusion was tried to substitute lupin proteins with *Spirulina plantesis* proteins to produce meat analogues at various concentrations (15, 30, and 45%) at different process parameters.

The products with 30 and 50% proteins were fibrous and changed the colour from yellow to green, whereas the product using 15% *Spirulina* did not show a difference as compared to the control using lupin proteins. Therefore, the success of producing a meat analogue from algae using extrusion technology depends on the level of substitution. Carrageenan is generally used as a binder and filler in structured

meat. Carrageenan improved the texturisation of a Lupin-based, *Spirulina*-containing high-moisture extrusion meat analogue. Algal protein can be used to prepare a meat analogue at a lower proportion. The challenge for the algal-based meat analogues is that consumer dislikes of sensory properties such as colour and odour that needs to be resolved.

Alternative sources of proteins represent an untapped opportunity to contribute to meaningful, sustainable food systems. Extrusion technology with complementary processing strategies can transform these alternative sources into affordable, functional, and acceptable food products that are healthier options for the global food future.

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# DIGESTIBILITY DRIVEN INNOVATIONS IN PROTEIN FORMULATIONS



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## Introduction

Protein is an essential macronutrient, required for forming muscles, hormones, enzymes and various structural and functional components of the human body. Protein is important for every life stage- from childhood growth to healthy ageing. While an adequate amount of protein intake is important, consuming good-quality protein is equally crucial. Hence, protein digestibility and bioavailability are important determinants to translate protein into physiological and health benefits.

Protein supplements have gained popularity among gym-goers and health-conscious individuals to help bridge the protein gap in their diets. To fulfil daily

protein requirements, protein is often consumed in high amounts in a single serving through protein shakes. Consuming large quantities of protein at once may reduce the efficiency of absorption in the intestine (Ten Have et al., 2007). Distributing protein intake across multiple meals throughout the day may allow for more effective utilisation than consuming large quantities in a single serving. Additionally, consuming protein as part of a mixed meal may support more efficient digestion and absorption.

Undigested protein in the gut may lead to gastrointestinal discomfort, including bloating and heaviness. Therefore, commercial protein supplements are often formulated with digestive enzymes, probiotics, and other ingredients to enhance protein digestion and absorption. As a result, claims such as “no bloat,”

“gut-friendly,” “easy to digest,” and “light on the gut” are increasingly being used in protein supplements, emphasizing the importance of protein digestibility and gut comfort.

## Role of Processing in Protein Digestibility

Processing methods play a crucial role in protein digestibility. Plant protein contains anti-nutritional factors (ANF) like phytates and tannins which can interfere with protein digestibility. Processing methods like wet fractionation, alkalization involved in protein isolation removes such compounds and improves digestibility. Furthermore, isolation procedures cause protein denaturation, making protein susceptible for attack by digestion enzymes like proteases, thereby facilitating improved digestion (Sá et al., 2020).

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## Rice

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- Starch Fraction 17.69%



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## Ingredients to Improve Protein Digestibility

### • Digestive Enzymes

Overprocessing of protein can inhibit endogenous protease activity, resulting in decreased digestion of protein (Rufián-Henares et al., 2007). Enzymes blended with protein have been shown to increase digestion and absorption. They help break down protein into its structural components, i.e., amino acids, improving their availability for absorption. Adding digestive enzymes to commercial plant protein powders also helps overcome compositional shortcomings of plant proteins.

Bromelain and papain are among the most common enzymes used in protein supplements available in the Indian market. Proteases from *Aspergillus niger* are also used to enhance protein digestibility by increasing the degree of hydrolysis of proteins (Jadhav et al., 2021). A proprietary blend of proteases, peptidase, bromelain, and alpha-galactosidase, has been shown to enhance amino

acid appearance in blood when consumed with plant protein blends, thereby narrowing the difference in amino acid appearance in blood between whey protein concentrate and plant protein sources such as pea and rice protein concentrates (Minevich et al., 2015).

### • Probiotics

High protein intake may contribute to imbalance in the gut microbiota (dysbiosis) (Jackson et al., 2024). Incorporating probiotics into protein powders helps support gut health. Commonly used probiotics in protein supplements available in the Indian market include *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Bifidobacterium longum*, *Bacillus coagulans*, *Bacillus subtilis*, and *Bacillus clausii*.

In an in-vitro study, *B. animalis* subsp. *lactis* B420, *B. animalis* subsp. *lactis* BI-04, *L. acidophilus* NCFM, *L. rhamnosus* HN001 and *L. paracasei* subsp. *paracasei* Lpc-3, when combined with soy protein, showed improvement in protein digestibility parameters such as protein solubility, protein hydrolysis and free amino acid content. Among these strains, *B. animalis* subsp. *lactis* B420 and BI-04 demonstrated the best survival rates, with reduction in cell count of less than 0.5 log (Marttinen

et al., 2023).

A novel study on whey protein combined with synbiotics (*Lactobacillus paracasei* and the prebiotic isomaltooligosaccharide) was tested among athletes in Thailand and demonstrated beneficial effects in maintaining gut microbiota balance (Keawyoket et al., 2025).

Co-administration of *B. coagulans* GBI-30, 6086 with protein has been shown to increase protein digestion and absorption (Jäger et al., 2018). It showed a 2-fold reduction in the TN/AAN ratio, suggesting greater protein breakdown into shorter peptides and a higher release of free amino acids compared to protein digestion without the probiotic.

By promoting more efficient protein digestion and absorption in the upper gastrointestinal tract, the strain may also reduce the quantity of undigested protein reaching the colon, where it could otherwise undergo microbial fermentation and produce undesirable metabolites. Consequently, improved protein digestion facilitated by BC30 may provide a dual advantage: enhanced amino acid availability in the upper GI tract and support for a healthier colonic environment (Keller et al., 2017).

An enzyme-probiotic blend of protease and probiotics, has also been shown to support improved digestion and absorption of plant proteins (Rathi et al., 2024). Similarly, a multi-strain probiotic blend has been reported to increase the maximum concentration of essential amino acids (EAA) in circulation (Jäger et al., 2020). Another probiotic strain, *Lactiplantibacillus plantarum* TWK10, has demonstrated benefits such as increased gut microbial diversity, improved amino acid absorption from pea protein, and enhancements in muscle mass, thickness, strength, and power (Lee et al., 2024).

#### • Herbal Blends

New-age brands are increasingly incorporating traditional Indian digestive herbs such as ginger, fennel, cumin and fenugreek into protein formulations. These herbs may help reduce digestive discomfort such as bloating and indigestion and support better tolerance of protein supplements.

### Protein-Probiotic Synergy

The combination of protein and probiotics demonstrates a synergistic effect. Protein acts as a substrate for probiotic metabolism, creating a favourable environment for probiotic growth and proliferation, while probiotics facilitate protein absorption and

utilization through proteolysis.

Plant proteins can serve as substrates for probiotics, supporting their growth and metabolic activity. These protein substrates can enhance probiotic cell biomass and growth rate by stimulating the synthesis of cytoplasmic proteins. Additionally, the carbon and nitrogen components derived from protein provide essential nutrients that further support probiotic growth and metabolism.

On the other hand, probiotics can improve protein digestion through several mechanisms. They regulate gut pH, which facilitates the solubility and digestion of plant proteins. Through fermentation, probiotics can modify protein structure, improve functional properties, and enhance the availability of bioactive peptides. Probiotics may also stimulate host digestive processes by enhancing the activity of proteases and peptidases and by releasing microbial exoenzymes that contribute to protein breakdown into peptides and amino acids required for probiotic proliferation and host absorption.

Probiotics improve the digestion and uptake of protein through two pathways: direct and



indirect. In the direct pathway, probiotics release exoenzymes that contribute to the further breakdown of protein fragments. In the indirect pathway, probiotics create a favourable environment for protein metabolism by modulating the gut ecosystem.

The interaction between protein and probiotics may offer several health benefits, including:

- Maintenance of gut barrier integrity
- Improved gut homeostasis
- Enhanced immune function
- Generation of bioactive complex with potential antioxidant, anti-inflammatory, antibacterial, and anti-allergenic properties.

Such interactions may also influence food processing characteristics. The protein-probiotic complex may improve fermentation performance, emulsification, foaming and gelling properties of proteins, thereby increasing their functional applications in food formulations (Wu et al., 2024).



components (Cao et al., 2025).

• **Fermented Protein Supplements**  
Protein supplements fermented with specific microbial strains have been studied

can significantly influence protein bioavailability, particularly in plant-based protein sources.

To address these challenges, the nutraceutical and functional food industry is incorporating digestive enzymes, probiotics, and traditional herbal digestive blends into protein formulations to enhance digestion and reduce gastrointestinal discomfort.

Among these strategies, the protein-probiotic synergy is gaining particular attention due to its potential to improve protein hydrolysis, enhance amino acid availability, and support gut microbiota balance. Such approaches not only improve nutrient absorption but may also contribute to broader health benefits including improved gut homeostasis, immunity, and metabolic health.

In parallel, emerging innovations such as fermentation technologies and yeast-derived proteins are expanding the landscape of alternative protein sources. These advances offer promising opportunities to improve protein functionality, sustainability, and nutritional quality, although further human clinical research is needed to fully understand their digestibility.

### Other Interesting Trends

• **Fermented Yeast Protein**  
Yeast-based protein is a by-product of yeast fermentation and has a well-balanced amino acid profile, making it a potential source of high-quality protein. Recently, the European Food Safety Authority (EFSA) approved the use of protein derived from *Yarrowia lipolytica* yeast as a safe supplement for human consumption.

The essential amino acid profile of yeast-based protein is comparable to that of whey and casein and meets WHO/FAO/UNU requirements for essential amino acid content. However, its digestibility compared to whey and casein remains inconclusive.

Some studies report lower digestibility than whey protein (Wang et al., 2023). This could be due to factors such as anti-nutritional components, lower biological utilization or interactions with other food

for their impact on digestibility. Fermentation may improve digestibility by reducing anti-nutritional factors present in plant proteins and partially hydrolysing protein structures. However, the microbial strains used in fermentation should be well characterized and scientifically validated.

### Conclusion

As awareness around protein nutrition continues to grow in India, the focus is gradually shifting from mere protein quantity to protein quality, digestibility, and bioavailability.

While protein supplements are increasingly used to bridge the dietary protein gap, their physiological benefits depend largely on how effectively the protein is digested, absorbed, and utilized by the body.

Factors such as processing techniques, presence of anti-nutritional factors, and individual digestive capacity

Overall, integrating gut-health-focused strategies with protein supplementation represents an important evolution in nutrition science. Future product development and research should continue to explore how protein digestion, gut microbiota modulation, and functional ingredient synergy can together enhance the nutritional efficacy of protein products.

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# SPRAY DRYING OF MILK

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Drying is one of the oldest methods of food preservation, used to inhibit the growth of microorganisms by removing moisture. Historical records indicate that Mongolians practised sun-drying milk to produce milk powder centuries ago.

Today, dehydration is widely applied across industries such as dairy, food processing, pharmaceuticals, and chemicals. A variety of products, including fruits, meats, milk, whey, and infant foods, are preserved through drying. Different drying technologies are available, and the choice of dryer depends on the desired quality and characteristics of the product. Milk is dried to make milk powder, which is used in different types of products and recipes. Earlier, sun-drying was the only source for drying; nowadays, modern machines and technologies have been introduced to make the

drying process easier and faster. One of them is the spray drying technique. Other than milk, fruit juices, coffee, tea, sauces, etc., are spray-dried.

Spray drying was first patented in 1872 by Samuel Percy. Over time, it has become one of the most important industrial drying methods, especially in the food, nutraceutical, and pharmaceutical industries. In the 1920s, the dairy industry played a major role in expanding its use. During World War II, the high demand for milk powder further accelerated improvements in spray drying technology. After the war, continued growth in milk production led to even more advancements. Today, spray drying is widely used across many industries and is considered one of the most efficient methods for producing fine, stable, and uniform powders (1).

Various dairy products are dried, including whole milk,

skim milk, milk protein concentrates (MPCs), milk protein isolates (MPIs), whey protein concentrates (WPC), and whey protein isolates (WPI). Skim milk has most of its fat removed, containing about 0.1 - 0.5% fat compared to whole milk. MPCs and MPIs are high-protein ingredients made from milk, enhancing nutrition, texture, and stability in food products. WPC contains about 70-80% protein after removing lactose, fats and minerals, while WPI, with an additional purification step, contains around 90% protein after removing extraneous carbs and fats (1). Other spray-dried dairy products include butter powder, cream powder, lactose powder, cheese powder and buttermilk powder.



powders play a great role. Milk powders can also be fortified with essential vitamins and minerals.

### Process & Changes in the Properties

#### of Spray Dried Milk Products (2,3)

Spray drying is a widely used technique that converts liquid foods into powder by atomizing a liquid feed into fine droplets that come into contact with hot air in a drying chamber, leading to rapid moisture evaporation. In milk powder production, fresh milk is first tested for quality and stored at temperatures below 5 °C. It is then standardized for fat and solids, preheated, pasteurized, and concentrated through evaporation to about 40-50 % total solids. The concentrated milk is then homogenized and spray-dried to produce fine powder particles. This process generally forms spherical particles with low moisture content and reduced water activity, which enhances microbial stability and improves shelf life.

The physical characteristics of the resulting powder, such as particle size, bulk density, flowability, and reconstitution behaviour, are strongly influenced by drying conditions. High

drying temperatures and rapid moisture removal may sometimes reduce powder wettability and dispersibility. To overcome poor reconstitution properties, the process of agglomeration is commonly applied. During agglomeration, fine powder particles are partially rewetted to approximately 8-15 % moisture and then dried again. This causes smaller particles to stick together, forming larger porous granules that improve wettability, dispersibility, and solubility in water. The agglomerated powder is then packed and stored in cool, dry conditions to maintain product quality.

In high-protein dairy ingredients such as Milk Protein Concentrate, Milk Protein Isolate, Skim Milk Powder, and Whey Protein Concentrate, spray drying can lead to structural and functional modifications in proteins. During the drying process, the combined effects of heat exposure, dehydration, and shear forces may cause protein denaturation and aggregation. These structural changes can negatively affect functional properties such as solubility, dispersibility, and rehydration ability. Spray drying may also influence the flavour stability of dairy powders.

### Need for Drying

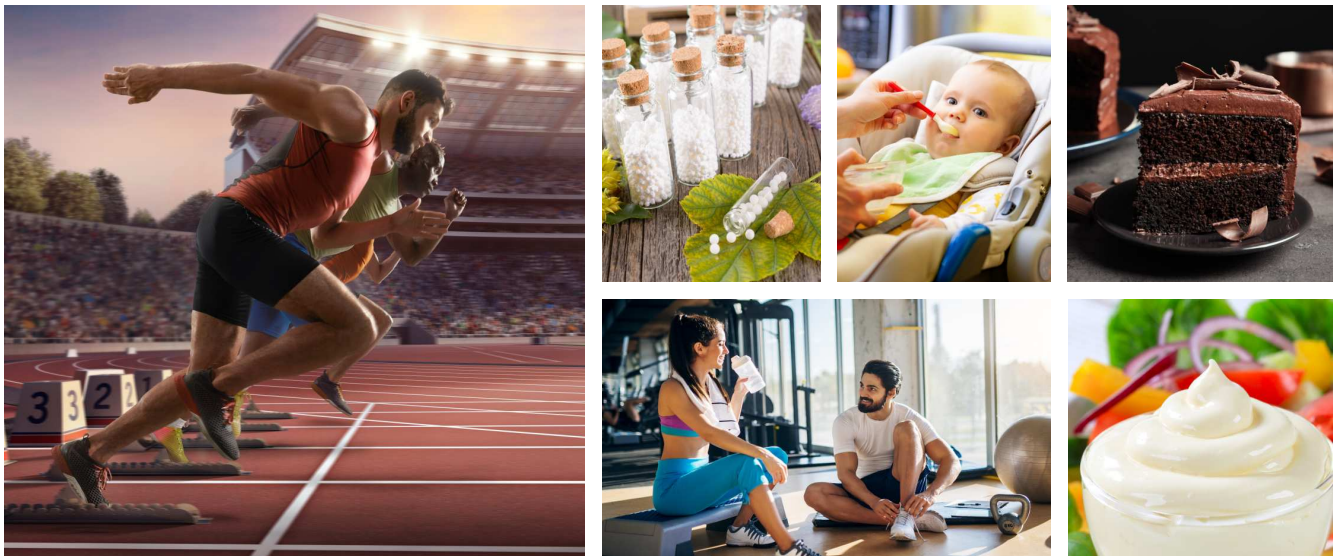
Drying milk into powder provides several important purposes. By removing moisture, the shelf life is extended, as reduced water content inhibits microbial growth and enzymatic activity. Powders are lighter, easier to transport, and do not require refrigeration, making storage and distribution more economical. They are highly convenient and versatile, as they can be easily reconstituted and incorporated into a wide range of products such as beverages, bakery items,

infant formula, and sports nutrition. In addition, spray drying helps maintain the quality and functionality of sensitive ingredients such as flavours, vitamins, enzymes, etc. The process produces fine, uniform powders that dissolve easily in water, making them convenient for instant products. One of the best things about dried milk and dairy products is their ease and convenience. Since it lasts long, it can be used and stored for months if you handle it with care. In regions without access to refrigeration, dry milk



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higher  $\beta$ -casein and lower  $\kappa$ -casein levels.

Studies comparing spray-dried camel and bovine milk powders show that camel milk powder has higher bulk and

tapped density and lower porosity. Moreover, protein denaturation during spray drying is limited in camel milk, with proteins such as  $\alpha$ -lactalbumin remaining stable even after drying (7)

### Effect of Spray Drying on Nutritional Parameters of Milk

Nutritional changes also occur during spray drying. Milk contains several vitamins, including B-complex vitamins, vitamin A, and vitamin D.

Some of these nutrients are sensitive to heat, oxygen, and processing conditions, which may lead to partial losses during drying. Oxidation is one of the major factors contributing to nutrient degradation. High temperatures can also cause protein denaturation, which involves structural changes.

Additionally, fats may undergo oxidative reactions at elevated temperatures, leading to fatty acid degradation and the development of rancid flavours. Furosine was also affected by spray drying in

both Non-Fat Dairy Milk Powder and Milk Protein Concentrate. Furosine is an indicator of early Maillard reaction and has been used to measure the nutritional quality of dairy proteins.

Several strategies can help minimize these quality changes in spray-dried dairy powders. Maintaining appropriate spray-drying parameters, particularly inlet and outlet temperature and residence time, can reduce excessive protein denaturation and aggregation.

Treatments such as homogenization and agglomeration improve powder structure and enhance solubility and reconstitution behaviour. Controlling feed solids concentration and viscosity also helps produce stable powder particles with desirable physical properties.

Also, maintaining low moisture content and water activity reduces caking and slows chemical deterioration reactions. The use of oxygen-barrier packaging materials and storage under low temperature and humidity conditions can further minimize lipid oxidation and help preserve flavour, nutritional quality, and functional properties of spray-dried dairy powders.

Even in low-fat powders such as skim milk powder, lipid oxidation can occur during storage, producing compounds that contribute to undesirable off-flavours.

Off-flavours decrease consumer acceptance. In whey protein powders, spray drying can alter flavour and functional characteristics compared with the original forms.

A study has shown that heat treatment affects the stability of bovine milk proteins, leading to thermal denaturation and aggregation through intermolecular disulfide bonds depending on time, temperature, and heat. Such changes can reduce important functional properties, particularly solubility.

With the growing consumption of camel milk, technologies like spray drying are being explored to extend shelf life, although camel milk powder production is challenging due to its physicochemical differences from bovine milk. Camel milk contains

Different types of spray dryers may influence the size, surface composition, and morphology of the powder produced due to differences in nozzle diameter and the extent of mechanical processes.

### Advantages and Disadvantages of Spray Drying as compared to other drying methods

Spray drying has several advantages, such as it causes rapid drying, ensures uniform particle size and distribution, it's versatile, provides consistent product quality, but despite these advantages, there are a few drawbacks, like it requires a high amount of energy, it is expensive, can cause loss of volatile compounds, etc.

This technique is effective and helps preserve many nutrients due to its quick process. However, high temperatures can degrade some heat-sensitive nutrients, especially certain vitamins like B vitamins. Prolonged exposure to heat can trigger the Maillard reaction and oxidation.

Drum drying is another technique used for producing milk powder. In this method, milk concentrate is spread as a thin film over the surface of rotating heated drums.

Water evaporates as the

product contacts the hot surface, and the dried film is then scraped off as flakes or powder.

One advantage of drum drying is that the equipment is simpler, cheaper, and generally more energy-efficient compared with spray dryers. However, the product remains in direct contact with the heated drum surface for a longer period, which results in greater heat exposure.



This prolonged heating can cause protein denaturation and reduced solubility of milk proteins (4).

Freeze-drying, or lyophilization, freezes milk and then pulls the water out through sublimation at low pressure. This helps in retaining more nutrients as



it is a non-thermal process. Still, oxidative processes during processing or storage can produce some losses, particularly if exposure to light or oxygen is not properly regulated.

Proper packaging and storage conditions are therefore essential to maintain product quality. Also, the process is very expensive and requires more energy consumption. However, freeze-dried powders dissolve evenly in water, improving usability in beverages, sports nutrition, and culinary applications (5).

While there are some hitches to using a spray dryer, it is effective in producing a diverse range of dry powders that, when mixed with water, can closely resemble the original fresh product.

As a result, spray dryers will continue to play a significant role in manufacturing convenience products that benefit consumers.



including beverages, bakery products, infant nutrition, and sports supplements. The spray drying process offers many advantages, but it also comes with challenges.

## Conclusion

Spray drying has become one of the most important technologies in modern dairy processing, enabling the conversion of liquid milk into stable and convenient powdered forms. By rapidly removing moisture through atomization and hot air drying, the process produces fine, uniform powders with long shelf life, good solubility, and excellent handling properties. These characteristics make spray-dried dairy ingredients highly valuable in a wide range of food applications,

Working with sensitive materials or those that have complex properties can complicate production. Common issues include product sticking to the chamber walls, inconsistent particle sizes, and low energy efficiency. Effectively addressing these challenges is essential for producing a high-quality final product and ensuring efficient operations. A thorough understanding of both the drying process and the materials involved is crucial (6).

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# STRENGTHENING NUTRITION THROUGH FOOD FORTIFICATION



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Micronutrient deficiencies, known as “hidden hunger,” affect billions and pose a significant public health issue. One effective solution is food fortification, highlighted by India’s successful iodized salt initiative to combat iodine deficiency disorders like goitre. Launched in the 1950s, universal salt iodization (USI) was mandated in 1992, dramatically reducing these disorders.

India had earlier started fortifying foods by adding Vitamins A and D to hydrogenated oils. Food fortification enhances the nutritional value of widely consumed foods and is a safe, cost-effective strategy

to prevent micronutrient deficiencies. Commonly fortified nutrients include iron, iodine, vitamin A, vitamin D, folic acid, and zinc, with careful consideration needed for food laws, labelling, cost-effectiveness, and consumer acceptance.

## Types of Fortification

### Commercial

**Commercial fortification:** Commercial fortification is the process of enhancing the nutritional value of regularly consumed foods by adding essential vitamins and minerals. It can be either mandatory, which means the government starts and regulates them, or voluntary, where food manufacturers add nutrients to their food while still being subject to regulatory restrictions. It encompasses three major categories:

**Mass fortification:** This

refers to the addition of essential micronutrients to widely consumed staple foods such as flour, oil, and salt. This action is carried out when a nation or region shows signs of a developing trend in the spread of nutritional deficiencies (1). Examples include: Salt iodization and Rice fortification (enrichment of rice with iron, folic acid, and vitamin A)

### Targeted fortification:

Targeted fortification aims at specific groups with higher nutritional needs, such as infants, pregnant women, and older adults. Examples include micronutrient powders for children, fortified complementary foods, prenatal supplements, and human milk fortifiers for premature infants.



Human milk fortification adds essential macronutrients to support growth in these infants. Prenatal vitamins containing folic acid, iron, calcium, and DHA are crucial for maternal and foetal health. Powders can be added to meals or used as drinks. For young children, complementary foods like porridges and snacks can be enriched with micronutrient powders, effectively reducing rates of anaemia (18%) and iron deficiency (53%) (2). Older adults also benefit from fortification in everyday foods.

### Market-driven fortification:

Market-driven fortification is an opportunity for food manufacturers to contribute to the fight against the major global public health problem of micronutrient deficiencies. This type of fortification is normally practised voluntarily. It is usually in response to consumer demand, enhancing product value, competitive positioning, and brand differentiation rather

than government mandate.

These types of foods are often priced higher due to perceived added value and a unique selling proposition. Common examples include Iron-fortified breakfast cereals, Vitamin D-fortified milk and fruit beverages, B12-fortified plant-based meat alternatives, Omega-3-enriched eggs, and Protein powders with added zinc and magnesium.

FSSAI has defined the permitted levels of vitamins and minerals that may be added for fortified foods, and they must display the +F logo and clearly indicate the added nutrients on the label.

### Technical aspects to be considered while Food Fortification:

Fortifying staple foods provides essential nutrients to populations, particularly in low- and middle-income countries (LMICs), where dietary deficiencies are prevalent. The rise in packaged foods due to urbanization and increased incomes has boosted the popularity of food fortification in these regions.

This strategy addresses micronutrient deficiencies but faces challenges, such as ensuring nutrient stability during processing and maintaining food quality. Being cautious when

selecting fortificants, food vehicles, and methods is crucial for successful implementation.

### Selection of Suitable Food Vehicles

An important consideration is the choice of an appropriate food vehicle. Staple foods such as rice, wheat flour, salt, and edible oils are commonly used. The ideal vehicle should be widely consumed, affordable, centrally processed, and relatively stable during storage and cooking. However, challenges arise in regions where people rely heavily on locally produced or minimally processed foods. In such cases, large-scale fortification programs may not effectively reach the most vulnerable populations; it becomes important to select food vehicles that match local consumption patterns.

Even the compatibility between the nutrient and the food vehicle must be considered. For example, iron fortification of cereal-based complementary foods can be challenging because highly soluble compounds like ferrous sulphate may cause rancidity or colour changes when mixed with fruits. Therefore, less reactive forms such as ferrous fumarate or electrolytic iron are used, sometimes with ascorbic acid to enhance absorption.

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Similarly, while dried milk powders and infant formulas can be fortified with ferrous sulphate, the same compound cannot be used in liquid milk because it can cause rancidity and off-flavours. In such cases, more stable forms like ferrous bisglycinate or micronized ferric pyrophosphate are preferred (3).

These examples highlight that selecting a suitable food vehicle requires careful consideration of consumption patterns, nutrient stability, and interactions between the fortificant and the food matrix to ensure the effectiveness and consumer acceptability.

### Selection of Appropriate Fortificants (3,4):

A major challenge in fortification is selecting the appropriate chemical form of the nutrient to be fortified. The compound must be sufficiently bioavailable while remaining stable and compatible with

the food product. For example, in **iron** fortification, highly soluble compounds such as ferrous fumarate are well absorbed by the body but may react with food components, causing undesirable changes in colour, taste, or shelf life. As a result, less reactive forms such as elemental iron powders are sometimes used in cereal products, although they generally have lower bioavailability.

In salt iodization programs, potassium iodate is often preferred over potassium iodide because it is more stable under conditions of heat, humidity, and storage that are common in many tropical countries. Selecting the correct fortificant involves balancing stability, cost, bioavailability, and consumer acceptability.

Fortifying products with **Vitamin A**, while maintaining its stability during processing and storage, is a challenge. High moisture levels can accelerate deterioration by increasing water activity and promoting degradative reactions. Repeated heating, such as when vegetable oils are reused for frying, can also lead to loss. Encapsulated vitamin A has been studied to provide a protective moisture barrier, but the high cost of such protected fortificants can limit their use. In many developed countries,

vitamin A fortification is therefore largely confined to staple food vehicles such as milk and dairy products, margarine, fat spreads, and breakfast cereals. Although carotenoids can serve as a source of vitamin A, their bioavailability and conversion to retinol depend on individual vitamin A status and dietary factors, and their high cost makes them less practical for large-scale fortification programs.

The number of suitable food vehicles for **vitamin D** fortification is relatively limited, with margarine, vegetable oils, and dairy products being the most commonly used.

Cholecalciferol is the most commonly used form in dairy, while Ergocalciferol is used mainly in plant-based or vegan fortified foods. Vitamin D is fat-soluble, so it is typically added to fat-containing foods or delivered in oil-based or encapsulated preparations to improve stability and uniform distribution. As the deficiency is seen worldwide, fortification becomes a key approach.

**Vitamin E** is usually added in a stable esterified form because natural tocopherols can easily oxidize. It is added in the form of DL- $\alpha$ -tocopherol acetate to fats and oils, margarine, fat spreads, and breakfast cereals.

Since vitamin E intake is closely linked to dietary fat consumption, its absorption can vary depending on the overall diet. Vitamin E may enhance the absorption and conversion of carotenoids to vitamin A.

**Vitamin C** is commonly used to fortify fruit juices, beverages, dairy products, and breakfast cereals, and it also improves the bioavailability of iron in fortified foods. However, it is water-soluble and sensitive to heat, oxygen, and light, so more stable derivatives are sometimes used. Ascorbic acid, Sodium ascorbate, and Calcium ascorbate are common fortificants.

### Fortification Methods and Technologies

Different fortification technologies are used depending on the type of food being fortified. Some common methods are dusting, coating, extrusion, and microencapsulation to protect sensitive nutrients. For example, in rice fortification, dusting involves mixing micronutrient powder with rice kernels, but the nutrients can easily be lost during washing. Coating applies a protective layer over the rice grain, improving nutrient retention. Extrusion technology, which produces fortified rice kernels that are blended with regular

rice, is currently considered the most effective method because it provides better nutrient stability during washing and cooking.

In salt iodization, iodine is typically added using spray mixing or drip-feed systems to ensure uniform distribution across salt crystals. Proper mixing and quality control are essential to ensure that the iodine concentration remains within recommended levels throughout the supply chain.

### Protecting Fortificants from Nutrient Loss

The success of any fortification product largely depends on the stability of the micronutrients within their carriers. Various physical and chemical factors including heat, moisture, air, light, and varying acidity or alkalinity can compromise the stability of these fortificants throughout food processing, packaging, distribution, and storage.

For example, when selecting the appropriate forms of iron for fortification, several factors must be considered, such as bioavailability, functional and stability properties, the commercial availability of food-grade materials, and cost.



Unfortunately, the forms of iron that typically exhibit the highest functional stability often have lower bioavailability, while those with optimal bioavailability can negatively affect the overall quality of the product.

In addition to the challenge of selecting the right form of micronutrients, maintaining their stability during processing and storage poses another significant issue. Many essential vitamins and minerals, such as vitamin A and iodine, are particularly sensitive to environmental stressors. For example, iodine can be lost from fortified salt when it is exposed to humidity and elevated temperatures, whereas vitamin A added to oils is prone to degradation via oxidation, compromising both its nutritional value and the quality of the product.

To overcome these challenges, food technologists implement various protective strategies.



Microencapsulation is a popular technique that helps shield sensitive nutrients from detrimental environmental conditions and reduces undesirable interactions with other food components. Additionally, they utilize stabilizing agents and innovative packaging materials designed to enhance nutrient retention and extend product shelf life. These strategies not only improve the nutritional profile of fortified foods but also ensure that they meet consumer safety and quality expectations, contributing to overall public health (5).

### Bioavailability of fortified nutrients:

The effectiveness of food fortification depends not only on the amount of nutrient added but also on its bioavailability. Nutrient absorption is influenced by factors such as the chemical form of the nutrient, the food matrix, and the presence of substances that either enhance or inhibit absorption. For example, compounds such as phytates and tannins in cereals and

legumes can reduce the absorption of minerals like iron and zinc.

To address this, more bioavailable forms of

nutrients, such as NaFeEDTA, may be used in high-phytate diets (6). NaFeEDTA is sodium iron ethylene-diamine-tetra-acetate, a chelated form of iron that does not bind to inhibitors. Food technologists aim to select compounds that are well absorbed without affecting taste, colour, or shelf life.

To enhance micronutrient intake through fortified foods, selecting appropriate nutrient forms and understanding food interactions is essential. Processing techniques such as soaking, germination, and fermentation can also help reduce inhibitory compounds like phytates, thereby improving mineral absorption. Therefore, selecting the appropriate nutrient form and considering interactions within the food matrix are important for maximizing the nutritional benefits of fortified foods.

### Advantages of Food Fortification:

Food fortification offers significant health benefits,

as shown by studies indicating its positive effects on micronutrient status. It can effectively prevent diseases linked to nutrient deficiencies, such as rickets, anaemia, and goitre (7). Population-wide fortification programs have led to notable reductions in these conditions, enhancing immune function and lowering infection rates. Also, food fortification is a cost-effective method to improve nutritional status, crucial for addressing hunger and malnutrition, especially in LMICs. During emergencies like pandemics or natural disasters, fortified foods can help prevent micronutrient deficiencies.

Combining fortification with social safety net programs, such as school feeding and food distributions, can improve its outcome. However, while fortification improves nutrient intake, it should be part of a broader strategy that includes dietary diversification, supplementation, and nutrition education.

### Challenges of Food Fortification:

Food fortification offers benefits but also presents challenges. One major issue is the risk of excessive nutrient intake when fortified foods are combined with dietary supplements, leading to imbalances.

Other challenges include the need for comprehensive regulations to ensure the quality of fortified products. Nutrient interactions during processing and cooking can affect nutrient effectiveness.

Fortified foods are often less consumed by vulnerable groups, particularly in rural or low-income areas where unprocessed foods are more common. Limited availability and increased production costs can make some of the fortified foods less affordable.

### Conclusion:

Food fortification is one of the most practical and cost-effective strategies for addressing deficiencies at the population level. However, the success of fortification programs depends on several factors, which are discussed above.

Addressing technical

challenges is essential for maximizing the impact of these interventions. When combined with other nutrition strategies like a varied diet, supplementation, and regulatory oversight, food fortification can play a crucial role in improving public health.

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# BIOTECHNOLOGY IN THE PRODUCTION OF FOOD ADDITIVES



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Many of the ingredients that shape the flavour, colour, texture, and shelf life of modern foods can now be produced through biotechnological processes. From organic acids to natural pigments and alternative sweeteners, biotechnology has enabled large-scale production of many food ingredients used across the food industry.

Although biotechnology is often considered modern science, it has been used in food production for thousands of years. Traditional fermentation techniques used to produce foods such as beer, wine,

vinegar, soy sauce, and cheese represent some of the earliest examples of biotechnology in practice. Advances in microbiology, molecular biology, and fermentation engineering have transformed these traditional practices into highly controlled industrial processes capable of producing food ingredients efficiently and consistently.

In recent decades, consumer demand for natural, sustainable, and "clean label" ingredients has grown. Consumers are more aware of ingredient lists and often prefer foods containing ingredients derived from natural processes rather than chemical synthesis. In response, the food industry has adopted microbial fermentation and enzymatic bioconversion to produce a wide range of additives, including organic acids, vitamins, colourants, enzymes, and alternative

sweeteners.

Many biotechnology-derived food ingredients are produced using controlled microbial fermentation processes.

Typical fermentation-based production involves the following steps:

1. Preparation of substrate - Sugars such as glucose or molasses are used as substrates.
2. Microbial cultivation - Bacteria, yeasts, or fungi are introduced into fermentation tanks.
3. Controlled fermentation - Conditions such as temperature, pH, oxygen supply, and nutrient composition are carefully regulated to support microbial growth and product formation.
4. Product accumulation - The desired compound accumulates in the fermentation broth.
5. Recovery and purification - The compound is separated and purified

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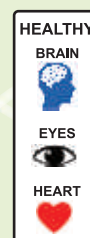
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contributes the characteristic sour taste found in beverages, candies, fruit preparations, and jams while also functioning as a preservative.

form, is widely used in pickled foods, sauces, and condiments where it contributes acidity and antimicrobial activity. Biological production of acetic acid typically occurs in two stages. In the first stage, yeasts convert sugars from raw materials such as fruits, cereals, or honey into ethanol. In the second stage, acetic acid bacteria, including species of *Acetobacter* and *Gluconacetobacter*, oxidize ethanol into acetic acid.

through filtration, extraction, crystallization, etc.

6. The purified compound is used as a food ingredient. This general process underlies the production of many fermentation-derived food additives used today (1).

## Biotechnologically Produced Food Additives

### Organic Acids

Organic acids are among the most widely produced ingredients obtained through biotechnology. They play an important role in foods by providing acidity, flavour enhancement, and preservation. Because many organic acids are naturally formed during microbial metabolism, fermentation offers an efficient method for their industrial production.

#### Citric Acid

Citric acid is one of the most widely used acidulants in the food industry. It

Industrial production of citric acid primarily relies on fermentation using the fungus *Aspergillus niger*. During the process, the microorganism converts carbohydrate-rich substrates such as molasses or glucose syrup into citric acid under controlled conditions of temperature, aeration, and nutrient availability. It is recovered through filtration, precipitation, and crystallization.

Citric acid production represents one of the largest industrial fermentation processes worldwide, with global production estimated to exceed 2 million tonnes annually. Researchers have also investigated the use of alternative fermentation substrates such as fruit processing waste, which supports waste valorisation (2).

#### Acetic Acid

Acetic acid, commonly known as vinegar in dilute

Modern vinegar production uses aerated fermentation systems that improve oxygen transfer and allow faster oxidation compared with traditional fermentation methods. Studies have also shown that acetic acid bacteria can be isolated from natural sources such as fruit waste, where strains have produced up to 4.88g/100 ml of acetic acid. Globally, acetic acid production exceeds 10 million metric tons per year, and bio-based production accounts for roughly 20% (3,4).

In addition to citric and acetic acid, several other organic acids are produced through fermentation technologies. Gluconic acid can be produced through microbial oxidation of glucose using microorganisms such as *Aspergillus niger* or *Gluconobacter* species.

Similarly, fumaric acid may be produced using fungi such as *Rhizopus* species, while malic acid can be generated through microbial or enzymatic conversion of sugars (1).

### Natural Colourants and Flavour Compounds

The use of colourants and flavour compounds to enhance foods dates back thousands of years. Today, biotechnology provides efficient methods to produce these compounds at an industrial scale with greater consistency and purity.

#### Carotenoids

Carotenoids are natural pigments responsible for the yellow, orange, and red colours seen in many fruits and vegetables. They are widely used in foods such as beverages, dairy products, sauces, and confectionery. Microbial production of carotenoids typically involves cultivating microorganisms such as yeasts, fungi, or microalgae in fermentation systems. Under optimized growth conditions, these organisms accumulate pigments within their cells. After fermentation, the biomass is harvested, and pigments are extracted and purified.

Compared with plant extraction, microbial production offers advantages including higher yields, improved

consistency, and reduced dependence on seasonal agricultural production.

#### Xanthophylls and Chlorophyll

Xanthophylls are oxygenated carotenoids that contribute yellow colouration, while chlorophyll is the green pigment responsible for photosynthesis in plants and algae. Chlorophyll is often extracted from plant sources; however, production by microalgae cultivation is also being explored.

Biotechnological production often involves cultivating microalgae in photobioreactors or open pond systems where light, carbon dioxide, and nutrients support photosynthetic growth. Once sufficient biomass has been produced, pigments are extracted and purified for use as natural colourants.

#### Riboflavin

Riboflavin (vitamin B<sub>2</sub>) is both a bright yellow pigment and an essential nutrient commonly added to cereals, dairy products, beverages, and infant formulas.

Today, more than 90% of global riboflavin production is achieved through microbial fermentation using organisms such as *Ashbya gossypii* or



genetically optimized strains of *Bacillus subtilis*. These microorganisms convert glucose into riboflavin through natural metabolic pathways.

Fermentation-based production has largely replaced earlier chemical synthesis methods because it offers improved efficiency and lower environmental impact.

In addition to natural colourants, biotechnology is also widely applied in the production of flavour and aroma compounds that contribute significantly to the sensory quality of foods.

#### Vanillin

Vanillin is one of the most widely used flavour compounds in the food industry, providing the characteristic vanilla aroma in confectionery, dairy products, beverages, and baked goods. Because extraction from *Vanilla planifolia* is limited and expensive, biotechnological production methods have been developed.



Microbial biotransformation of precursors such as ferulic acid or eugenol allows vanillin to be produced at industrial scale while maintaining a “natural flavour” classification in many regulatory systems.

### γ-Decalactone

γ-Decalactone is a peach-like aroma compound widely used in fruit-flavoured foods, beverages, and dairy products. It can be produced through microbial conversion of ricinoleic acid using certain yeasts and fungi. Due to its strong fruity aroma and low sensory threshold, it is an important ingredient in flavour formulations.

### Isoamyl Acetate

Isoamyl acetate provides the characteristic banana-like aroma commonly used in confectionery and beverage flavourings. It is produced naturally by yeasts during fermentation through esterification of isoamyl alcohol with acetyl-CoA.

## Low-Calorie Sweeteners

Concerns about excessive sugar consumption have driven demand for alternative sweeteners that provide sweetness with fewer calories.

Biotechnology plays a major role in the production of several sugar alcohols and natural high-intensity sweeteners.

**Xylitol** is widely used in products like sugar-free chewing gum and confectionery. It provides sweetness comparable to sucrose but with fewer calories and a lower glycaemic response. Biotechnological production involves microbial conversion of xylose derived from plant biomass. Certain yeasts and fungi contain the enzyme xylose reductase, which converts xylose into xylitol during fermentation.

**Erythritol** is another commonly used sweetener. It is typically produced by fermenting glucose using yeasts or fungi, after which the compound is recovered through purification and crystallization.

**Sorbitol** is used in confectionery and bakery products where it contributes sweetness, improves texture, and helps retain moisture. Microbial processes can convert glucose into sorbitol through enzymatic reduction reactions.

**Mannitol** is produced by microorganisms such as lactic acid bacteria or yeasts that convert fructose into mannitol during fermentation. This method is increasingly attractive because it offers greater efficiency compared with traditional chemical synthesis(5).

Researchers have also explored sweet proteins, such as thaumatin, miraculin, and brazzein, as potential next-generation sweeteners. These proteins are naturally found in certain tropical plants but occur in very low concentrations, making large-scale extraction impractical. As a result, recent research has focused on producing them using recombinant DNA technology and microbial fermentation systems, enabling more efficient and scalable production.

## Emerging Applications of Biotechnology in Food Ingredients

Biotechnology is also enabling the development of novel food ingredients.

Enzymes such as amylases, lipases, and rennet are widely produced through microbial fermentation and play essential roles in food processing applications, including baking, brewing, and cheese production.

Similarly, antimicrobial peptides such as nisin, produced by certain lactic acid bacteria, are used as natural preservatives to inhibit spoilage microorganisms and foodborne pathogens in products such as dairy foods and processed meats.

More recently, precision fermentation has expanded the range of ingredients that can be produced using engineered microbial systems. In this approach, microorganisms such as yeast, fungi, or bacteria are programmed to synthesize specific target molecules during fermentation. This technology is being applied to produce high-value food components, including heme proteins, egg proteins, and dairy proteins such as whey and casein, supporting the development of plant-based meat and dairy alternatives with improved flavour, texture, and nutritional properties.

Certain microorganisms and microalgae can produce long-chain omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are traditionally obtained from fish oil. Fermentation-based production offers a more sustainable alternative, with engineered yeasts such as *Yarrowia lipolytica* being investigated for large-scale manufacturing of these

fatty acids (8).

### Role of Biotechnology:

Impact, Advantages & Challenges

Biotechnologically produced ingredients contribute significantly to food quality. Organic acids and antimicrobial compounds help extend shelf life by inhibiting microbial growth, while enzymes improve texture and processing characteristics. Together, these ingredients enable manufacturers to maintain product stability, safety, and quality while meeting evolving consumer expectations.

Fermentation-based production offers several advantages for the food industry. These processes can achieve high yields and consistent product quality while reducing dependence on conventional chemical synthesis. In many cases, renewable raw materials and agricultural by-products can also be used as substrates, supporting more sustainable production systems.

Despite these benefits, several challenges remain. Fermentation processes often require significant technological investment and specialized infrastructure. In addition, regulatory approval is required for many



fermentation-derived ingredients, particularly when genetically engineered microorganisms are involved. In addition to microbial fermentation, food additives can also be produced through enzymatic bioconversion, where purified enzymes convert specific substrates into desired products. This method differs from fermentation as it relies on isolated enzymes under controlled conditions, allowing for efficient and selective substrate conversion with fewer by-products. Examples include the production of high-fructose syrups from glucose using glucose isomerase, galactooligosaccharides (GOS) from lactose using  $\beta$ -galactosidase, and flavour esters through esterification reactions catalysed by specific enzymes (9).

Microorganisms isolated from food can also serve as sources of bioactive compounds. For example, certain lactic acid bacteria have been studied for their ability to produce vitamin B12 and for their probiotic potential.



Among the strains identified, one showed particularly high vitamin B12 production and may be useful for developing vitamin B12-enriched formulations (10).

Enzymes often require only cold storage and can operate in simple temperature-controlled reactors, making continuous processing easier compared with fermentation systems. However, it also has limitations, such as higher production costs and possible stability issues that may reduce enzyme activity over time.

Overall, these technologies have significantly transformed the manufacture of food ingredients by enabling efficient, scalable, and more sustainable processes. Through fermentation, enzymatic conversion, and metabolic engineering, a wide range of ingredients,

including organic acids, pigments, enzymes, and alternative sweeteners, can now be produced with high consistency and reduced environmental impact.

Consumer acceptance of biotechnology-derived food ingredients has increased significantly in recent years, particularly when these ingredients are produced through natural fermentation processes.



Many consumers perceive fermentation-derived additives, such as organic acids, enzymes, and vitamins, as more natural and sustainable compared with chemically synthesized alternatives. The global clean-label ingredients market, driven by demand for natural and minimally processed ingredients, is expected to grow from about US\$52.5 billion in 2025 to nearly US\$84.9 billion by 2032, reflecting the increasing consumer preference for transparent ingredient sourcing (6).

At the same time, the market for fermentation-derived ingredients used in foods continues to expand rapidly. The global fermented ingredients market was valued at approximately US\$44 billion in 2025 and is projected to exceed US\$115 billion by 2034, highlighting the growing industrial reliance on microbial processes for producing food additives such as organic acids, enzymes, flavour compounds, and vitamins (7).

In summary, biotechnology has become an essential tool in modern food ingredient production, offering efficient, scalable, and sustainable solutions to meet the changing demands of both industry and consumers.

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# REGULATORY ROUND UP



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Dear Readers,

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

[Validity Order of FSSAI notified Food Testing laboratories as on 12th February 2026](#) :

This order provides the latest list of FSSAI-approved

laboratories with validity of their accreditation as on 12.02.2026.

[Compliance to provisions of FSS \(Recognition and Notification of the laboratories\) Regulations 2018 by FSSAI recognized Laboratories](#) :

This order pertains to FSSAI-recognised laboratories complying with regulation 9 of FSS (Recognition and Notification of the laboratories) Regulations

2018. Laboratories are obliged to

- a) upload test reports on InFoLNet portal without delay.
- b) should adhere to prescribed test methods specified under FSS Rules and regulations and within the scope of accreditation.
- c) comply with the test reports in the formats as suggested in the rules and regulations.

## The overlooked nutrition risk of Ozempic and Wegovy

Researchers from the University of Cambridge and UCL have raised concerns about the nutritional risks associated with the widespread use of weight-loss drugs such as Ozempic and Wegovy.

These medications, which mimic the hormone GLP-1 to suppress appetite and increase feelings of fullness, can reduce calorie intake by 16 to 39 percent and are highly effective for weight loss. However, the study published in Obesity Reviews highlights that many users are not receiving adequate nutritional guidance, which may lead to deficiencies in protein, vitamins, and minerals, as well as significant loss of muscle mass. Evidence suggests that lean body mass can account for up to 40 percent of the weight lost during treatment, underscoring the importance of dietary support.

While guidelines from the National Institute for Health and Care Excellence recommend that semaglutide be prescribed only under structured programs including diet and exercise, most users in the UK obtain these drugs privately, often without access to professional nutrition advice. This gap in care raises the risk of fatigue, weakened immunity, hair loss, osteoporosis, and increased vulnerability to injuries due to muscle loss. The researchers found only twelve studies examining nutrition alongside GLP-1 therapy, with inconsistent methods and limited conclusions, leaving major questions unanswered.

Experts suggest that lessons from bariatric surgery nutrition care could help fill the gap, emphasizing the need for nutrient-dense foods, high-

quality protein distributed across meals, and balanced fat intake. They also note that smaller, more frequent meals may ease side effects such as nausea. To better understand real-world experiences, the team has launched the AMPLIFY project, which will explore how people from diverse communities live with these medications and what support they find most useful.

The study concludes that without integrated nutritional care, the rapid rise in GLP-1 drug use risks replacing one set of health problems with another, making structured dietary guidance essential for safe, long-term weight management.

<https://www.sciencedaily.com/releases/2026/02/260203030551.htm>

# RESEARCH IN HEALTH & NUTRITION

## Methionine supplementation may boost immunity by reducing inflammation

The article from Nutrition Insight reports on new research from the Salk Institute showing that methionine supplementation can significantly alter disease outcomes in mice by reducing inflammation and protecting

against organ damage, wasting, and death.

In infection models, methionine improved kidney filtration, which helped clear pro-inflammatory cytokines from the bloodstream and limit immune driven damage. The study highlights the kidney's underappreciated role in recovery from infection, showing that enhanced filtration capacity allowed the body to excrete harmful cytokines more effectively.

The researchers found that infected mice had lower circulating methionine levels, and supplementing their diet restored protection against inflammation related complications, including blood brain barrier dysfunction. Methionine also showed protective effects in models of sepsis and kidney injury. The mechanism appears to involve balancing the immune response by reducing excessive cytokine release, which otherwise leads to tissue damage and worsens disease outcomes.

Senior author Janelle Ayres emphasized that small biological differences, including diet, can have large effects on how diseases progress, suggesting nutrition could be used as a mechanistically informed medical intervention.

## Experts urge fibre's recognition as an essential nutrient for reducing chronic disease risk

Researchers at the University of Otago are calling for dietary fibre to be recognized globally as an essential nutrient, which would mark the first addition to the essential nutrient list in 50 years.

Currently, carbohydrates, proteins, fats, vitamins, minerals, and water are considered essential, but fibre has not been included despite growing evidence of its role in reducing risks of chronic diseases such as diabetes, heart disease, and colorectal cancer. The team argues that fibre meets the criteria for essentiality because it is not produced by the body, is required for health, and its absence leads to deficiency-like states, particularly in the gut

While the findings add to evidence that dietary elements may act as medicine, the authors caution that the results are limited to mouse models. Clinical studies are needed to determine whether methionine supplementation could safely

microbiome, which relies almost exclusively on fibre.

In New Zealand, average fibre intake is about 20 grams per day, below the World Health Organization's recommendation of 25 grams. The researchers emphasize that simple dietary changes, such as consuming more whole grains and legumes, could help populations meet these targets. They also note that recognizing fibre as essential would strengthen public health messaging, encourage government monitoring, and motivate the food industry to reformulate products to increase fibre content.

Lead author Andrew Reynolds highlights that fibre has historically been overlooked, often discussed only in terms of fecal bulking, but recent research has shifted attention to its benefits for gut health and the microbiome. He stresses that evidence-based dietary guidelines already support higher fibre intake, but

and effectively be applied to humans as a therapeutic nutrition strategy.

<https://www.nutritioninsight.com/news/methionine-supplementation-inflammation-kidney-disease-mice.html>

competing messages from lifestyle media and marketing often drown out scientific advice. Recognizing fibre as essential could help cut through this noise, making it a priority in nutrition policy, education, and food reformulation.

The commentary also points out that while protein has dominated nutrition trends, most people already consume sufficient amounts, whereas fibre intake remains consistently low. Reynolds suggests that increasing fibre consumption would benefit population health more than any other nutrient, and he praises recent Dutch dietary guidelines that emphasize fibre intake through whole grains, legumes, vegetables, and fruit. This push reflects a growing recognition that fibre is central to long-term health and disease prevention.

<https://www.nutritioninsight.com/news/new-zealand-dietary-fiber-essential-nutrient-status.html>

PLA), that appears to suppress IgE antibody production – the immune “alarm bell” behind allergic reactions and asthma.

Their study in Nature Microbiology shows that infants with higher bifidobacteria levels, often linked to vaginal birth and breastfeeding, had reduced immune overreaction to allergens.

The mechanism is striking: 4 OH PLA lowered IgE production by about 60% without affecting other antibodies, suggesting a targeted way to dampen allergy risk. Stool and blood samples from large birth cohorts in Sweden, Germany, and Australia confirmed the link between bifidobacteria abundance, metabolite presence, and lower IgE levels.

## Bifidobacteria metabolite may prevent allergy and asthma in children

Researchers at the Technical University of Denmark have uncovered a bifidobacteria derived metabolite, 4 hydroxyphenyl lactate (4 OH

Lifestyle factors play a role too. Vaginally born infants were far more likely to acquire bifidobacteria from their mothers, while breastfeeding and early exposure to other children also boosted colonization. Yet modern lifestyles have reduced bifidobacteria prevalence, raising interest in preventive

strategies. Researchers propose probiotic supplementation or enriched infant formulas containing bifidobacteria or 4 OH PLA to restore protective gut microbiomes.

within a few years. If successful, it could reshape early life nutrition and allergy prevention, offering a science based way to reduce the burden of asthma and allergies in children.

<https://www.nutritioninsight.com/news/bifidobacteria-metabolites-infant-gut-allergy-asthma-risk.html>

Clinical trials are already underway in Denmark, with hopes that this approach could become a preventive strategy

## Research debunks view that calcium lowers pre-eclampsia risk during pregnancy



There is a major shift in understanding calcium supplementation during pregnancy.

Researchers at Stellenbosch University analysed data from over 37,000 participants across 10 large randomized controlled trials and found no evidence that calcium – whether at high or low doses – reduces the risk

of pre eclampsia.

Earlier claims of benefit were largely driven by small, lower quality studies and publication bias. Once those were excluded, the supposed protective effect disappeared. The review also found no meaningful differences in outcomes such as maternal death, preterm birth, or neonatal mortality.

with low intake levels. The authors stress that unreliable trials can distort systematic reviews and scientific consensus, underscoring the need for rigorous, transparent evidence before shaping policy.

In short, calcium remains important for general maternal health, but its role as a preventive measure against pre eclampsia is no longer supported by strong evidence.

<https://www.nutritioninsight.com/news/calcium-supplementation-pre-eclampsia-risk-review.html>

This challenges long standing assumptions and raises questions about current WHO guidance, which still recommends calcium supplementation in populations

## Probiotic restores gut microbiome as bifidobacteria decline in breastfed infants

PROBIOTIC  
THE ART OF BETTER MEDICINE

The study you're reading highlights how supplementation with *Bifidobacterium infantis* (specifically strain EVC001) can restore beneficial gut bacteria in exclusively breastfed infants, even beyond the newborn stage.

Researchers found that the probiotic thrives on human milk oligosaccharides (HMOs), allowing it to persist in the gut

after supplementation stops. This persistence challenges the assumption that it's "too late" to influence the infant microbiome after early infancy.

In a nine week randomized controlled trial with 40 infants, supplementation at low, medium, or high doses all led to significant increases in *B. infantis* levels compared to placebo. Importantly, the probiotic remained in the gut for at least a month after supplementation ended, regardless of dose. The abundance of bifidobacteria nearly doubled, showing that even short term supplementation can have lasting effects.

The findings are particularly relevant because in high resource regions like the US and Europe, bifidobacteria are declining in breastfed infants, raising risks for allergies, asthma, eczema, and dermatitis. By demonstrating that colonization can be restored past the newborn stage, the study suggests that probiotic supplementation could be a practical strategy to strengthen infant gut health and immune development in real world settings where timing and dosage vary.

<https://www.nutritioninsight.com/news/probiotic-b-infantis-restores-gut-microbiome-breastfed-infants.html>

## Key compound in dark chocolate may slow biological aging

The research you're reading highlights how theobromine, a natural compound found in dark chocolate, may be linked to slower biological aging.

Scientists at King's College London analysed blood samples from over 1,600 participants in the TwinsUK and KORA cohorts, measuring DNA methylation patterns — markers of biological age. They found that higher levels of theobromine

correlated with a younger biological age, suggesting that certain dietary compounds can influence longevity.

Theobromine is an alkaloid already known for potential cardiovascular benefits, but this study adds a new dimension by connecting it to epigenetic aging.

Importantly, the effect was specific to theobromine, not other cocoa or coffee metabolites. Researchers caution, however, that this is an observational association, not proof of causation. Excessive dark chocolate

consumption is not advised, since commercial products often contain sugar and fat that could offset health benefits.

Experts outside the study emphasize that while the findings are intriguing, stronger evidence from longitudinal and intervention trials is needed. The work does, however, reinforce the idea that plant compounds in everyday foods can interact with our genes and potentially shape long term health.

<https://www.nutritioninsight.com/news/dark-chocolate-slow-aging-theobromine.html>

## Vitamin C: Two kiwis a day shown to boost skin collagen and support cell renewal

The study shows that dietary vitamin C, rather than topical application, is the most effective way to boost skin collagen and renewal.

Researchers at the University of Otago found that consuming vitamin C rich foods raises plasma levels, which the skin then absorbs efficiently. They demonstrated that vitamin C

penetrates all layers of the skin, concentrating especially in collagen producing cells, and also supports epidermal regeneration by activating genes linked to cell renewal.

Two kiwifruit per day provided about 250 mg of vitamin C, which significantly improved skin thickness and structure in participants. The findings challenge the widespread use of topical vitamin C creams, since the compound is water soluble and poorly absorbed through the skin barrier. Instead, the body prioritizes vitamin C delivery to tissues that need it most, including the

skin, adrenals, and brain.

The researchers emphasize that vitamin C intake of around 200 mg daily — achievable through fruits like kiwifruit, oranges, guava, capsicum, broccoli, and berries — is sufficient to sustain skin health. Their conclusion is clear: nutrition from whole foods is the most reliable way to support collagen production and epidermal renewal, while expensive topical solutions are less effective.

<https://www.nutritioninsight.com/news/vitamin-c-foods-boost-skin-collagen-renewal.html>

## Three-quarters of global population is deficient in omega-3, signalling public health gap

The article highlights a major public health gap: 76% of the global population does not consume enough omega 3 fatty acids, specifically EPA and DHA.

Researchers from the University of East Anglia, the University of Southampton, and Holland & Barrett reviewed global recommendations and intake levels, finding that most people fall short of the advised 250 mg daily for adults, with pregnant women needing an additional 100-200 mg of DHA.

The review emphasizes that omega 3s are vital across all

life stages, supporting cardiovascular health, immune function, cognition, maternal health, and reducing risks of depression and cognitive decline. Yet inconsistent country level guidelines, low seafood consumption, sustainability concerns, and limited access to supplement advice keep intake critically low.

Experts argue that accessible, sustainable solutions are needed, such as enriched foods and algae based supplements, to close the gap. They also stress that while omega 3s are

essential, achieving recommended levels through diet alone is challenging, making supplementation an important tool. The findings are expected to inform future

nutrition policy and public health strategies worldwide

<https://www.nutritioninsight.com/news/global-omega-3-deficiency-gap.html>



**Scientists propose triple-nutrient "cocktail" for alleviating markers of autism in childhood**

The study describes how scientists at Academia Sinica in Taiwan tested a low dose combination of zinc, serine, and branched chain amino acids (BCAAs) in three different mouse models of autism.

The nutrients, when given together, improved social behaviours and reduced abnormal hyperactivity in the amygdala, a brain region linked

to emotional regulation. Importantly, the same low doses of each nutrient given individually had no effect, highlighting the synergistic nature of the "cocktail."

The researchers observed that the supplement mix restored synaptic protein expression in the autistic mice to resemble that of normal mice, suggesting improved neuronal connectivity. They argue that because autism involves hundreds of genes with distinct functions, a single target therapy is impractical, and a broad nutritional approach may be safer and more effective.

The findings, published in PLOS

Biology, support the idea that nutrition can act as an environmental factor influencing autism spectrum disorder. While dietary interventions for autism are still debated, this study adds to growing evidence that combinations of nutrients or microbiome focused strategies may help alleviate certain symptoms. The authors believe their approach could eventually be adapted for long term, practical use in children, though human trials would be needed to confirm the benefits.

<https://www.nutritioninsight.com/news/autism-supplements-zinc-serine-bcaa.html>



**New scientific principles address "highly-processed" gap in US dietary guidelines**

The Institute for the Advancement of Food and Nutrition Sciences has stepped into the debate over "highly processed" foods with nine guiding principles designed to bring scientific clarity to classification.

The move comes as the new US dietary guidelines urge Americans to avoid "highly processed" foods but stop short of defining what that means.

These principles challenge frameworks like Nova by insisting that processing and formulation be treated as distinct concepts. Processing refers to the methods used to transform raw agricultural products, while formulation describes how ingredients are selected and combined.

The authors argue that conflating the two has led to misclassification of nutrient dense foods such as whole grain bread or yogurt. They also emphasize that any classification system must be reproducible, transparent, and grounded in biological evidence linking food properties to health outcomes, rather than relying on associative logic.

Industry groups like the

Institute of Food Technologists and the soy sector have echoed these concerns, warning that vague terminology risks discouraging consumption of foods that are nutritionally beneficial. Soy stakeholders point out that fermentation and fortification are forms of processing that enhance nutrition and accessibility, not diminish it.

The regulatory landscape remains unsettled. The FDA and USDA are gathering data to develop a federal definition of ultra processed foods, while the WHO is working on global guidance. Consumer behaviour shows rising avoidance of processed foods, yet confusion persists about what qualifies as "ultra processed."

The IAFNS principles aim to bridge this gap by offering a framework that distinguishes between how foods are made and what they contain,

potentially reshaping how regulators, industry, and consumers interpret the term “highly processed.”

<https://www.foodingredientsfirst.com/news/iafns-food-classification-principles-upf-guidelines.html>

## What happens when patients stop using GLP-1 medications for weight loss?

When patients stop using GLP 1 medications like Ozempic, Wegovy, or Mounjaro, research shows several consistent outcomes:

### Weight Regain

- Most people regain weight quickly, often returning to their starting weight within 1-2 years.
  - Average regain is about 0.4 kg per month, faster than after behavioural weight loss programs.
  - This reflects obesity's nature as a chronic, relapsing condition rather than a short term problem.
- Muscle Mass & Nutrition
- Up to 40% of weight lost during GLP 1 treatment can be lean body mass, including muscle.

- Without structured nutritional support, patients risk muscle loss and nutrient deficiencies.
- High protein foods and companion products are being developed to help preserve or rebuild lean mass.

### Health Markers

- Cardiometabolic improvements (blood sugar, cholesterol, blood pressure) seen during treatment tend to return to baseline within ~1.4 years after stopping.
- This underscores the need for
- ongoing lifestyle support to maintain health gains.

### Role of Nutrition & Lifestyle

- Appetite suppression during treatment reduces food intake, making nutrient dense foods (protein, fibre, micronutrients) essential.
- Experts emphasize that GLP 1s are not a “magic fix” — they should be paired with diet quality, physical activity, and behavioural support.
- Post bariatric nutrition

principles (high quality protein, evenly distributed meals, nutrient dense foods) are recommended as a model.

### Implications for F&B Industry

- The rise of GLP 1 users is driving demand for protein rich, fibre enhanced, and functional foods to support long term weight management.
- Companies are innovating companion products (yogurts, shakes, fortified snacks) to meet these needs.

**Bottom line:** GLP 1 medications are highly effective for short term weight loss, but stopping them often leads to rapid regain unless paired with structured nutrition, exercise, and behavioural support. Long term success depends on building sustainable habits and nutrient dense diets alongside or after medication use.

<https://www.foodingredientsfirst.com/news/glp1-weight-regain-risks-studies.html>

## Brain boom: 3 ingredients boosting cognitive health

The global brain health food market is expanding rapidly, with a projected CAGR of 8.38% through 2029. Functional ingredients are at the centre of this growth, particularly those that support sleep, focus, and long term cognitive function.

Magnesium is emphasized as a key mineral for improving sleep quality, which in turn reduces

stress, prevents mood disruption, and alleviates brain fog. By enhancing rest, magnesium indirectly boosts cognitive performance and multitasking ability. Companies like Threotech are developing highly bioavailable magnesium formulations suitable for functional bars, beverages, gummies, and soft chews.

L theanine, an amino acid found in green tea, is another ingredient gaining traction. It enhances focus and memory while working synergistically with caffeine to avoid the crash often associated with

stimulants. Its solubility and neutral profile make it particularly effective in functional beverages, which are increasingly popular as convenient carriers of cognitive benefits.

Docosahexaenoic acid (DHA), an omega 3 fatty acid, plays a crucial role in brain development in children and maintenance in adults. Friesland Campina Ingredients highlights DHA's importance across age groups, noting that many people fail to consume enough due to taste or odor concerns.

Incorporating DHA into foods such as milk drinks and yogurts helps overcome these barriers, making it more accessible and appealing.

Together, these three

ingredients—magnesium, L theanine, and DHA—illustrate the diverse strategies companies are using to meet consumer demand for functional products that support brain health, with

beverages emerging as the dominant format for delivering these benefits.

<https://www.foodnavigator-usa.com/Article/2025/12/08/top-brain-health-ingredients-trends/>

## India urges cuts of oil, sugar in foods under anti-obesity plan

India's Food Safety and Standards Authority (FSSAI) is intensifying its efforts to combat obesity following Prime Minister Narendra Modi's call for dietary reform.

At its 47th Central Advisory Committee meeting, the authority urged states to implement a 10% reduction in oil consumption and expand public awareness campaigns. Modi's remarks in his Mann Ki Baat radio address identified excessive oil intake as a major contributor to obesity, prompting coordinated action across government, schools, and the food industry. Prominent figures, including politicians, actors, and athletes, have been nominated to lead awareness initiatives encouraging healthier eating habits.

One of the key measures is the introduction of "sugar boards" in schools, mandated by the Central Board of Secondary Education. These boards display

the sugar content of common foods and beverages, recommended daily limits, and the health risks of excessive sugar intake. The initiative is designed to instil healthier eating habits among children from an early age. The FSSAI has urged states to fully support this program, seeing it as a critical tool in reducing sugar consumption among schoolchildren.

India's obesity statistics underscore the urgency of these measures. The share of overweight children under five rose from 2.1% in 2015-2016 to 3.4% in 2019-2021, while 24% of women and 23% of men were overweight or obese. Studies highlight poor dietary habits, processed food consumption, sugary beverages, physical inactivity, and inadequate sleep as key drivers. The government has identified six major factors contributing to obesity, ranging from high calorie diets and processed food access to sedentary lifestyles and the widespread use of genetically modified crops.

To address these challenges, India has launched a multi pronged strategy. The Ministry

of Health and Family Welfare is strengthening public health responses through improved screening and awareness campaigns. The Ministry of Ayush is promoting traditional wellness approaches such as Ayurveda, yoga, and personalized diets. Childhood obesity prevention is being advanced through the Poshan Abhiyaan program, while the Fit India Movement encourages schools to integrate physical activity into daily routines. The FSSAI's Eat Right India initiative complements these efforts with mandatory front of pack labelling for high fat, sugar, and salt foods, introduced in 2024, to help consumers make informed choices.

Together, these measures reflect a comprehensive national plan to reduce obesity by reforming food choices, promoting fitness, and encouraging healthier lifestyles. Modi's call for small but consistent changes in dietary habits is positioned as a pathway to a stronger, fitter, and disease free future.

<https://www.foodnavigator-asia.com/Article/2025/08/05/fssai-backs-pm-modis-obesity-plan-with-push-to-cut-oil-and-sugar/>

## Short-term oatmeal diet reduced cholesterol by changing gut microbiome

A recent study from the University of Bonn has shown

that a short-term, intensive oatmeal diet can significantly reduce harmful cholesterol levels by altering the gut microbiome.

In the trial, participants with metabolic syndrome consumed 300 grams of oatmeal daily for two days, replacing their usual Western diet. This intervention lowered LDL cholesterol by about 10 percent, a meaningful reduction though not as strong as modern medications.

The effect was linked to changes in gut bacteria, which broke down oats into phenolic compounds such as ferulic acid that help regulate cholesterol metabolism and reduce insulin resistance.

The researchers compared this short, high-dose intervention with a longer six-week program where participants replaced just one meal per day with oatmeal. While both

approaches improved cholesterol levels, the intensive two-day "oat days" proved more effective at quickly improving metabolic health.

Stool and blood samples revealed that oatmeal increased beneficial gut bacteria and enhanced kidney function in clearing pro-inflammatory molecules, supporting overall metabolic balance.

The findings suggest that periodic short-term oat-based diets could be a practical way to maintain healthy cholesterol levels and reduce diabetes risk, though further studies are needed to confirm long-term benefits.

<https://www.nutritioninsight.com/news/oatmeal-metabolism-diabetes-gut-microbiome-calories.html>

## Industry insights on reshaping nutrition for the GLP-1 consumer

The GLP 1 era is reshaping nutrition strategy. Companies are moving away from simply launching new SKUs and instead focusing on reformulating existing products to be more nutrient dense, protein rich, and fibre forward.

Novonesis frames this evolution in three horizons: today's reformulation, near term enzyme enabled tweaks to

improve bioavailability, and long term precision designed proteins tailored to individual needs.

WellVine sees this as a once in a generation opportunity, showing how indulgent products like chocolate can be reimaged with prebiotic grape extracts. ofi emphasizes "mindful indulgence," where smaller portions are packed with more nutrition, aligning cocoa and coffee with wellness goals.

Ingredion highlights reformulation as the most practical path forward, given retailer shelf space constraints, while stressing the importance

of responsible, science backed health claims.

Across the board, the message is clear: innovation in GLP 1 aligned nutrition will take time, investment, and collaboration.

Larger companies have the resources to scale but are cautious, while smaller players bring agility and creativity but often lack capital.

Those who succeed will be the ones who combine rigorous science with transparency and adapt to shifting consumer expectations.

<https://www.nutritioninsight.com/news/glp1-nutrition-innovation-novonesis-ingredient-ofi-wellvine.html>

## This new sugar tastes like the real thing without the usual downsides

# FOOD SCIENCE & INDUSTRY NEWS

Scientists at Tufts University have developed a highly efficient biosynthetic method to produce tagatose, a rare sugar that tastes almost identical to table sugar but with far fewer health drawbacks.

Tagatose occurs naturally in small amounts in dairy products and certain fruits, but its scarcity has made large-scale production difficult. Traditional manufacturing methods are costly and inefficient, typically yielding only 40 to 77 percent. The Tufts team overcame this by engineering *E. coli* bacteria to act as microscopic factories. They introduced a slime mould enzyme, galactose-1-phosphate-selective phosphatase (Gal1P), which allows the bacteria to generate galactose directly from glucose. This galactose is then converted into tagatose by

arabinose isomerase. The process achieves yields as high as 95 percent, making production far more economical.

Tagatose delivers about 92 percent of the sweetness of sucrose while containing roughly 60 percent fewer calories. It is recognized by the FDA as generally safe for use in food products. Unlike conventional sugar, tagatose is only partially absorbed in the small intestine, with much of it fermented by gut bacteria in the colon. This results in minimal effects on blood glucose and insulin levels, making it particularly promising for people with diabetes. Research also suggests that tagatose may support oral health by limiting cavity-causing bacteria and may promote beneficial gut microbes. Beyond its health

advantages, tagatose functions as a bulk sweetener, meaning it can replicate sugar's physical properties in cooking and baking. It browns when heated and provides a similar flavour and mouthfeel to sucrose, unlike many high-intensity sweeteners that fail to mimic sugar's texture.

The key innovation lies in reversing a natural biological pathway to generate galactose from glucose, opening the possibility of producing not only tagatose but other rare sugars more efficiently. This breakthrough could reshape the sweetener industry by offering healthier, natural-feeling alternatives to conventional sugar and artificial substitutes, with wide-ranging implications for nutrition, oral health, and food manufacturing.

<https://www.sciencedaily.com/releases/2026/01/260112214302.htm>

## Ready-to-stir whey ingredient for protein-enriched medical nutrition

Arla Foods Ingredients has introduced a new whey protein solution designed to improve medical nutrition by making protein supplementation more convenient and appealing for patients.

The product is a ready to stir beta lactoglobulin ingredient that delivers 10 grams of

protein per 100 milliliters and dissolves in just 30 seconds in warm or cold liquids. Unlike traditional medical nutrition products, which often come in heavy, milky formats that patients find unpalatable, this solution allows for lighter juice style options as well as milky alternatives, broadening the range of choices for patients with reduced appetites.

The innovation addresses a critical issue in healthcare: disease related malnutrition. The World Health Organization estimates that up to half of

hospital patients suffer from malnutrition, which is linked to longer hospital stays, poorer recovery, and higher mortality. Because many patients struggle to consume enough protein, Arla's new ingredient is formulated to be high in all nine essential amino acids and particularly rich in leucine, which stimulates muscle protein synthesis and helps prevent muscle loss. Its flexible powder format also allows healthcare providers to adjust dosage easily by changing the amount of water added, making it adaptable to individual patient needs.

Arla emphasizes that the product offers a refreshing taste with low bitterness and viscosity, enabling better compliance among patients. It can be incorporated into nutritionally complete or incomplete applications,

including juice style drinks, milky beverages, or even mixed into foods like porridge and soup. By expanding the range of textures and flavours available in medical nutrition it aims to improve patient adherence and support recovery, particularly

for those at risk of muscle wasting due to illness or reduced appetite.

<https://www.nutritioninsight.com/news/arla-foods-ingredients-blg-medical-nutrition.html>

## AI and plant-based innovation redefine guilt-free treats

The confectionery market is evolving into a space where indulgence and wellness coexist.

Manufacturers are increasingly focused on plant-based, sugar-free, and protein-rich formulations, while texture and flavour complexity remain the decisive factors for consumer satisfaction. Between 2020 and 2025, global launches rose by 7%, reflecting steady demand even as health-conscious preferences reshape innovation.

Protein inclusion is driving growth, with solutions addressing the challenge of maintaining softness in high-protein bars. Plant-based options are gaining traction, particularly gummies and

chocolates, which consumers perceive as healthier but still expect to deliver on taste and mouthfeel. Sugar reduction is another critical area, with stevia, allulose, polyols, and fibres layered to replicate sugar's sweetness and texture. Clean label claims and "no added sugar" formulations are becoming more important as regulations tighten.

Texture and multisensory experiences are central to premium appeal. Consumers gravitate toward contrasts—crisp chocolate snaps, chewy gummies, and layered textures that combine airy, soft, and crunchy elements. Flavour innovation is equally dynamic, with "savoury" crossovers like sweet-salty, sweet-spicy, and umami-forward profiles gaining popularity.

Technology and sustainability are shaping the future. AI is being used to decode consumer preferences and accelerate recipe development, particularly for sugar-reduced

and protein-enriched products. At the same time, responsible sourcing and eco-ethical positioning are becoming essential as climate pressures affect supply chains. HFSS advertising restrictions will further push reformulation toward healthier profiles.

Consumer insights highlight the importance of texture, with nearly 80% saying it determines satisfaction, and reduced-sugar claims influencing purchase decisions across regions. Yet variety remains limited, where many consumers feel sugar-free options lack excitement, opening opportunities for fruit-based and naturally sweet innovations.

Overall, confectionery is moving toward a model where indulgence is preserved but redefined through health, sustainability, and personalization, creating a new generation of guilt-free treats.

<https://www.foodingredientsfirst.com/news/confectionery-market-2026-indulgence.html>

## Cocoa prices ease but alternatives and reformulation stay in focus

Cocoa markets have entered a new phase in early 2026, with prices easing more than 10% year on year after years of volatility.

Favourable weather in Côte d'Ivoire and Ghana has lifted harvest expectations, giving exporters confidence to lock in future contracts and stabilize revenues. Daily prices in January hovered around US\$5,400–6,000 per ton, down from the record highs of 2024–25. Analysts expect surpluses in the 2025/26 and 2026/27 seasons, though

volatility will remain due to erratic weather, low liquidity, and geopolitical tensions.

The EU Deforestation Regulation is reshaping supply chains, requiring traceability back to land of origin and due diligence to ensure cocoa is not linked to deforestation after 2020.

Large companies must comply by December 2026, smaller ones by mid 2027, which could raise costs and burden smaller exporters.

Industry players are adapting in different ways. Barry Callebaut is reportedly considering separating its cocoa division to reduce exposure to price swings. Meanwhile, chocolate makers are reformulating products, shrinking pack sizes, and exploring cocoa alternatives. Cargill's NextCoa, made from grape and sunflower seeds, is one example of innovation aimed at reducing reliance on cocoa. Nestlé and Pladis have already

reformulated bars with lower cocoa content, leading to regulatory changes in how products can be labelled in the UK.

Global production is diversifying beyond West Africa. Ecuador is expanding rapidly and may surpass Ghana as the second largest producer, while Peru, Brazil, Uganda, Tanzania, and parts of Southeast Asia are also increasing output. Analysts warn that overplanting could lead to a price collapse by 2027/28, though climate change and disease pressures will eventually temper supply. On the demand side, high retail prices, shrinkflation,

reformulation, and even changing consumer habits linked to GLP 1 weight loss drugs are weighing on chocolate consumption. Demand recovery is expected only once prices decline further in 2025/26.

Overall, while cocoa prices have eased, the industry remains focused on hedging, reformulation, and alternatives to navigate ongoing volatility, regulatory pressures, and shifting consumer dynamics.

<https://www.foodingredientsfirst.com/news/cocoa-prices-ease-but-alternatives-and-reformulation-stay-in-focus.html>



Functional beverages are entering 2026 as one of the fastest moving categories in food and drink, evolving well beyond hydration into holistic wellness.

The focus is on immunity, gut health, cognitive function, stress relief, and nutrient density, with formats ranging from prebiotic sodas to protein enriched drinks and better for you energy alternatives.

Immunity centric drinks like kombucha, kefir, and probiotic waters remain popular,

reflecting consumer awareness of the gut-immune connection. Adaptogens and nootropics are increasingly integrated into beverages for mental clarity and stress reduction, with ingredients such as lion's mane, cordyceps, chamomile, and ashwagandha appearing in sparkling waters, teas, and energy drink hybrids.

Protein is another growth driver. Egg based prototypes, high protein dairy concepts from Arla, and sunflower protein innovations from Tetra Pak illustrate how companies are diversifying sources to meet demand for nutrient dense, convenient formats. Post workout recovery drinks and protein fortified everyday beverages are expanding rapidly.

Clean label expectations and

regulatory pressures are reshaping the energy drink segment, pushing brands toward natural caffeine sources like yerba mate and calming botanicals rather than synthetic stimulants. At the same time, GLP 1 medication users are emerging as a new consumer group, seeking nutrient dense, fibre rich, and protein enhanced beverages tailored to their reduced appetite and digestive needs.

Overall, 2026 is set to be a year of rapid innovation in functional drinks, with growth driven by wellness positioning, ingredient transparency, and the blending of nutrition with convenience and sensory appeal.

<https://www.foodingredientsfirst.com/news/functional-beverages-health-wellness-trends.html>



The article you're viewing highlights how mango leaf extract is emerging as a caffeine free alternative in energy drinks.

Unlike caffeine, which

dominates 85% of global energy drink formulations, it works by inhibiting the COMT enzyme, helping maintain higher levels of neurotransmitters like dopamine and adrenaline for up to five hours —

roughly double the duration of caffeine.

Nine clinical trials back its benefits, showing improvements in reaction time, attention, concentration, memory, physical recovery, and even pain perception, all without the jitteriness or sleep disruption associated with caffeine. A recent study in university students found significant gains in processing speed, task handling, and mood

with a 100 mg dose of the water soluble formulation.

The ingredient's water soluble version is particularly important for beverage applications, offering neutral taste, heat stability, and cost efficiency. This makes it versatile for energy drinks, shots, RTDs, and gummies, aligning with clean label and sugar free trends.

It is sourced sustainably from mango leaves, a by product of

mango cultivation, and processed via aqueous extraction. Its dual cognitive and physical performance benefits position it as a "smart, sustained energy" solution for diverse consumer groups — from students and gamers to athletes and busy professionals — at a time when demand for natural, functional energy is accelerating.

<https://www.foodingredientsfirst.com/news/mango-leaf-extract-caffeine-alternative.html>

## Ageing Asia: Food and nutrition takeaways for industry action

The Growth Asia Summit panel distilled healthy ageing in Asia into three interconnected insights.

First, nutrition is a lifelong process: it is never too early to begin eating well, and never too late to make positive changes. Epigenetics show that environmental factors can influence ageing, so even late interventions matter. Yet the paradox remains—calorie restriction may extend life, but risks malnutrition if nutrients are not preserved. The industry's challenge is to create nutrient-dense, low-calorie

foods that support longevity without compromising health.

Second, consumers increasingly demand holistic solutions that deliver visible results quickly. Current offerings often focus on single ingredients or isolated benefits, but the body functions as an interconnected system. While "food as medicine" is a promising concept, it remains vaguely defined. To resonate with mainstream consumers, nutrition solutions must integrate multiple ingredients and demonstrate tangible, whole-body benefits.

Third, social context is the missing link in Asia's healthy ageing narrative. Research shows that ageing well depends not only on diet and physical health but also on social connections and emotional wellbeing. Many seniors in Asia have digital networks but lack

close offline relationships. Products and experiences that foster social interaction, alongside nutrition, are crucial. Beyond consumer health, the economic dimension is significant: ageing populations will work longer, yet older workers remain underutilized despite their experience.

Together, these insights highlight that healthy ageing in Asia requires a blend of science, innovation, and social engagement. The food and nutrition industry must move beyond isolated solutions to embrace integrated approaches that nourish the body, deliver visible results, and strengthen social bonds.

<https://www.foodnavigator-asia.com/Article/2025/10/31/ageing-asia-3-expert-food-and-nutrition-takeaways-for-industry-action/>

## What's next for chocolate? Key trends shaping a \$184bn market

The global chocolate market, currently valued at \$123

billion, is projected to reach \$184 billion by 2033.

The cocoa crisis and volatile supply chains are pushing manufacturers to rethink sourcing and production, while consumer tastes are evolving rapidly, sometimes with short-lived fads like Dubai chocolate.

Premiumisation is emerging as a dominant theme, with demand rising for single-origin, bean-to-bar, and high-cacao formats that emphasize authenticity, craftsmanship, and ethical sourcing. At the same time, chocolate is being redefined as a health-conscious indulgence,

with functional inclusions such as protein, superfoods, and adaptogens, alongside sugar-free, organic, and vegan options. Europe remains the largest market, but the Middle East and Africa are expected to lead growth, followed closely by Asia Pacific, driven by rising incomes and expanding retail networks.

Innovation is increasingly

focused on sensory-rich experiences and functionality, with exotic flavours, dessert-inspired bars, portion-controlled luxury minis, and plant-based milk chocolates gaining traction. A particularly disruptive trend is the rise of cocoa-free alternatives made from carob, fermented grains, and upcycled ingredients, which promise supply chain resilience, lower environmental impact, and novel

flavour profiles.

The future of chocolate is complex but full of opportunity, blending premium indulgence, health-driven formats, regional expansion, and sustainability-focused innovation, while challenging the industry to preserve the essence of chocolate even as its definition evolves.



## Formulating for Functional Benefits

IFT.org explores how the functional food market has evolved from simple fortification toward products designed for specific health benefits.

It emphasizes that while protein continues to dominate product launches, most consumers already meet or exceed their protein needs, making fibre a more pressing nutritional gap. Fiber is highlighted as a versatile ingredient that supports gut health, heart health, and blood sugar control, with “fibremaxxing” emerging as a new trend.

The piece also examines the growing popularity of ingredients such as collagen, prebiotics, nootropics, cannabidiol, adaptogens, and functional mushrooms like lion’s mane and cordyceps. These are increasingly being incorporated into everyday foods and beverages to deliver benefits ranging from cognitive support to stress relief and hormonal balance.

A recurring theme is consumer scepticism. Shoppers are becoming more critical of front-of-package claims, often relying on ingredient lists and apps to verify product efficacy. The practice of “fairy dusting”—adding trendy ingredients in negligible

amounts—is losing credibility as consumers demand clinically validated doses. The taste and enjoyment remain essential; functional benefits alone are not enough to sustain consumer loyalty.

Overall, the narrative portrays a marketplace in transition, where functional foods are expected to deliver measurable health outcomes without compromising flavour, and where transparency and scientific backing are increasingly decisive factors in consumer trust.

<https://www.ift.org/news-and-publications/food-technology-magazine/issues/2025/november/features/formulating-for-functional-benefits>



## What's coming after stevia? New sweeteners on the horizon

The sugar reduction technologies beyond stevia, which has long dominated the natural sweetener market but struggles with a bitter aftertaste.

Consumers increasingly demand low calorie, natural options that taste good without compromise, and several start ups are working to meet that challenge.

From Peru, Yacon & Co is developing yacon syrup, derived from the Andean tuber known as the Peruvian ground apple. The syrup contains half the calories and one quarter the sugar of regular sugar, while also delivering gut

friendly fibre. It has applications in bakery, dairy, and beverages, offering both sweetness and functional benefits.

In Italy, Coccola is creating a non synthetic sweetener from coconut milk and coconut water powders. Beyond sweetness, it provides electrolytes, proteins, and minerals, positioning itself as a functional ingredient that hydrates, energises, and

nutrient absorption in drinks like coffee and smoothies.

The UK start up Zya takes a different approach with its enzyme Convero, which transforms about 30% of consumed sugar into prebiotic fibre during digestion. This allows consumers to enjoy the taste of sugar while reducing net sugar intake and boosting gut health, without altering recipes.

Finally, Finland's Gova is tackling the aftertaste problem with encapsulation technology. It blends erythritol with sugar or other sweeteners to create hybrid solutions that avoid bitterness. Gova has even produced a prototype of sugar free white chocolate, demonstrating the potential of its method.

Together, these innovations reflect a new phase in sugar reduction: products must not

only cut calories but also taste good, deliver functional benefits, and fit clean label expectations. If they succeed in real food and drink applications, they could reshape the sweetener landscape and challenge stevia's dominance.

<https://www.foodnavigator.com/Article/2025/12/04/new-sweeteners-for-sugar-reduction-innovation/>

## How affordable indulgence is driving APAC snack market

The "affordable indulgence" is reshaping the Asia Pacific snack market, with consumers increasingly drawn to products that balance taste, creativity, and value.

After a downturn in 2022 caused by rising ingredient costs, particularly in confectionery, the sector rebounded as brands introduced "affordable premium" offerings positioned between mass market and luxury segments. Chocolate has remained resilient despite high cocoa prices, largely due to packaging innovation that allows smaller, more accessible pack sizes. In 2024, 79% of chocolate confectionery in Asia Pacific

was sold in the 0-50g range, far above the global average of 55%, underscoring the importance of portion control in sustaining demand.

Consumer behaviour has shifted toward mindful spending, with fewer impulse purchases and more pre planned expenditure. This trend is pushing brands to rethink retail strategies, moving beyond traditional in store triggers toward digital engagement earlier in the shopping journey. While affordability remains central, taste has emerged as a powerful differentiator, with 35% of consumers prioritizing superior flavour alongside value. Indulgence is being redefined as accessible experience rather than luxury excess, with smaller, premium feeling products resonating strongly.

Vietnam and the Philippines are projected to lead regional

growth, driven by population increases and cultural practices that integrate snacks into social occasions. Confectionery and ice cream are expected to deliver the strongest value growth, with ice cream expanding per capita consumption despite cold chain limitations. Innovations such as mochi ice cream in Indonesia highlight the role of novelty and indulgence in driving demand. Overall, the market is entering a phase of "smart indulgence," where consumers continue to treat themselves but do so mindfully, seeking products that combine affordability, taste, and innovation. This approach is expected to sustain momentum through 2026 as brands adapt to evolving consumer expectations.

<https://www.foodnavigator.com/Article/2026/01/07/how-affordable-indulgence-is-driving-apac-snack-market/>

## 'India is ready for cultivated meat': Start-up to debut 'competitively priced' 3D-printed chicken

Biokraft Foods, a biotech start up founded in 2023, is preparing to launch 3D printed cultivated chicken in India, positioning itself as one of the country's first movers in this emerging food category.

The company's survey data

indicates strong consumer openness, with 60% willing to try cultivated meat and nearly half prepared to pay a premium. Its pricing strategy aims to match the B2B premium chicken market at Rs300-350 per kilogram, competitive with

traditional premium chicken costs, thanks to the efficiency of 3D bioprinting technology. This approach allows precise replication of natural textures and reduces waste, making production more scalable and cost effective.

The firm is initially targeting Tier 1 cities such as Mumbai, Pune, and Panaji, collaborating with restaurants to introduce the product. Chicken was chosen as the entry point given its widespread popularity among India's non vegetarian population. Positive feedback from India's first formal tasting event, where participants sampled chicken sliders and

Indo Chinese chilli chicken, reinforced confidence in consumer readiness. Biokraft is now working with the Food Safety and Standards Authority of India to secure regulatory approval under the novel foods category, with expectations of a six to eight month process.

Beyond chicken, Biokraft plans to expand into seafood and establish an independent R&D and production facility to enhance scalability. The company uses immortalised chicken cells cultivated on algal and plant based polymers, which are then 3D printed into meat like structures. Industry observers view these

developments as a significant step toward sustainable food innovation in India, potentially positioning the country as a global player in cultivated meat technology. The firm intends to continue hosting tasting events to build consumer familiarity and refine its products based on feedback.

<https://www.foodnavigator-asia.com/Article/2025/02/03/sixty-percent-of-consumers-in-india-are-willing-to-consume-cultivated-meat-and-46-percent-would-pay-a-premium-for-it-according-to-a-survey-by-biokraft-foods-a-biotech-start-up-aiming-to-leverage-this-interest-by-launching-3d-printed-chicken-in-2025/>

## Texture trends that will define bakery & snacks in 2026

The article highlights how texture has become the defining attribute for bakery and snack innovation in 2026, moving from a supporting role to the central driver of indulgence and consumer satisfaction.

With portion sizes shrinking and reformulation pressures rising, texture is now the fastest way to deliver emotional reward and satiety. Data from Puratos, Nestlé USA, Circana, Innova, and Datassential consistently shows that younger consumers, especially Gen Z and Millennials, view texture as equally important as flavour, and often more influential in shaping cravings and purchase decisions.

The shift is toward multi sensory, contrast driven experiences rather than single

note formats. Consumers actively seek novelty through combinations such as soft with crunchy, creamy with flaky, or chewy with crisp, which keep eating engaging even in smaller portions. Candy has become a testing ground for texture innovation, with peelable gummies, freeze dried formats, and interactive coatings inspiring bakery and snack makers. Crunch, once a differentiator, is now a baseline expectation, with precision in crispness and clean breaking required. At the same time, soft, creamy, and velvety textures are surging, offering comfort and compensating for reduced sugar or protein fortification.

Layered formats are gaining traction as indulgence shortcuts, creating variety and perceived generosity while also enhancing visual appeal and premium positioning. Texture language itself has become a marketing tool, with descriptors like "goeey," "pillowy," and "melty"

managing consumer expectations and reducing disappointment risk. Texture is also being strategically engineered to mask reformulation trade offs, with creaminess offsetting bitterness, crunch distracting from reduced sweetness, and chew adding satiety cues. Interactive textures that invite peeling, dipping, or snapping are driving shareability and emotional connection, particularly among younger consumers.

Poor texture, however, leads to "silent quitting," where consumers simply abandon products without complaint, making mouthfeel a critical factor in repeat purchase. Overall, texture in 2026 is not just an enhancement but the core of indulgence, satisfaction, and loyalty in bakery and snacks.

<https://www.foodnavigator-asia.com/Article/2026/01/13/10-texture-trends-that-will-define-bakery-snacks-in-2026/>



## Cell-cultured Cacao

Kokomodo, a cell cultured cacao start up, is positioning itself as a solution to the ongoing volatility in global cocoa markets, where climate change, crop disease, and political instability have driven record price spikes and supply shortages.

Its approach involves growing real cacao from plant cells in bioreactors, producing climate proof, customizable ingredients that can be harvested continuously rather than seasonally.

CEO Tal Govrin emphasizes that Kokomodo's technology is not limited to food but extends to beverages, cosmetics, and nutraceuticals, where

consistent access to cacao and its bioactive compounds is increasingly valued. The company is collaborating with global ingredient suppliers and retailers, including a Swiss partner on premium chocolate projects, and is beginning to explore functional applications in health and wellness. Govrin notes that texture is becoming a key area of interest, with clients seeking ingredients that behave differently under varying conditions, while the firm's processes also allow enhancement of bioactive qualities absent in traditional cacao.

The broader context is one of manufacturers struggling with rising costs and reformulation challenges, with some brands reducing cacao content to the point of losing the legal right to market products as

"chocolate." Govrin argues that while alternative cacao products may find a place in coatings and flavourings, they cannot replicate the complexity of real cacao, which contains over 300 molecules contributing to its taste. Kokomodo's advantage lies in producing authentic cacao that can be tailored to specific needs and harvested every few days, offering resilience against climate and supply disruptions.

This combination of authenticity, adaptability, and scalability is seen as the company's pathway to growth and as a potential milestone in redefining the future of chocolate and cacao based industries.

<https://www.foodnavigator-asia.com/Article/2026/01/07/kokomodo-rises-as-cocoa-crisis-fuels-demand-for-cellgrown-cacao/>



## Trends shaping healthy dairy snacking

The article outlines how dairy is emerging as a strong contender in the healthy snacking market, driven by consumer demand for convenient, nutrient dense options that support wellness goals.

Globally, the category is valued at over \$108 billion and is projected to nearly double by 2035, with the U.S. market alone generating \$5 billion in sales and growing at a CAGR of 9.3%. This growth is anchored in dairy's natural protein content, satiety benefits, and versatility across formats.

Protein remains the leading

driver, with products like skyr, strained yogurt, cottage cheese, and high protein cheese bites gaining traction among consumers focused on weight management and holistic health. Fermented dairy is also moving mainstream, with kefir and probiotic beverages expanding rapidly as gut health becomes a top priority. Sugar reduction and clean labels are reshaping categories such as flavored milk, yogurt, and creamers, with brands simplifying ingredient lists to appeal to health conscious buyers. Snackification of meals is another trend, with formats like yogurt pouches and cheese bites serving busy lifestyles, while technological advances such as microencapsulation enable functional ingredients to move beyond refrigerated products.

Finally, sustainability is increasingly intertwined with health, as consumers favor brands offering organic, regenerative, or grass fed claims, alongside innovations like upcycled whey and eco friendly packaging.

Together, these trends show dairy's ability to deliver protein, functionality, and indulgence in formats that align with modern snacking habits. The category is positioned to thrive as consumers seek foods that balance convenience, nutrition, and sustainability in their daily routines.

<https://www.foodnavigator-asia.com/Article/2026/01/19/top-5-healthy-dairy-snacking-trends-in-2026/>



## Plant-based struggling? Here's how to win at hybrid

The article explores how hybrid meat and dairy strategies are evolving as plant based products struggle to maintain momentum.

Early hybrid products often promoted a 50/50 split between animal and plant ingredients, but this balance is shifting. Start ups such as Maash argue that higher meat ratios of 70-90% deliver better taste and texture, with plant components playing a supporting role. Other suppliers, like Beneo, recommend a gradual approach, introducing small

amounts of plant based ingredients step by step to help consumers adapt, similar to how sugar or salt reduction is managed in reformulation.

Another key development is the way hybrids are marketed. Companies such as PlanetDairy avoid using the word "hybrid" on packaging, believing it confuses consumers or risks alienating both dairy loyalists and plant based adopters. Instead, they present products as cheese or milk with added plant elements, keeping the focus on familiarity. Messaging around sustainability is also being downplayed.

While reduced emissions matter to retailers and regulators, consumers are more motivated by taste, texture, and functionality. PlanetDairy's acquisition of plant based cheese maker StockeldDreamery's intellectual property reflects this emphasis,

particularly on improving meltability, a critical technical challenge in dairy alternatives.

Overall, the hybrid category is being reshaped by four strategies: moving away from equal splits toward meat forward ratios, adopting gradual formulation changes, avoiding overt hybrid branding, and prioritizing taste and texture over sustainability claims.

These shifts suggest that hybrids are finding their footing not as a compromise between meat and plants, but as a pragmatic way to deliver quality, familiarity, and incremental change in a market where pure plant based products have faltered.

<https://www.foodnavigator-asia.com/Article/2026/01/21/strategies-to-win-in-hybrid-meat-and-dairy/>



## Asia's alt protein roadblocks

The study conducted by researchers at Nanyang Technological University highlights why Asia has been slow to embrace alternative proteins despite its immense protein needs.

Surveying over 1,000 participants, the research found that perceived health and nutritional benefits are the strongest and most consistent driver of consumer acceptance. Messaging that emphasizes these benefits early on has durable impacts, with acceptance levels remaining

higher months later.

This correlation is particularly strong for plant based and fungi based proteins, but less so for insect protein. In fact, insect protein initially scored highest in acceptance due to novelty and social desirability, but dropped sharply over time as the reality of consumption set in.

The findings also show that food safety, often the focal point of regulatory discussions, is no longer sufficient to attract consumers. Safety is now seen as a baseline expectation rather than a selling point.

To build long term acceptance, regulators and companies must reduce food technology

neophobia and highlight positive justifications for choosing alternative proteins.

Strategies include transparent sourcing, religious clarifications, sample tastings, and clear communication of benefits.

The study concludes that acceptance will grow only if messaging leads with benefits, supports them with safety assurances, and actively works to normalize new technologies, rather than relying solely on the argument that these foods are safe.

<https://www.foodnavigator-asia.com/Article/2026/01/26/asias-alt-protein-roadblocks-key-study-insights/>

## Maeva unveils metabolic wellness brand for personalized GLP-1 support

Maeva has introduced a new metabolic wellness brand specifically designed to support individuals using GLP 1 medications, such as Ozempic, by addressing nutritional gaps that often arise during rapid weight loss.

The product line is built around customizable nutrition solutions intended to prevent muscle loss, nutrient deficiencies, and declines in energy. The core of Maeva's offering is a set of gender specific protein shakes. For men, the shakes include creatine to support lean muscle and energy, along with KSM 66 ashwagandha to help maintain healthy testosterone levels.

Each serving provides 230 calories and 25 grams of plant protein. For women, the shakes feature collagen peptides, hyaluronic acid, iron, and B complex vitamins to support hair, skin, bone, and muscle health, with 200 calories and 20 grams of plant protein per serving.

Maeva also offers targeted "Boosters" that can be mixed directly into the shakes to personalize nutrition. The Beauty booster contains collagen peptides, vitamin C, hyaluronic acid, biotin, and a superfood powder fermented from more than 50 plant sources. The Energy booster includes taurine, tyrosine, carnitine, B vitamins, and S7 powder, a plant based ingredient shown to increase nitric oxide production. The Gut Health booster combines

probiotics, sea moss, digestive enzymes, inulin, and mushroom powders to support microbiome balance. Additionally, Maeva provides electrolyte sachets with probiotics for hydration and gut wellness. The brand launches with a subscription first model, offering curated starter kits to encourage long term habits. Co founders Steven and Dean Neiger emphasize that Maeva was created to fill a gap in nutrition support for GLP 1 users, aiming to redefine weight loss support by focusing on nourishment rather than restriction. The approach reflects a growing secondary market around GLP 1 therapies, where nutrition and pharma are increasingly merging to provide holistic solutions for metabolic health.

<https://www.nutritioninsight.com/news/maeva-glp-1-weight-loss-personalized-nutrition-metabolism.html>

## Innovative ways to serve GLP-1 users- for today and tomorrow

The article outlines four distinct innovation pathways emerging to serve consumers using GLP 1 medications, a fast growing demographic with unique nutritional needs.

The first approach focuses on slow release nutrition to counter the risk of malnutrition caused by reduced appetite. Eden Brewery in Australia is developing technology based on casein micelles that can gradually release nutrients such as iron, magnesium, zinc, protein, and fibre over several hours, ensuring each bite delivers maximum nutritional value.

The second pathway addresses nutritional gaps and gut

health challenges. Remedy Health has created Collagen+ Gut gummies under its Nourished brand, combining collagen with pre, pro, and postbiotics, plus vitamins C and D3, to support digestive health and muscle maintenance. The company is also exploring gummies that stimulate natural GLP 1 secretion, offering satiety without pharmaceutical intervention.

The third innovation has launched Boost Pre Meal Hunger Support drinks. These beverages deliver 35 grams of protein, fibre, and 25 vitamins and minerals in a single serving. To overcome formulation challenges like viscosity and mouthfeel, it uses proprietary whey protein microgel technology, resulting in a smooth, milkshake like texture that avoids the chalkiness often associated with high protein drinks.

The fourth pathway emphasizes nutrition standards across all categories rather than focusing on single hero products. Nutrition consultant Maha Tahiri advocates for systemic innovation that ensures nutrient density, fibre diversity, microbiome support, and behavioural cues across soups, bars, beverages, and other foods. Drawing from her own experience as a GLP 1 user, she stresses the importance of products that help structure eating habits and prevent nutritional deficiencies.

Together, these approaches illustrate how the food industry is moving beyond simple product launches toward comprehensive strategies that combine functionality, taste, and nutritional completeness for GLP 1 users.

<https://www.foodnavigator.com/Article/2025/12/01/food-innovations-for-glp-1-users/>

## Nutri-Score 'most effective' nutrition label

The study conducted in Riyadh demonstrates that Nutri-Score is the most effective front-of-pack nutrition label for Saudi consumers compared to other internationally recognized systems.

Over the course of a year, more than 2,500 adults participated in trials where they ranked products with and without labels. Nutri-Score's five-colour scale consistently enabled participants to identify healthier options more quickly and accurately than formats such as Guideline Daily Amounts, Traffic Lights, Health Star Ratings, or Chilean Warning Octagons. Its summary design and intuitive colour coding reduced the cognitive effort required, leading to nearly twice the likelihood of choosing healthier products compared to GDA, with particularly strong improvements in categories like cereals and chicken nuggets. Comprehension gains were also striking, with participants using Nutri-Score almost six times



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more likely to correctly rank products by healthiness than those without labels.

The findings are significant given Saudi Arabia's rising obesity and diet-related disease rates, with nearly one in four adults classified as obese and more than 80% exceeding recommended fat intake. Current labelling initiatives, such as calorie counts in restaurants, have not yet extended to packaged foods, leaving a gap in consumer guidance. The study highlights that while labels improve decision-making, their effectiveness is shaped by demographics: higher education and nutrition knowledge correlated with better outcomes, while younger and lower-income groups benefited less. Awareness gaps remain substantial, with many consumers unfamiliar with food labels or daily calorie requirements, underscoring the need for accompanying

education campaigns.

Policy implications are clear. Researchers recommend adopting Nutri-Score nationally, pointing to its proven effectiveness in Saudi trials and successful implementation in European countries. Such a move could not only guide consumers toward healthier choices but also encourage manufacturers to reformulate products to achieve better scores, thereby improving the overall nutritional quality of the food supply. Retailers could further amplify impact by promoting higher-rated products through placement and marketing. Industry stakeholders are expected to monitor policy discussions closely, as adoption in Saudi Arabia could influence other GCC countries to follow suit.

<https://www.foodnavigator-asia.com/Article/2025/11/11/nutri-score-most-effective-nutrition-label-for-saudi-consumers/>

## UK food industry counters new stricter salt and sugar limits for "healthy" ranges

The UK government has updated its Nutrient Profile Model, shifting the focus from total sugars to free sugars, which includes added sugars and those naturally present in fruit juices and purees.

This change has sparked debate between health advocates and food manufacturers. Supporters argue that the update is necessary to close loopholes that allowed high sugar products to be marketed as "healthy," particularly to children. They emphasize that products too unhealthy to advertise should not be able to present themselves as nutritious through misleading claims.

Food producers, however, contend that the new system is too blunt, unfairly penalizing nutrient dense products such as smoothies and yogurts by classifying them alongside confectionery and crisps. Industry representatives warn that this could confuse consumers and undermine trust, especially after companies have invested heavily in reformulating products to reduce fat, salt, and sugar.

Danone has voiced concern that the changes may add to consumer uncertainty about what qualifies as healthy, noting that terms like “ultra processed foods” already cause confusion due to inconsistent definitions.

Advocacy groups such as Action on Salt & Sugar and Bite Back Right Now welcome the stricter standards, arguing that they will help remove misleadingly marketed sugary products from

the spotlight and promote genuinely healthier options. They highlight that children in the UK consume far more free sugars than recommended, contributing to long term health risks. Public health experts stress that the update reflects modern dietary guidance and strengthens efforts to improve the food environment by ensuring healthier products are more visible.

Overall, the revision represents a significant tightening of nutritional standards, aiming to better align food marketing and regulation with current scientific evidence, though it has triggered strong pushback from parts of the food industry concerned about consumer confusion and commercial impact.

<https://www.nutritioninsight.com/news/uk-food-industry-nutrient-profiling-model.html>



UK shoppers are voicing strong support for mandatory traffic light nutrition labels, seeing them as a clearer and more trustworthy way to make healthier choices.

Research by Which? shows that while the system has been in place for over a decade, its voluntary nature has led to inconsistent use across retailers and products. Consumers say this inconsistency undermines

confidence, especially when portion sizes are manipulated or labels are presented in black and white instead of colour. The findings highlight that nutrition labels are a key factor in purchasing decisions, particularly for snacks, dairy, and breakfast cereals. Many shoppers want labels to be larger, more prominent, and easier to read, with simplified information that avoids confusing reference intakes and unrealistic serving sizes.

Which? consumer organisation, is urging the UK government to make front of pack traffic light labelling mandatory, backed by oversight from the Food Standards Agency and Food Standards Scotland. The push

comes amid the UK’s ongoing obesity crisis, with advocates arguing that consistent, transparent labelling could help consumers make quicker, healthier decisions.

The debate also touches on international context: Canada has already introduced mandatory nutrition labelling, while the UK’s regulatory flexibility may be influenced by agreements with the EU. For now, the call is clear — shoppers want a uniform, mandatory system that prioritizes clarity and trust.

<https://www.nutritioninsight.com/news/uk-traffic-light-nutrition-labels.html>



The ingredient suppliers are becoming central to clarifying the ultra processed food (UPF) debate.

The lack of a clear, science based definition of UPFs has

created confusion among consumers, uncertainty for regulators, and mistrust across the food system. Industry voices like the ACI Group and Specialised Nutrition Europe argue that processing itself is not inherently harmful; rather, the purpose and intensity of processing determine health outcomes. They emphasize that processing can ensure food safety, nutrient adequacy, and accessibility, particularly in infant and specialized nutrition, while warning that demonizing

all processing oversimplifies the issue.

Karsten Smet of ACI Group stresses that reformulation with natural functional equivalents and clean technology processing systems is the first step toward transparency and consumer trust. He notes that the Nova classification system, widely cited but contested, often fails to capture the nuances between beneficial processing methods like

pasteurization or fermentation and industrial formulations that rely heavily on additives, refined starches, sugars, and fats. UNICEF's report linking UPFs to poor diet quality in children highlights legitimate concerns, but industry leaders caution that the debate must distinguish between processing for nutrition and processing for hyper-palatability or cost cutting.

California's 2024 UPF Assembly Bill 1264 is cited as the first law to formally define UPFs, combining ingredient and nutrient based criteria and

phasing out certain products in schools between 2029 and 2035. This signals a deeper regulatory focus on processing methods rather than nutrient content alone, with potential global implications. Smet calls for innovation using natural fibres, fermentation cultures, and botanical extracts, alongside next generation processing systems like cold pressing and high pressure processing, to deliver functionality without crossing into "ultra" territory.

The article concludes that ingredient suppliers can play a pivotal role by linking science

with consumer perception, investing in cleaner reformulation, and proactively collaborating with regulators. The ultimate goal is to establish evidence based frameworks that define ultra processing in terms of measurable outcomes such as nutrient density, bioavailability, metabolic impact, and long term health relevance, positioning responsible processing as part of the solution rather than the problem.

<https://www.nutritioninsight.com/news/ultra-processed-foods-definition-industry-calls-for-clarity.html>



## US FDA scrutinizes gluten warnings on food labels

The FDA's latest move signals a potential tightening of gluten related labelling rules in the US.

By issuing a Request for Information, the agency is probing how packaged foods disclose gluten containing grains like rye, barley, and oats, and how cross contact is managed.

Celiac disease, affecting around

1% of the population, is central to this push. Even trace amounts of gluten can trigger damaging immune reactions, making accurate labelling critical. Current rules require disclosure of nine major allergens, but gluten containing grains beyond wheat often escape mandatory listing unless a product is marketed as "gluten free." The FDA is now gathering data on how often these grains appear undisclosed, the severity of allergic responses, and consumer concerns about cross contamination.

While the focus is on packaged foods, the implications extend to restaurants and foodservice,

where gluten free claims are not federally regulated. This gap raises questions about consistency and consumer protection in dining settings.

The agency's action is not yet a regulatory change but an exploratory step. It could pave the way for stricter rules on ingredient disclosure, harmonized standards, and clearer labelling practices, reshaping how both manufacturers and foodservice operators address gluten and allergen safety.

<https://www.foodingredientsfirst.com/news/regulatory-action-us-fda-scrutinizes-gluten-warnings-on-food-labels.html>



## America's new dietary guidelines reshape product formulation and nutrition policies

The new 2025-2030 Dietary Guidelines for Americans mark a significant shift in US nutrition policy and product formulation strategies.

The guidelines nearly double daily protein recommendations, encourage higher intake of healthy fats, grains, fruits, and vegetables, and explicitly call for limiting "highly processed" foods. This last point is particularly disruptive because the term remains undefined, leaving food companies and regulators grappling with how to interpret and implement it.

The Institute of Food Technologists stresses that ambiguous terminology could complicate reformulation, labelling, and compliance. Without science based definitions, nutrient dense foods like whole grain bread or yogurt risk being misclassified, potentially discouraging consumption of products that support public health.

Industry stakeholders are therefore pushing for clarity and reproducible standards that distinguish between processing methods and nutritional quality.

Another major theme is the growing recognition of “food as medicine.” The guidelines reinforce the idea that diet can prevent, manage, and even treat disease, positioning food companies as essential partners in healthcare delivery. This includes developing nutrient dense products, collaborating with healthcare systems, and scaling access to medically tailored meals.

Implementation will take time. Agencies like USDA and FDA are

expected to use the guidelines as a scientific foundation for future rulemaking, but translating broad recommendations into actionable standards will require consensus building and input from food science experts. In the meantime, companies may voluntarily reformulate products to align with the new guidance.

Food safety remains non negotiable. As companies innovate to meet new nutritional targets, they must balance shelf life, sensory properties, and consumer appeal without compromising safety. The guidelines therefore place food science and

technology at the centre of reformulation efforts, ensuring that innovation supports health while maintaining trust and compliance.

In essence, the new DGA reshape the landscape by raising protein targets, redefining healthy fats and grains, and introducing stricter scrutiny of processing. They set the stage for deeper collaboration between science, industry, and healthcare, while highlighting the urgent need for clear definitions to guide reformulation and policy.

<https://www.foodingredientsfirst.com/news/dga-impact-nutrition-policy-product-formulation.html>

## UK junk food ad ban: Why nutrition-led reformulation drives long-term growth

The UK's new junk food advertising ban is reshaping the food and beverage landscape by making reformulation, rather than marketing spend, the key to long term growth.

Under the rules, products must pass a nutrient profiling score that balances fat, sugar, and salt against positive nutrients like fibre and protein. Anything scoring above the threshold is classed as “less healthy” and barred from TV ads before 9 pm and all online advertising.

ACI Group argues that this shift forces brands to move beyond

compliance and treat reformulation as a growth engine. By fortifying products with functional ingredients such as plant proteins, novel fibres, and sugar reduction systems, companies can both meet regulatory thresholds and align with consumer demand for healthier, evidence based options. Reformulation is rarely a simple swap; it requires system wide changes across supply chains, ingredient sourcing, and logistics. Distributors and ingredient partners play a critical role in ensuring availability, scalability, and transparency.

The ban also levels the playing field. For decades, visibility was driven by advertising budgets, but now nutrient profiling shifts attention to what is actually in the product. Smaller brands with simpler, cleaner recipes

gain an advantage, while larger players must rethink formulations to maintain access to key marketing channels. Transparency and authentic nutrition led innovation become more powerful than advertising spend, building consumer trust and reshaping what counts as “junk food.”

In practice, this means fewer quick fixes and more holistic recipe redesigns, with cleaner labels and functional benefits embedded into products. Over time, the regulation could drive a fundamental redefinition of the category, turning regulatory pressure into an opportunity for differentiation and sustainable growth.

<https://www.foodingredientsfirst.com/news/uk-junk-food-ad-ban-reformulation-functional-ingredients.html>

## EU Biotech Act: Approval pathways for precision fermentation eased despite restrictions on novel foods

The EU's new Biotech Act marks a significant regulatory shift for precision fermentation but leaves important gaps unresolved.

The legislation expands the European Food Safety Authority's pre submission guidance, giving companies clearer technical and scientific

advice before filing applications. This should help reduce delays that have plagued the EU's novel food authorization process, where startups often struggled with unclear evidentiary requirements.

However, the Act excludes novel foods from the EU's proposed regulatory sandboxes – collaborative frameworks meant to allow regulators, industry, and academics to co-develop standards for emerging technologies.

The European Commission justified the exclusion on grounds of potential ethical or cultural concerns, but critics like GFI Europe argue this undermines transparency and

consumer confidence. They see it as a missed opportunity to build trust through open dialogue.

Consumer research shows growing willingness to try precision fermentation products, such as animal free dairy proteins or sustainable palm oil alternatives, especially when offered samples or prepared foods.

Yet commercialization remains constrained by Europe's lack of large scale fermentation facilities. The Act does not address this infrastructure gap, focusing instead on health biotechnology.

Industry groups are calling for

investment in food biotechnologies in a planned second Biotech Act expected in late 2026, with blended public private financing models seen as essential to scale production.

In short, the Biotech Act strengthens regulatory clarity and EFSA's advisory role, but by excluding novel foods from sandboxes and failing to tackle infrastructure needs,

it leaves Europe's precision fermentation sector at risk of lagging behind faster moving markets like Singapore and the US.

<https://www.foodingredientsfirst.com/news/eu-biotech-act-novel-foods-sandboxes.html>



## EU "meaty" label ban talks collapse into prolonged regulatory limbo

EU negotiations over restricting meat related terminology for plant based products have collapsed, leaving the issue in prolonged regulatory limbo until at least 2026.

The trilogue talks between the European Parliament, Council, and Commission failed to reconcile positions after Parliament voted in October to reserve terms like "burger," "sausage," and "steak" exclusively for animal products.

The breakdown highlights the political and legal complexity of the proposal. Critics, including the "No Confusion" campaign

representing over 600 organizations, argue that no official impact assessment data has been collected on rebranding costs, consumer understanding, or supply chain effects. They warn that the absence of evidence risks unintended consequences for farmers, small businesses, and consumers.

Translation issues add another layer of difficulty. Terms such as "steak" are used differently across EU languages – in Spanish and Portuguese, for example, they can apply to tuna – raising questions about consistency and enforcement.


Traditional plant based products like bean burgers or soy sausages, as well as mixed formulations containing both meat and plant proteins, further complicate the regulatory picture.

Manufacturers now face at least 18 months of uncertainty, caught between costly rebranding or waiting for clarity. Cyprus will inherit the file during its EU Council presidency in 2026, but given its limited livestock sector, the issue may be deprioritized.

The stakes are high: Europe is the world's largest market for meat alternatives, projected to grow from US\$108 billion in 2025 to nearly US\$590 billion by 2035.

For now, plant based producers remain in limbo, with campaigners pushing for impact assessments and policymakers under pressure to balance farmer protection with consumer choice and market growth.

<https://www.foodingredientsfirst.com/news/eu-veggie-burger-ban-delayed.html>



## The Protein Brewery: EFSA publishes a positive scientific opinion on Fermotein as a "novel" food

The Protein Brewery has reached a major milestone with EFSA's positive scientific opinion on Fermotein, its novel fungal mycoprotein ingredient.

After a five year review process, EFSA concluded that Fermotein is safe under proposed conditions of use, validating its production process, composition, and stability. This approval paves the way for EU commercialization from Q3 2026 and strengthens global credibility, adding to existing US GRAS and Singapore approvals.

Fermotein is produced from a novel strain (*Rhizomucor pusillus*) and stands out for its nutrient dense profile: 50% complete protein (PDCAAS 1), 30 fibre, and a broad spectrum of vitamins and minerals, all with a neutral taste and carb free composition. Its versatility allows integration into powders, beverages, bars, and functional foods without masking systems. Unlike other mycoproteins focused on meat replacements, Fermotein is positioned as a whole food ingredient for active nutrition, longevity, gut health, weight management, and performance.

The company highlights sustainability as another differentiator. A Wageningen Food & Biobased Research LCA shows Fermotein has lower land use and CO2 emissions compared to dairy proteins like

wehey when produced at scale. This aligns with consumer trends favouring minimally processed, nutrient dense foods and the growing interest in fungi based nutrition.

With EFSA's approval, The Protein Brewery is preparing for commercialization in Europe, targeting active nutrition markets such as sports drinks, functional bars, and supplements. Clinical studies are underway to substantiate Fermotein's benefits for gut health, satiety (including GLP 1 relevance), metabolic health, and cognitive function. The company sees this as a turning point, positioning Fermotein as a credible, scalable, and sustainable protein source for the next generation of functional foods.

<https://www.foodingredientsfirst.com/news/protein-brewery-fermotein-efsa-approval.html>



## Natural or not? Cape Cod Chips called into court over citric acid

The article details two lawsuits filed against Campbell's Company over its Cape Cod Chips brand, focusing on the use of citric acid and the brand's "no artificial preservatives" claims.

The plaintiffs argue that while the packaging promotes a clean, natural image, the chips contain citric acid produced through industrial fermentation with *Aspergillus niger*, a black mould, rather than being extracted from citrus fruits. Since fruit-derived citric acid is no longer commercially

available, nearly all citric acid in food today is made synthetically, which the lawsuits claim contradicts Cape Cod's marketing promises.

The first case, filed in New York federal court in October 2025, alleges that the "No Artificial Colours, Flavours or Preservatives" claim misled consumers. A second case, filed earlier in July, makes similar arguments, stating that health-conscious shoppers paid a premium under the belief the chips were preservative-free. Comparable suits have also been filed against other snack makers.

The controversy highlights how citric acid, one of the most common additives in processed foods, sits at the centre of the

debate over what counts as "natural." While it is safe and widely used to enhance flavour, stabilize pH, and extend shelf life, plaintiffs argue that its preservative function and synthetic origin undermine clean label claims. Historical FDA letters from 2001 advising against "all natural" claims on foods containing citric acid add weight to their argument, though they are not legally binding.

Campbell's has declined to comment beyond stating that its chips are made with "high quality, carefully selected ingredients." The lawsuits come at a time when the clean label market is booming, with consumers willing to pay more for snacks perceived as minimally processed.

If the courts side with the plaintiffs, the implications could ripple across the industry, forcing widespread label changes, reformulations, or more cautious marketing language.

At its core, the dispute reflects the unresolved question of how “natural” should be defined—by an ingredient’s source, its processing method, or its role in the finished product. The outcome could reshape not only Cape Cod’s branding but also

broader industry practices around transparency and consumer trust.

<https://www.foodnavigator-usa.com/Article/2025/11/26/c-ape-cod-chips-in-court-over-synthetic-citric-acid-claims/>

## Consumers embrace gene-edited foods when brands focus on value, not science

The article highlights new research showing that consumers are more receptive to gene edited foods when the benefits are explained in terms of personal value rather than scientific detail.

Historically, technologies like GMOs faced resistance because they lacked transparency and direct consumer benefit. Gene editing, however, is being received differently. When consumers understand outcomes such as healthier animals, reduced antibiotic use in pork, high GABA tomatoes

that support blood pressure, or bananas and eggs that reduce waste and stabilize supply, they respond positively.

Charlie Arnot of the Center for Food Integrity emphasizes that science is necessary but not sufficient; what matters most is how the technology aligns with consumer values. He notes that more than 500 gene edited food applications are in development, and companies should begin crafting policies to decide which innovations fit their brands and how to integrate them into supply chains. Transparency and third party oversight, such as FDA or USDA approval, are also critical to building trust.

Early adoption is expected in produce and specialty ingredients, with examples like seedless blackberries, high

GABA tomatoes, and longer lasting fruits and vegetables that directly address shrink and waste. The biggest risk, according to Arnot, is fragmented industry responses that treat each product in isolation. He urges companies to develop broad frameworks for gene editing acceptance rather than a piecemeal “whack a mole” approach.

Overall, the findings suggest that consumer acceptance hinges less on the science itself and more on how clearly companies communicate the tangible benefits—whether they involve health, affordability, or sustainability.

<https://www.foodnavigator-usa.com/Article/2025/12/04/w-hat-drives-consumer-acceptance-of-gene-edited-foods/>

## EU Labelling Rules Could Reshape the Plant-Based Market - Industry Voices Are Sounding the Alarm

In October, the European Parliament voted to restrict the use of meat related terms like “burger,” “steak,” and “chicken” on plant based products, framing the move as a way to improve consumer transparency.

The proposal now heads into trilogue negotiations between the European Commission, Parliament, and Council, with implementation targeted for 2026.

Industry voices gathered in a ProVeg International whitepaper argue the rules could have damaging consequences. For brands such as The Vegetarian Butcher, La Vie, Planted, and Rügenwalder Mühle, familiar “meaty” language is central to consumer understanding and brand identity. They warn that banning these terms would

create confusion rather than clarity, while also imposing costly rebranding and packaging changes.

Executives highlight broader risks: Europe currently leads the global plant based meat market, but restrictive labelling could undermine competitiveness and push innovation elsewhere. Hybrid products that combine plant based and cultivated components may also fall into a regulatory grey zone, unable to use either conventional meat or plant based descriptors.

Research cited in the article shows consumers are not confused by terms like “veggie burger” or “plant based steak.” Companies selling large volumes report that shoppers understand these labels perfectly well.

Critics argue the proposal runs counter to the EU’s own sustainability and food security

goals, potentially slowing adoption of alternative proteins at a time when climate and health imperatives call for acceleration.

As trilogue negotiations begin, the debate has moved beyond semantics. The outcome will shape brand strategies, investment flows, and Europe’s role in the global protein

transition. Industry leaders are calling for harmonised EU wide labelling rules based on evidence, designed to support rather than hinder sustainable food innovation.

<https://vegconomist.com/politics-law/eu-labelling-rules-could-reshape-plant-based-market-industry-voices-sounding-the-alarm/>

## UK Government Publishes First Safety Guidance for Cultivated Meat Approvals

The UK’s Food Standards Agency (FSA) and Food Standards Scotland (FSS) have published the country’s first safety guidance for cultivated meat, marking a clear departure from EU era novel food regulations.

This guidance is part of a regulatory sandbox launched in early 2025 to help shape a framework for emerging food technologies.

Two documents have been released. The first clarifies hygiene requirements, confirming that cultivated meat produced from animal cells is considered a product of animal origin, meaning existing food

safety rules apply during production. However, it does not legally qualify as “meat,” since it isn’t an edible part of an animal. The guidance also requires

companies to establish Hazard Analysis and Critical Control Point (HACCP) systems to identify and mitigate risks.

The second document sets out scientific requirements for allergenicity and nutritional evaluation. Companies must demonstrate that cultivated meat is not nutritionally inferior to conventional foods it may replace, providing detailed data on nutrient profiles, amino and fatty acid compositions, and intended uses. Regulators stress the need to assess allergenicity carefully, given that cell cultivated proteins could expose consumers to unfamiliar allergens.

The sandbox programme, funded until 2027, includes startups from the UK, Europe, the US, and Australia. It is designed to accelerate regulatory learning and reduce barriers without compromising safety. So far, only one cultivated meat product has reached UK shelves, and it was for pets. Human use applications from Aleph Farms, Ivy Farm Technologies, and Parima are under review.

The FSA emphasizes that this approach will boost business confidence and regulatory efficiency, ensuring cultivated meat meets the same rigorous safety standards as conventional foods while supporting innovation in the sector.

<https://www.greenqueen.com.hk/uk-fsa-lab-grown-meat-cell-cultivated-products-safety-guidance/>

