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Underutilized Flowers in Food Processing: Nutritional, Bioactive and Technological Potential

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Flowers are familiar components of food traditions, yet many species with potential culinary value remain underused in commercial food processing. Beyond their colour, fragrance and visual appeal, selected edible flowers can contribute dietary fibre, minerals, vitamins and a diverse range of phytochemicals, including phenolic acids, flavonoids, anthocyanins, carotenoids and volatile aroma compounds. These constituents create opportunities for developing natural colourants, flavouring ingredients, herbal infusions, bakery products, confectionery, fermented beverages, dairy foods, sauces and functional powders. Their use also presents practical challenges: flowers are highly perishable, composition varies with species and growing conditions, some pigments and aromas are sensitive to heat, light and oxygen, and incorrect identification or contamination can create serious safety risks. This article reviews the nutritional characteristics, bioactive potential, processing behaviour, product applications and safety requirements of underutilized edible flowers, with attention to flowers relevant to Indian food systems such as hibiscus, mahua, banana blossom, pumpkin flower, moringa flower, drumstick flower, butterfly pea and selected marigold types. The discussion emphasizes that a flower should not be considered suitable for food merely because it is traditionally used or appears attractive. Botanical identity, food-grade cultivation, contaminant control, validated processing and regulatory compliance must precede product development. Underutilized flowers could become useful ingredients when research moves beyond claims of health benefit and establishes reproducible composition, sensory acceptance, stability and safe levels of use.

Keywords: Underutilized flowers; edible flowers; food processing; phytochemicals; natural colourants; functional foods; preservation; food safety

Introduction

Flowers occupy a distinctive place in human culture. They are used in festivals, household cooking, traditional preparations, beverages and herbal practices, but their role in the modern food industry is still limited compared with that of leaves, fruits, seeds and roots. In many regions, flowers are harvested seasonally and consumed in a small range of familiar dishes. Others are grown mainly for ornament or religious use and are not collected through systems designed for food production. As a result, potentially useful plant materials may remain outside formal food value chains. The term underutilized flower is used here for a flower or flowering part that has a history of local use, or plausible food-processing potential, but is not yet widely standardized, marketed or researched as a food ingredient. It does not mean that every flower in this category is edible. Edibility is species-specific and can also depend on the plant part, maturity, preparation method and amount consumed. A flower suitable for a traditional preparation may not be appropriate for concentrated extracts or frequent consumption without further evaluation. Recent reviews describe edible flowers as sources of nutrients and phytochemicals and identify applications in infusions, salads, bakery foods, dairy products and other value-added foods. They also stress the need to assess toxicological and microbiological risks rather than assuming that a natural ingredient is automatically safe (Prabawati et al., 2021; Chetia et al., 2025). For food technologists, the central question is therefore not simply whether a flower contains beneficial compounds, but whether these compounds can be retained, standardized and delivered in a safe, acceptable product. This article follows the general structure of a food-science review article, moving from the raw material and its composition to processing, applications, safety and future research. The aim is to provide a practical framework for students and product developers considering flowers as ingredients in food processing.

Meaning and Scope of Underutilized Flowers

Underutilization may arise for several reasons: short flowering seasons, limited consumer familiarity, delicate tissues, low post-harvest keeping quality, labour-intensive picking, inconsistent supply, lack of validated processing methods or uncertainty about food safety. In some cases, flowers are used locally but have not been developed into shelf-stable ingredients. In others, their use is largely decorative, even though the petals or inflorescences may contain pigments and aroma compounds of interest. The word flower is also used loosely in food discussions. It can refer to petals, whole blossoms, unopened flower buds, or an inflorescence made up of many small flowers. Banana blossom and moringa flower, for example, are structurally different from a rose petal or a butterfly pea flower. Their composition and processing requirements should not be assumed to be the same. For development work, flowers can be grouped by their main technological contribution: (i) pigment-rich flowers for colour; (ii) aromatic flowers for flavour and fragrance; (iii) flowers used as vegetables or bulk ingredients; and (iv) flowers considered for their phenolic-rich extracts. These categories overlap, but they help define product objectives and suitable tests.

Nutritional Composition

Macronutrients and dietary fibre

Fresh flowers generally contain substantial moisture, so their energy and nutrient contribution per serving may be modest. The amounts of carbohydrate, protein, lipid and fibre differ widely between species and between petals and more substantial flower parts. Flowers consumed as vegetables, such as banana blossom and pumpkin flowers, may contribute more bulk and fibre than small quantities of petals used as garnish. Drying removes water and concentrates solids on a weight basis, but this does not automatically make a dried powder nutritionally superior: drying can also cause losses of sensitive vitamins and volatile compounds. Protein is not usually the main reason for adding petals to a product because the amount incorporated is often low. Nevertheless, the amino-acid profile and protein content of selected flower materials may be worth measuring when the flower is consumed in meaningful quantities. For any nutrient comparison, results should clearly state whether they are reported on a fresh-weight or dry-weight basis. Without this information, values from different studies can be misleading.

Vitamins and minerals

Some edible flowers contain measurable amounts of vitamin C, carotenoids and minerals such as potassium, calcium, magnesium and iron. Actual levels depend on the plant genotype, soil, irrigation, climate, stage of flowering and post-harvest handling. Vitamin C is sensitive to oxygen,

heat and prolonged storage, while mineral elements are generally more stable during ordinary thermal processing. Minerals can still be lost when soluble components leach into water that is subsequently discarded. Claims that a flower is a rich source of a nutrient should be supported by laboratory results and a realistic serving size. The presence of a nutrient in raw material does not prove that a finished food delivers a nutritionally meaningful quantity. Bioaccessibility, processing losses and the amount of ingredient used in the formulation all influence the final contribution.

Variation and analytical reporting

A sound nutritional profile should include moisture, ash, protein, fat, crude fibre or dietary fibre, and carbohydrate estimated using a clearly stated method. Depending on the intended use, vitamin C, carotenoids and selected minerals may also be measured. Samples should be botanically authenticated, collected at a defined flowering stage and handled consistently. Replicate sampling across seasons or growing locations is important before commercial specifications are proposed. For dried flower ingredients, reporting both fresh-weight and dry-weight values can help separate natural variation from the concentration effect caused by water removal. A specification sheet should also identify the plant part, drying method, particle size, moisture content and storage conditions.

Bioactive Compounds and Their Potential

Phenolic acids and flavonoids

Phenolic acids and flavonoids are among the most frequently studied phytochemicals in edible flowers. They contribute to antioxidant responses in chemical assays and may also influence bitterness, astringency, colour and interactions with proteins. The profile varies markedly across species. Total-phenolic and total-flavonoid tests are useful screening tools, but they do not identify individual compounds and should not be treated as direct proof of a health effect in humans. Analytical approaches such as high-performance liquid chromatography and liquid chromatography–mass spectrometry can help identify and quantify specific phenolics. For early-stage projects, total phenolic content and an antioxidant assay may be useful, followed by compound-specific analysis when a promising ingredient is selected. Different assays measure different chemical reactions, so results from unrelated methods should not be compared as if they were equivalent.

Anthocyanins and other pigments

Red, purple and blue flowers may contain anthocyanins, while yellow and orange flowers can contain carotenoids and other pigment compounds. These pigments are attractive to processors seeking plant-derived colour ingredients. Butterfly pea flower, for example, is known for blue pigments whose visible colour changes with pH. Hibiscus calyces are widely used in beverages for their red colour and tart taste. Certain marigold species contain yellow-orange carotenoids, although species identity and the intended food use must be confirmed before an ingredient is developed. Pigment stability depends on pH, temperature, light, oxygen, metal ions, water activity and the presence of other ingredients. Anthocyanin-rich extracts can shift colour in acidic or alkaline formulations, while heat and oxygen may accelerate fading. Carotenoids are susceptible to oxidation and can be affected by light. A colour ingredient therefore needs to be tested in the actual food matrix, not only in a laboratory solvent.

Volatile aroma compounds

Flowers may contain volatile compounds that produce floral, citrus-like, herbal, spicy or honey-like notes. Their concentration can be low, and the aroma may change rapidly after harvest. High temperatures can drive off desirable volatiles or generate cooked notes. Where aroma is the main value, gentle drying, low-temperature extraction or short processing times may be preferable.

Aroma should be assessed using sensory methods alongside instrumental techniques when available. A fragrant flower is not automatically suitable as a flavouring ingredient. Some highly aromatic plants contain compounds that are unsafe at concentrated levels, and a compound's safety depends on identity, dose and exposure. Food use should be based on documented edible status and appropriate regulatory assessment rather than fragrance alone.

Antioxidant and other biological activities

Extracts of some edible flowers show antioxidant activity in in-vitro assays, and published studies have investigated antimicrobial, anti-inflammatory and other biological responses. These findings can help identify materials for further research, but the strength of evidence varies. An assay in a test tube does not establish that eating the flower prevents or treats disease. Digestion, absorption, metabolism, dose and the overall diet all influence whether an observed activity has relevance to human health. For product development, it is more accurate to describe a flower ingredient as phenolic-rich or as showing antioxidant capacity in a specified laboratory assay than to make broad therapeutic claims. Health claims on commercial foods must be supported by suitable evidence and comply with applicable food regulations.

Examples of Underutilized or Less-Commercialized Flowers

Hibiscus

Hibiscus is one of the better-known examples of a flower material used in beverages, infusions, syrups and preserves. The fleshy calyx of selected Hibiscus sabdariffa varieties gives a deep red colour and an acidic taste. It can be dried for tea blends, extracted for beverage bases, or incorporated into jams and fruit preparations. Its organic acids and pigments influence flavour as well as colour. During processing, high heat and prolonged exposure to air may affect pigment retention, so extraction temperature, pH and storage should be optimized. Hibiscus provides a useful model for studying how a traditional plant material can move into standardized food ingredients. Quality parameters can include colour intensity, acidity, moisture, microbial load and selected phytochemical markers. The edible plant part and species should be specified because common names can refer to different plants.

Butterfly pea flower

Butterfly pea (Clitoria ternatea) has gained attention as a source of blue colour in infusions and specialty beverages. Its anthocyanin-related pigments are sensitive to pH, making it useful for products where colour change is desired, but this same property can be a formulation challenge. Acidification may shift blue toward purple or pink shades. Its performance should be assessed in the presence of sugar, acids, minerals, heat and packaging materials. Potential applications include

tea blends, beverage concentrates, frozen desserts and selected confectionery. Before using an extract commercially, processors should verify the species, establish a controlled extraction method, determine microbiological quality and confirm applicable regulatory requirements for the intended food category.

Mahua flowers

Mahua (Madhuca longifolia) flowers have a long history of use in parts of India, particularly in traditional foods and fermented preparations. Their naturally sweet taste makes them interesting for sweet products, syrups, bakery formulations and ingredient blends. Collection, drying and storage practices strongly affect quality because freshly harvested flowers are moist and can deteriorate if they remain in warm, humid conditions. Potential product development should focus on hygienic collection, controlled drying, moisture and water-activity management, and a clear understanding of traditional processing. If fermentation is explored, the process needs a defined starter culture or validated control strategy, a monitored fermentation profile and testing for undesirable metabolites and microorganisms. Traditional use alone should not replace a modern safety assessment.

Banana blossom

Banana blossom is a substantial edible inflorescence used in several regional cuisines. Unlike delicate petals, it can function as a vegetable ingredient and may contribute fibre and texture to patties, cutlets, curries, fillings and plant-based products. Its preparation often includes trimming, slicing and treatments intended to reduce browning or manage astringency. The choice of pretreatment affects colour, texture, nutrient retention and processing yield. For industrial use, banana blossom could be washed, cut, blanched where appropriate, drained, frozen, dried or incorporated into retortable and refrigerated products. Processors should assess enzymatic browning, texture after cooking, water-holding behaviour and microbial stability. Product development should also consider the labour and waste associated with removal of inedible or tough parts.

Pumpkin and other squash flowers

Pumpkin and squash flowers are eaten in some cuisines, often stuffed, battered or cooked with grains and vegetables. Their delicate tissues and short shelf life limit distribution. They may be suited to local fresh-food markets, frozen products or fillings rather than long ambient storage in whole form. Gentle handling is essential because bruising quickly reduces appearance and market value. Possible processed products include frozen stuffed flowers, flower-containing savoury mixes and dried inclusions for specialty foods. The nutritional and sensory contribution depends on the formulation and the proportion of flower used. Because the flowers are fragile, cold-chain management and careful packaging are central to maintaining quality.

Moringa flowers

Moringa flowers are available seasonally in regions where moringa is cultivated. They are used in some traditional preparations and are of interest because the plant is already recognized as a multipurpose food crop. Their potential applications include cooked vegetable products, savoury mixes, dried ingredients and blended formulations. Flower-specific composition and safety data should be generated rather than assuming that results for moringa leaves apply equally to flowers. A practical development pathway would compare fresh, blanched and dried flowers for sensory acceptance, colour, moisture, microbial quality and selected nutrients. Drying and powdering may improve handling and extend storage, but a high inclusion level could alter flavour or produce an undesirable texture.

Marigold and calendula

The common names marigold and calendula can refer to different species, which is an important safety and quality issue. Selected species have been investigated or used as sources of yellow-orange pigments and as decorative edible petals. Potential applications include rice dishes, bakery toppings, spreads and natural-colour extracts. However, food suitability cannot be inferred from the common name; the exact botanical species and plant part must be authenticated. Where pigment extraction is the objective, the processor should assess extraction yield, colour strength, stability to light and heat, and the presence of unwanted residues. Petals intended for direct food use require food-grade cultivation and careful sorting to remove stems, insects and foreign matter.

Other candidates and the need for caution

Other flowers discussed in food literature include rose, lavender, elderflower, cornflower, sunflower and selected blossoms used as vegetables. Their culinary roles range from aroma and colour to bulk and texture. These examples illustrate the diversity of the category, but they should not be treated as a universal list of safe flowers. Species, cultivar, plant part and intended use all require verification. Ornamental flowers purchased from florists are generally unsuitable for eating unless the supplier can confirm food-grade production and chemical-use history.

Technological Potential in Food Processing

Natural colour ingredients

Colour is one of the most immediate opportunities for flower-derived ingredients. Dried petals or extracts may be used to tint beverages, confectionery, desserts, bakery products and sauces. A processor must distinguish between direct addition of a dried flower and use of a standardized extract. Direct addition also contributes fibre, flavour and particles, while an extract can provide more controlled colour but requires extraction, concentration and possibly drying. Development trials should record colour using instrumental parameters such as L*, a* and b*, alongside visual and sensory observations. Colour should be measured at the start and during storage. The formulation should be evaluated under expected pH, heat treatment, light exposure and packaging conditions. If a colour is unstable, microencapsulation or blending with compatible ingredients may improve handling, though it cannot remove the need for safety assessment.

Flavouring and beverage applications

Flower infusions and concentrates are relatively accessible product formats because hot water can extract soluble colour, acids and flavour compounds. Tea blends may combine dried flowers with tea leaves, spices or fruit pieces. Syrups, cordials and fermented beverages are further possibilities, provided the process is designed for microbiological safety and consistent flavour. Infusion time, water temperature, particle size and flower-to-water ratio influence extraction and should be standardized. The balance of aroma, acidity, bitterness and astringency should be determined through sensory evaluation. A highly concentrated extract may deliver stronger colour but also extract bitter or harsh compounds. Therefore, extraction yield alone is not a sufficient measure of ingredient quality.

Bakery, dairy and confectionery products

Dried flower petals or powders can be incorporated into cookies, breads, cakes, snack bars, fillings and confectionery. Their performance depends on particle size, moisture content, colour stability and flavour intensity. In bakery products, heat may fade pigments and reduce aroma, while the powder can alter dough hydration and texture. Trials should compare several inclusion levels and examine colour, spread, volume, texture, flavour and consumer acceptance. Flower extracts can

also be evaluated in yoghurt, ice cream, frozen desserts and other dairy products. Their acidity and polyphenols may interact with milk proteins, affecting colour, sedimentation or texture. Compatibility testing is therefore essential. The ingredient should not be added at a level chosen solely for visual impact; the formulation must remain sensorially acceptable and stable throughout shelf life.

Sauces, spreads and savoury foods

Flowers that contribute a vegetable-like texture, such as banana blossom and selected squash flowers, can be used in savoury products. Possible formats include cutlets, fillings, sauces, chutneys, frozen mixes and plant-based prepared foods. The main processing issues are browning, moisture control, texture, bitterness and microbial stability. Blanching may inactivate browning enzymes, but excessive blanching can soften tissue and leach water-soluble nutrients. For a flower-based product, ingredient functionality should be measured in the full recipe. For example, the water-holding capacity of a dried powder may affect a dough or patty differently from a fresh chopped flower. Small pilot batches can help identify the most useful pretreatment and inclusion level before scale-up.

Extracts, powders and encapsulated ingredients

Drying converts a seasonal raw material into a more manageable ingredient. Hot-air drying is relatively simple but may cause losses of heat-sensitive compounds; freeze-drying often preserves colour and structure better but usually involves higher cost. Vacuum, microwave-assisted and hybrid drying methods may offer useful compromises depending on the material and production scale. The best method is the one that meets quality, safety, energy and cost requirements for the intended market. Extraction can use water, food-grade ethanol or other permitted solvents selected for the target compounds and the intended application. Solvent choice affects yield, selectivity, cost and downstream processing. Residual-solvent control and compliance with food regulations are necessary. Encapsulation using suitable wall materials may protect sensitive pigments and aromas from oxygen, light and moisture, and can improve dispersibility. The encapsulated ingredient must still be tested for release behaviour, stability and sensory impact. Emerging preservation approaches reported in edible-flower research include modified-atmosphere packaging, edible coatings and non-thermal technologies such as high-pressure processing. These methods may help maintain freshness or reduce quality losses, but their effectiveness is species- and process-specific. Validation is required before making shelf-life or safety claims (Zhang et al., 2019).

Post-Harvest Handling and Preservation

Flowers are often more fragile than conventional produce. Thin tissues, high moisture and large exposed surfaces make them susceptible to water loss, bruising, enzymatic changes and microbial growth. Harvest should take place at a defined maturity stage using clean tools and containers. Flowers should be protected from direct sunlight and excessive heat, transported quickly and sorted to remove damaged or diseased material. Washing may reduce soil and surface debris, but it must use potable water and hygienic equipment.

Washing does not sterilize flowers and can spread contamination if water quality and handling are poor. After washing, excess surface moisture should be removed when the process requires it. Fresh edible flowers generally benefit from prompt cooling and appropriate packaging; exact temperature and humidity conditions must be established for each species.

Drying is a common way to extend usability, but the endpoint should be defined by moisture content and preferably water activity, not by touch or appearance alone. Dried material should be cooled before packing and protected from moisture regain. Light- and oxygen-barrier packaging may be useful for pigment-rich powders. Storage trials should monitor colour, aroma, moisture, microbial quality and, where relevant, marker compounds.

Freezing can retain the usability of some flowers but may damage delicate structures during ice-crystal formation. This matters less when the material will be used in a cooked filling or extract than when whole-flower appearance is important. Modified-atmosphere packaging and edible coatings can be explored for fresh flowers, but gas composition, film permeability, condensation and temperature control need careful validation.

Food Safety and Regulatory Considerations

Correct botanical identification

Correct identification is the first safety requirement. Common names can refer to more than one species, and edible and toxic plants may look similar. Only botanically authenticated species and appropriate plant parts should be considered. The intended use must also be defined: a flower used occasionally as a garnish is a different exposure scenario from a concentrated extract added to a beverage consumed every day.

Pesticides, heavy metals and environmental contaminants

Flowers may be exposed to pesticides, roadside pollution, contaminated irrigation water, soil contaminants and residues from ornamental crop production. Flowers grown for decoration may have been treated with chemicals not approved for food crops. Therefore, sourcing from a food-grade grower with traceability and documented agricultural practices is essential. Risk-based testing should consider pesticide residues, heavy metals and other contaminants relevant to the growing area and species.

Microbiological hazards

Fresh flowers can carry microorganisms from soil, irrigation water, insects, handling surfaces and packaging. Reviews report concerns involving pathogenic bacteria and spoilage organisms in edible flowers, especially when they are consumed fresh or minimally processed (Chetia et al., 2025; Bortolotti et al., 2025). Good agricultural practices, hygienic harvesting, potable wash water, clean equipment, temperature control and suitable packaging help reduce risk. A drying step is not automatically a validated kill step; microbial survival and post-process contamination must be considered.

Natural toxins, allergens and antinutritional factors

Some plants contain naturally occurring compounds that can be toxic or undesirable at particular doses. Certain flower-derived foods may also be vulnerable to contamination by toxic plant materials during harvesting. The presence of phenolics or other bioactive compounds should not be equated with safety. Depending on the species and use, toxicological assessment may need to consider alkaloids, allergenic potential, antinutritional factors and the consequences of concentration during extraction. Processors should not develop a food ingredient from a species with uncertain edible status simply because an extract shows high antioxidant activity. A safety dossier should document botanical identity, traditional exposure where relevant, intended daily intake, processing effects, contaminant results and available toxicological evidence. If evidence is insufficient, the appropriate conclusion is that further evaluation is needed.

Regulatory compliance and labelling

In India, product developers should review the applicable Food Safety and Standards Authority of India requirements for ingredients, additives, contaminants, labelling and the relevant food category. The legal status of a flower or extract can depend on its identity, preparation and proposed function. A material used as a traditional food ingredient is not necessarily authorized for every concentrated or novel application. Regulatory status should be checked before commercialization, and labels should accurately identify the ingredient and avoid unsupported health claims. A practical safety plan should include supplier approval, traceability, written specifications, hazard analysis, sanitation controls, a sampling plan and a documented recall procedure. For new ingredients, these measures should be supported by pilot-scale process validation and shelf-life studies.

Quality Evaluation and Product Development Framework

A structured product-development programme can reduce uncertainty and prevent attractive but impractical concepts from progressing too far. The following sequence is suitable for a student project or early industrial feasibility study:

- Select a candidate species based on documented edible use, local availability, supply season and a clearly defined food application.
- Authenticate the species and plant part, and obtain raw material from a traceable food-grade source.
- Prepare a baseline profile covering moisture, ash, selected nutrients, colour, sensory characteristics and microbial quality.

- Compare pretreatments such as sorting, washing, blanching, drying or extraction using defined operating conditions.
- Measure relevant bioactive markers with suitable methods and interpret antioxidant assays as screening data rather than proof of clinical benefit.
- Develop several formulations with different inclusion levels and evaluate colour, texture, aroma, taste and overall acceptability.
- Conduct storage studies using packaging suitable for the product and monitor microbial, physicochemical and sensory changes.
- Complete a safety and regulatory review before recommending commercial use.

For natural colourants, important response variables include extraction yield, colour strength, pH stability, heat stability and colour retention during storage. For dried powders, moisture, water activity, bulk density, dispersibility, particle size and microbial quality are useful. For flower-based vegetable products, texture, browning, cooking loss, water-holding capacity and sensory acceptance may be more relevant. The analytical plan should follow the product objective rather than applying the same tests to every flower. A suitable experimental design should include replicates, controls and a clear statistical plan. If the purpose is to compare drying methods, the raw material batch, flower maturity and pre-treatment should be held as consistent as possible. If the purpose is to compare formulations, a control without flower ingredient helps determine whether the flower changes product quality. Results should include variation and statistical significance where appropriate, not only the best-performing sample.

Sustainability and Economic Opportunities

Flowers may offer an opportunity to diversify farm income and create seasonal value-added products. In regions where edible flowers are already known, better handling and processing could reduce post-harvest losses and create markets for dried ingredients, infusions or frozen preparations. Small-scale enterprises may begin with products that require relatively simple equipment, such as dried flower blends or syrups, while extracts and encapsulated ingredients require more specialized facilities and quality control. The sustainability case must be assessed rather than assumed. Harvesting flowers can compete with pollinators or reduce seed production if it is poorly managed. Some flowers are available only briefly, and drying or cold storage requires energy. Commercial use should consider biodiversity, responsible cultivation, water use, pesticide management, fair returns to growers and the use of by-products. Cultivation for food should avoid collecting unidentified flowers from roadsides, parks or chemically treated ornamental beds. Economic feasibility depends on yield, labour for picking and sorting, transport, seasonal supply, drying losses, packaging costs, product acceptance and regulatory requirements. A flower with high laboratory antioxidant values may still be commercially unsuitable if the supply is inconsistent or the flavour is unacceptable. Market research and sensory testing are therefore as important as chemical analysis.

Challenges and Research Gaps

Several limitations continue to restrict the wider use of underutilized flowers. First, compositional data are not always comparable because studies use different cultivars, plant parts, maturity stages, extraction solvents and reporting bases. Second, the presence of a compound is sometimes discussed as if it guaranteed a health benefit, even when evidence is limited to chemical assays. Third, the stability of pigments and aromas during realistic processing and storage is insufficiently characterized for many species. Additional work is needed on microbial ecology, pesticide residues, naturally occurring toxicants and safe intake levels. More attention should also be given to sensory acceptance: unfamiliar bitterness, astringency or floral notes can limit consumer interest even when a product has attractive colour. For ingredient manufacturers, reproducible specifications and scalable processing conditions are essential. Studies should report extraction yield, energy use, process costs and losses, not only total phenolic content. Future research could prioritize locally available species with a documented history of food use. Studies should combine botanical authentication, nutrient analysis, compound-specific profiling, process optimization, safety assessment, sensory evaluation and storage testing. Human nutrition claims require a stronger evidence base than a laboratory antioxidant assay. Collaboration among food technologists, botanists, toxicologists, growers and regulatory specialists would make this research more reliable.

Conclusion

Underutilized flowers represent a diverse group of plant materials with potential roles in natural colouring, flavouring, beverages, bakery foods, dairy products, savoury preparations and dried functional ingredients. Their value comes from the combination of colour, aroma, texture and phytochemical diversity rather than from a single universal nutritional advantage. Hibiscus, butterfly pea, mahua, banana blossom, selected squash flowers, moringa flowers and certain marigold types illustrate different routes to food use, from extracts to vegetable-like ingredients.

Successful development depends on matching the flower to a realistic application and controlling the raw material from harvest to finished product. Species identity, contaminant control, processing stability, microbial safety, sensory quality and regulatory status must be addressed together. Flowers should not be promoted as medicines or described as safe solely because they are natural. With careful research and responsible sourcing, selected underutilized flowers could contribute to ingredient innovation, local enterprise and more diverse food products.