



HERBAL GUMMIES AS A MODERN APPROACH TO HERBAL SUPPLEMENTATION: A COMPREHENSIVE REVIEW

Pharmacy

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ABSTRACT

Herbal supplements are widely used for health maintenance, yet consumers often poorly accept conventional dosage forms such as tablets, capsules, and bitter liquid extracts. Gummies, soft, chewable, gel-based confections, have emerged as an alternative delivery format for botanical actives. This review examines gummy matrix composition and manufacture, the technological challenges of incorporating herbal extracts, the evidence base for commonly used botanicals, and the quality, safety, and regulatory issues that affect these products. Gummies improve palatability and adherence, and they suit people who have difficulty swallowing solid dosage forms. However, limited dose capacity, the heat- and moisture-sensitivity of phytoconstituents, sugar content, and inconsistent label accuracy remain important concerns. Standardised extracts, validated analytical methods, and clearer regulatory frameworks are needed before herbal gummies can be considered a reliable form of supplementation. Future work should also compare gummies with conventional dose forms in well-designed clinical and pharmacokinetic studies.

KEYWORDS

Herbal Gummies; Botanical Supplements; Formulation; Quality Control

INTRODUCTION

Plant-derived products have a long history in health care. The World Health Organization has recognised traditional and complementary medicine as an important part of health systems and has encouraged its safe and effective integration (World Health Organization, 2013). Natural products have also remained a major source of pharmaceutical leads, which reflects the chemical diversity of plant metabolites (Fabricant & Farnsworth, 2001; Newman & Cragg, 2020). In many countries, herbal products are now sold as dietary supplements, nutraceuticals, or health supplements, and many adults report using them (Bailey et al., 2011; Bent, 2008).

Despite this popularity, conventional herbal dosage forms have practical limitations. Many extracts taste bitter or astringent, and large tablets or capsules can be difficult to swallow. In general practice, many patients report difficulty swallowing solid oral dosage forms, which can reduce adherence (Schiele et al., 2013). Concerns about safety, adulteration, and variable quality further complicate this issue (Calixto, 2000; Ekor, 2014).

Gummies were first popularised as vitamin and mineral supplements and have since been adapted for botanical ingredients. Their chewable texture, pleasant flavour and sweet taste make them attractive to children, older adults and people who dislike pills. The aim of this review is to summarise current knowledge on herbal gummies, with attention to formulation science, manufacturing, representative botanical actives, quality and safety, and regulatory aspects, and to identify gaps for future research.

Herbal Supplementation and the Rationale for Gummy Delivery

Herbal supplementation generally aims to support physiological function, relieve mild symptoms or reduce the risk of nutritional deficiency. Dietary supplements occupy a regulatory space between foods and medicines, and the lack of premarket efficacy testing in many jurisdictions places responsibility on manufacturers to ensure quality (Dwyer et al., 2018). Consumer acceptance therefore depends

strongly on sensory properties and convenience as well as perceived benefit.

Gummies offer several advantages as a delivery format. First, they mask unpleasant tastes through sweeteners, acids and flavours. Second, they require no water for administration, which suits use on the move. Third, they may be easier for people with dysphagia to consume than hard tablets (Schiele et al., 2013). Finally, their confectionery appearance can encourage regular use, although this same feature raises the risk of overconsumption, particularly by children. These benefits must be weighed against the limited quantity of active material that can be loaded into a single piece, usually a few hundred milligrams at most, which restricts the use of botanicals that require high daily doses.

Composition of the Gummy Matrix

A gummy is a hydrocolloid gel in which sugars or polyols, water and flavouring components are dispersed. Its texture is determined mainly by the gelling agent, the solids content and the processing conditions (Burey et al., 2009; Edwards, 2000; Hartel et al., 2018).

Gelling Agents

Gelatin is the traditional gelling agent. It forms a thermoreversible gel with the elastic, chewy texture and melt-in-the-mouth quality that consumers associate with gummies. Gelatin is derived from collagen of mammalian or fish sources, and its gel strength depends on source and molecular weight distribution (Gómez-Guillén et al., 2011). Fish gelatin has been explored as an alternative for religious or dietary reasons, although its gels are generally weaker and melt at lower temperatures than those made from mammalian gelatin (Karim & Bhat, 2009).

Pectin is the principal plant-based alternative. High-methoxyl pectin gels in the presence of high sugar concentrations and low pH, and these conditions are compatible with fruit-flavoured gummies (May, 1990). Starch, agar, carrageenan and gellan gum are also used, alone or in

combination, to adjust firmness, elasticity and heat stability. Replacing one gelling agent with another changes hardness, chewiness and drying behaviour, so each substitution requires reformulation (Delgado & Bañón, 2015).

Sweeteners, Acids and Other Excipients

Sucrose and glucose syrup provide sweetness, bulk and water-binding capacity. Because high free-sugar intake is associated with dental caries and weight gain, the World Health Organization recommends limiting free sugars to less than 10% of total energy intake (World Health Organization, 2015). Formulators have therefore investigated honey, fruit concentrates and polyols such as maltitol, sorbitol and xylitol as partial or complete sugar replacements (Edwards, 2000; Livesey, 2003; Mutlu et al., 2018). Polyols have a lower glycaemic response, but excessive intake may cause gastrointestinal discomfort, and they change the texture and shelf life of the product (Livesey, 2003).

Citric or malic acid is added to adjust pH and flavour, while lecithin, oils or wax coatings are used to prevent stickiness. Colourants of natural origin, such as anthocyanins and carotenoids, are increasingly preferred but are less stable than synthetic dyes during processing and storage.

Manufacturing Considerations

Industrial gummy production typically involves dissolving the gelling agent, cooking the sugar syrup to the required solids concentration, blending the two phases, adding heat-sensitive ingredients, depositing the mass into moulds and allowing it to set and cure. Starch mogul systems use moulds formed in starch trays, whereas starchless systems use silicone or other moulds. A drying or conditioning stage reduces moisture and water activity to levels that protect the product against microbial growth and give the desired final texture (Delgado & Bañón, 2015; Edwards, 2000; Hartel et al., 2018).

The composition of a botanical extract depends on the plant part, solvent and extraction technique used (Azmir et al., 2013; Sasidharan et al., 2011), so a defined and standardised extract should be specified before formulation begins. Herbal actives are usually added late in the process, after cooling to a temperature that preserves the gel structure while limiting thermal degradation. Even so, pH, shear and residence time at elevated temperature can all influence the retention of phytochemicals. Process validation, including moisture, water activity, pH, texture and assay of marker compounds, is therefore important for reproducible quality.

Technological Challenges in Incorporating Herbal Actives Stability

Many phytoconstituents, including polyphenols, flavonoids, essential oils and certain glycosides, are sensitive to heat, light, oxygen and pH (Fang & Bhandari, 2010). Acidic gummy environments can hydrolyse some compounds, and prolonged storage at high humidity may cause stickiness, sugar crystallisation or microbial spoilage. Stability studies under defined temperature and humidity conditions, with quantification of marker compounds at intervals, should accompany any product development.

Taste Masking

Bitterness is a major barrier to the acceptance of herbal products. Taste-masking approaches include the use of sweeteners and flavours, complexation with cyclodextrins, ion-exchange resins, polymer coatings and microencapsulation (Sohi et al., 2004). Encapsulation of extracts or oils by spray drying, coacervation or lipid-based carriers can additionally protect labile compounds and control release (Ezhilarasi et al., 2013; Fang & Bhandari, 2010; Gibbs et al., 1999).

Bioavailability

Many herbal actives have low aqueous solubility or poor absorption, and polyphenols in general show limited and variable bioavailability in humans (Manach et al., 2004; Williamson & Manach, 2005). Curcumin is a well-known example, as its low solubility, rapid metabolism and fast elimination limit systemic exposure after oral intake (Anand et al., 2007; Nelson et al., 2017). Formulation strategies such as co-administration with absorption enhancers, phospholipid complexes and nanoparticle systems have been proposed, and some of these could in principle be combined with gummy matrices. Whether the gel environment helps or hinders absorption has not been studied systematically.

Representative Botanical Actives in Gummy Formats

Ashwagandha (*Withania somnifera*)

Ashwagandha root extracts are among the most popular botanicals in gummy products, usually marketed for stress and sleep support. The plant is a traditional Ayurvedic rejuvenator (Singh et al., 2011) and is often classed as an adaptogen (Panossian & Wikman, 2010). A randomised, double-blind, placebo-controlled trial reported lower perceived stress and anxiety scores in adults taking a high-concentration root extract (Chandrasekhar et al., 2012), and a later meta-analysis suggested improvements in stress and anxiety outcomes, although trial quality and extract composition varied (Akhgarjand et al., 2022). Safety is a concern, since case reports and a case series have linked ashwagandha products to liver injury (Björnsson et al., 2020). The suitability of a gummy format therefore depends on a standardised extract and clear labelling of dose and precautions.

Elderberry (*Sambucus nigra*)

Elderberry is commonly formulated into gummies for immune support. A meta-analysis of randomised controlled trials indicated that elderberry supplementation reduced upper respiratory symptoms, though the included studies were small and heterogeneous (Hawkins et al., 2019). Fruit-based extracts blend easily with the acidic, fruity matrix of gummies, which is an advantage over bitter root or leaf extracts.

Turmeric (*Curcuma longa*)

Curcumin has shown a wide range of biological activities in preclinical research (Aggarwal et al., 2007), but clinical results have been mixed, partly because of poor bioavailability (Anand et al., 2007; Gupta et al., 2013). Curcumin has also been described as a compound with chemical properties that can interfere with assays, which complicates the interpretation of some findings (Nelson et al., 2017). Gummies containing turmeric extract therefore require careful claims and bioavailability-enhancing strategies.

Other Botanicals

Ginger, moringa, tulsi, ginseng and fruit-derived extracts are also used in gummy products. For most of these, direct clinical evidence in the gummy format is limited, and efficacy is usually inferred from studies of other dose forms. Such extrapolation assumes that the active remains intact and bioavailable after processing, which should be demonstrated rather than assumed.

Quality, Safety and Label Accuracy

Quality problems are well documented in the wider herbal market. DNA barcoding of commercial herbal products revealed substitution, contamination with fillers and absent labelled species in a substantial proportion of samples (Newmaster et al., 2013). Analyses of traditional herbal medicines have also detected heavy metals such as lead, mercury and arsenic in some products (Saper et al., 2004). Because gummies are manufactured from blends of extracts and confectionery ingredients, they are exposed to the same risks, in addition to confectionery-specific hazards such as microbial growth in high-moisture products.

Label accuracy is a particular concern for gummies. An analysis of melatonin products sold in the United States found that most gummy products contained quantities that differed markedly from the labelled amounts, and some also contained undeclared compounds (Cohen et al., 2023). Earlier work on melatonin supplements likewise reported considerable variability in content (Erland & Saxena, 2017). Although these data concern melatonin rather than botanicals, they illustrate how weak oversight can affect the dose delivered by gummy supplements.

Safety issues specific to gummies include accidental overconsumption by children, who may mistake products for sweets, as well as allergens and interactions between botanicals and prescribed medicines (Ang-Lee et al., 2001; Izzo & Ernst, 2009). Manufacturers should therefore provide child-resistant packaging where appropriate, clear dosing instructions, and warnings for pregnancy, lactation and concurrent drug use. Good manufacturing practice, identity testing of raw materials, limits for contaminants and microbiological testing are essential control measures (World Health Organization, 2007a; World Health Organization, 2007b).

Regulatory and Labelling Aspects

Regulation of herbal supplements differs widely between regions. In

the United States, they are regulated as a category of food under the Dietary Supplement Health and Education Act of 1994, and manufacturers bear responsibility for safety and truthful labelling (Dwyer et al., 2018; United States Congress, 1994). The European Union regulates food supplements through Directive 2002/46/EC, which sets rules for vitamins and minerals and leaves botanicals largely to national provisions (European Parliament and Council, 2002). In India, health supplements and nutraceuticals are governed by the Food Safety and Standards Authority of India under dedicated regulations (Food Safety and Standards Authority of India, 2016). Functional foods and supplements are also subject to claim regulations that distinguish between permitted nutritional or health claims and prohibited disease claims (Hasler, 2002).

This diversity creates uncertainty for manufacturers who wish to sell herbal gummies across borders, and it contributes to inconsistency in quality. Harmonised standards for extract specification, permitted daily doses, contaminant limits and labelling would strengthen consumer protection.

Consumer and Nutritional Considerations

Because gummies resemble confectionery, they may encourage excessive consumption and may add sugar and energy to the diet. Reformulation using lower-sugar or polyol-based systems can address part of this problem (Livesey, 2003; Mutlu et al., 2018), but such products need to be tested for sensory acceptability and stability. Gelatin-based products are unsuitable for vegetarian, vegan and some religious dietary patterns, which is a driver for the development of pectin- and starch-based alternatives (Karim & Bhat, 2009; May, 1990). Dental health is another point of attention, since sticky, sugary products can adhere to teeth (Moynihan & Petersen, 2004). Clear communication that gummy supplements are not sweets, and that they are not a substitute for a balanced diet or for medical treatment, is important.

Research Gaps and Future Directions

Several gaps limit the evidence base for herbal gummies. Few clinical trials have evaluated botanical actives delivered specifically in gummy form, and pharmacokinetic comparisons with capsules or tablets are scarce. Long-term stability data for phytochemical markers are often unpublished. Future work should therefore focus on (a) standardised extracts with validated marker compounds, (b) encapsulation and delivery technologies that protect actives and improve absorption, (c) plant-based and sugar-reduced matrices with acceptable texture, (d) independent surveillance of label accuracy, and (e) well-designed clinical studies on efficacy and safety. Advances in analytical techniques, including chromatographic fingerprinting and DNA-based authentication, can support these aims.

CONCLUSION

Herbal gummies combine the long tradition of botanical use with a modern, consumer-friendly dosage form. They can improve palatability and adherence, but their value depends on sound formulation, validated manufacturing and reliable labelling. Present evidence for efficacy in the gummy format is limited, and quality and regulatory gaps persist. Collaboration among formulation scientists, clinicians, regulators and industry will be needed to ensure that herbal gummies are not only appealing but also safe, consistent and effective.

REFERENCES

- Aggarwal, B. B., Sundaram, C., Malani, N., & Ichikawa, H. (2007). Curcumin: The Indian solid gold. *Advances in Experimental Medicine and Biology*, 595, 1–75.
- Akhgarjand, C., Asoudeh, F., Bagheri, A., Kalantar, Z., Vahabi, Z., Shab-Bidar, S., et al. (2022). Does ashwagandha supplementation have a beneficial effect on the management of anxiety and stress? A systematic review and meta-analysis of randomized controlled clinical trials. *Phytotherapy Research*, 36(11), 4115–4124.
- Anand, P., Kunnumakkara, A. B., Newman, R. A., & Aggarwal, B. B. (2007). Bioavailability of curcumin: Problems and promises. *Molecular Pharmaceutics*, 4(6), 807–818.
- Ang-Lee, M. K., Moss, J., & Yuan, C.-S. (2001). Herbal medicines and perioperative care. *JAMA*, 286(2), 208–216.
- Azmir, J., Zaidul, I. S. M., Rahman, M. M., Sharif, K. M., Mohamed, A., Sahena, F., et al. (2013). Techniques for extraction of bioactive compounds from plant materials: A review. *Journal of Food Engineering*, 117(4), 426–436.
- Bailey, R. L., Gahche, J. J., Lentino, C. V., Dwyer, J. T., Engel, J. S., Thomas, P. R., et al. (2011). Dietary supplement use in the United States, 2003–2006. *The Journal of Nutrition*, 141(2), 261–266.
- Bent, S. (2008). Herbal medicine in the United States: Review of efficacy, safety, and regulation. *Journal of General Internal Medicine*, 23(6), 854–859.
- Björnsson, H. K., Björnsson, E. S., Avula, B., Khan, I. A., Jonasson, J. G., Ghabril, M., et al. (2020). Ashwagandha-induced liver injury: A case series from Iceland and the US Drug-Induced Liver Injury Network. *Liver International*, 40(4), 825–829.
- Burey, P., Bhandari, B. R., Rutgers, P. G., Halley, P. J., & Torley, P. J. (2009). Confectionery gels: A review on formulation, rheological and structural aspects.

- International Journal of Food Properties*, 12(1), 176–210.
- Calixto, J. B. (2000). Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicines (phytotherapeutic agents). *Brazilian Journal of Medical and Biological Research*, 33(2), 179–189.
- Chandrasekhar, K., Kapoor, J., & Anishetty, S. (2012). A prospective, randomized double-blind, placebo-controlled study of safety and efficacy of a high-concentration full-spectrum extract of ashwagandha root in reducing stress and anxiety in adults. *Indian Journal of Psychological Medicine*, 34(3), 255–262.
- Cohen, P. A., Avula, B., Wang, Y.-H., Katragunta, K., & Khan, I. (2023). Quantity of melatonin and CBD in melatonin gummies sold in the US. *JAMA*, 329(16), 1401–1402.
- Delgado, P., & Bañón, S. (2015). Determining the minimum drying time of gummy confections based on their mechanical properties. *CyTA – Journal of Food*, 13(3), 329–335.
- Dwyer, J. T., Coates, P. M., & Smith, M. J. (2018). Dietary supplements: Regulatory challenges and research resources. *Nutrients*, 10(1), Article 41.
- Edwards, W. P. (2000). The science of sugar confectionery. *Royal Society of Chemistry*.
- Ekor, M. (2014). The growing use of herbal medicines: Issues relating to adverse reactions and challenges in monitoring safety. *Frontiers in Pharmacology*, 4, Article 177.
- Erland, L. A. E., & Saxena, P. K. (2017). Melatonin natural health products and supplements: Presence of serotonin and significant variability of melatonin content. *Journal of Clinical Sleep Medicine*, 13(2), 275–281.
- European Parliament and Council. (2002). Directive 2002/46/EC of 10 June 2002 on the approximation of the laws of the Member States relating to food supplements. *Official Journal of the European Communities*, L183, 51–57.
- Ezhilarasi, P. N., Karthik, P., Chohanwal, N., & Anandharamakrishnan, C. (2013). Nanoencapsulation techniques for food bioactive components: A review. *Food and Bioprocess Technology*, 6(3), 628–647.
- Fabricant, D. S., & Farnsworth, N. R. (2001). The value of plants used in traditional medicine for drug discovery. *Environmental Health Perspectives*, 109(Suppl. 1), 69–75.
- Fang, Z., & Bhandari, B. (2010). Encapsulation of polyphenols – A review. *Trends in Food Science & Technology*, 21(10), 510–523.
- Food Safety and Standards Authority of India. (2016). Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016. FSSAI.
- Gibbs, B. F., Kermasha, S., Allii, L., & Mulligan, C. N. (1999). Encapsulation in the food industry: A review. *International Journal of Food Sciences and Nutrition*, 50(3), 213–224.
- Gómez-Guillén, M. C., Giménez, B., López-Caballero, M. E., & Montero, M. P. (2011). Functional and bioactive properties of collagen and gelatin from alternative sources: A review. *Food Hydrocolloids*, 25(8), 1813–1827.
- Gupta, S. C., Patchva, S., & Aggarwal, B. B. (2013). Therapeutic roles of curcumin: Lessons learned from clinical trials. *The AAPS Journal*, 15(1), 195–218.
- Hartel, R. W., von Elbe, J. H., & Hofberger, R. (2018). Confectionery science and technology. Springer.
- Hasler, C. M. (2002). Functional foods: Benefits, concerns and challenges—A position paper from the American Council on Science and Health. *The Journal of Nutrition*, 132(12), 3772–3781.
- Hawkins, J., Baker, C., Cherry, L., & Dunne, E. (2019). Black elderberry (*Sambucus nigra*) supplementation effectively treats upper respiratory symptoms: A meta-analysis of randomized, controlled clinical trials. *Complementary Therapies in Medicine*, 42, 361–365.
- Izzo, A. A., & Ernst, E. (2009). Interactions between herbal medicines and prescribed drugs: An updated systematic review. *Drugs*, 69(13), 1777–1798.
- Karim, A. A., & Bhat, R. (2009). Fish gelatin: Properties, challenges, and prospects as an alternative to mammalian gelatins. *Food Hydrocolloids*, 23(3), 563–576.
- Livesey, G. (2003). Health potential of polyols as sugar replacers, with emphasis on low glycaemic properties. *Nutrition Research Reviews*, 16(2), 163–191.
- Manach, C., Scalbert, A., Morand, C., Rémésy, C., & Jiménez, L. (2004). Polyphenols: Food sources and bioavailability. *The American Journal of Clinical Nutrition*, 79(5), 727–747.
- May, C. D. (1990). Industrial pectins: Sources, production and applications. *Carbohydrate Polymers*, 12(1), 79–99.
- Moynihan, P., & Petersen, P. E. (2004). Diet, nutrition and the prevention of dental diseases. *Public Health Nutrition*, 7(1A), 201–226.
- Mutlu, C., Tontul, S. A., & Erbaş, M. (2018). Production of a minimally processed jelly candy for children using honey instead of sugar. *LWT – Food Science and Technology*, 93, 499–505.
- Nelson, K. M., Dahlin, J. L., Bisson, J., Graham, J., Pauli, G. F., & Walters, M. A. (2017). The essential medicinal chemistry of curcumin. *Journal of Medicinal Chemistry*, 60(5), 1620–1637.
- Newman, D. J., & Cragg, G. M. (2020). Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. *Journal of Natural Products*, 83(3), 770–803.
- Newmaster, S. G., Grguric, M., Shanmughanandhan, D., Ramalingam, S., & Ragupathy, S. (2013). DNA barcoding detects contamination and substitution in North American herbal products. *BMC Medicine*, 11, Article 222.
- Panosian, A., & Wikman, G. (2010). Effects of adaptogens on the central nervous system and the molecular mechanisms associated with their stress-protective activity. *Pharmaceuticals*, 3(1), 188–224.
- Saper, R. B., Kales, S. N., Paquin, J., Burns, M. J., Eisenberg, D. M., Davis, R. B., et al. (2004). Heavy metal content of Ayurvedic herbal medicine products. *JAMA*, 292(3), 2868–2873.
- Sasidharan, S., Chen, Y., Saravanan, D., Sundram, K. M., & Latha, L. Y. (2011). Extraction, isolation and characterization of bioactive compounds from plants' extracts. *African Journal of Traditional, Complementary and Alternative Medicines*, 8(1), 1–10.
- Schiele, J. T., Quinzler, R., Klimm, H.-J., Pruszylo, M. G., & Haefeli, W. E. (2013). Difficulties swallowing solid oral dosage forms in a general practice population: Prevalence, causes, and relationship to dosage forms. *European Journal of Clinical Pharmacology*, 69(4), 937–948.
- Singh, N., Bhalla, M., de Jager, P., & Gilca, M. (2011). An overview on ashwagandha: A Rasayana (rejuvenator) of Ayurveda. *African Journal of Traditional, Complementary and Alternative Medicines*, 8(5 Suppl.), 208–213.
- Sohi, H., Sultana, Y., & Khar, R. K. (2004). Taste masking technologies in oral pharmaceuticals: Recent developments and approaches. *Drug Development and Industrial Pharmacy*, 30(5), 429–448.
- United States Congress. (1994). Dietary Supplement Health and Education Act of 1994 (Public Law 103-417).
- Williamson, G., & Manach, C. (2005). Bioavailability and bioefficacy of polyphenols in humans. II. Review of 93 intervention studies. *The American Journal of Clinical Nutrition*, 81(1), 243S–255S.
- World Health Organization. (2007a). WHO guidelines on assessing quality of herbal medicines with reference to contaminants and residues.
- World Health Organization. (2007b). WHO guidelines on good manufacturing practices (GMP) for herbal medicines.
- World Health Organization. (2013). WHO traditional medicine strategy: 2014–2023.
- World Health Organization. (2015). Guideline: Sugars intake for adults and children.