

# Nutritional and technological potential of mushrooms for meat products development

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## Abstract

The growing demand for sustainable and nutritious protein sources has increased interest in alternative ingredients for meat products. Mushrooms are increasingly recognised as a meat substitute and supplement due to their umami-enhancing properties, high protein content (19–35 % of dry weight), bioactive compounds and functional properties. They offer a fibrous texture, essential amino acids and various health benefits, including improved cardiovascular and digestive health. They also have a smaller environmental footprint compared to conventional meat production. This review examines the nutritional contributions of mushrooms, their technological applications in meat products and their role in hybrid and plant-based meat alternatives. Advances are discussed and challenges such as low protein content in fresh weight, textural limitations and short shelf life are addressed. While mushrooms alone cannot fully replace meat, they are making an important contribution to the development of sustainable, nutritious and consumer-acceptable meat alternatives that align with future trends in food innovation.

**Keywords:** mushroom, hybrid meat, meat analogues, flavour, texture, nutritional properties

## Introduction

The human diet requires seven essential nutrients: carbohydrates, proteins, fats, minerals, vitamins, fiber and water. That requirements can be obtained from many food sources. Among those, meat remains a choice for many consumers due to its cultural significance, nutritional value, convenience, and affordability (Allievi et al., 2015), with strong consumer attachment further reinforcing its demand (Grača et al., 2015). Looking nutritionally, meat is a valuable source of high-quality protein, vitamins and minerals, but is deficient in vitamin C, calcium, fiber and antioxidants, highlighting the

need for a varied diet (Lawrie & Ledward, 2006). However, the consumption of processed meat has been linked to chronic diseases such as obesity, diabetes and cardiovascular disease, leading to a shift to a healthier diet rich in unsaturated fats, vitamins, minerals and nutraceuticals (Corpet, 2011; Young et al., 2013; McClements et al., 2021).

Given the increasing global demand for protein, ensuring adequate nutrition while maintaining a sustainable food supply is a major challenge (Mazac et al., 2022). Meat production has been marked with significant impact on the environ-

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ment through greenhouse gas emissions, extensive land use and high water consumption, raising sustainability concerns (Poore & Nemecek, 2018). In addition, the use of antibiotics in livestock farming contributes to antibiotic resistance (Llor & Bjerrum, 2014). As a result, more and more people are adopting a plant-based diet, with some avoiding animal products (vegans), others avoiding meat but consuming dairy products and eggs (vegetarians), and many reducing meat consumption while keeping their diet flexible (flexitarians) (Das et al., 2021).

These dietary changes are transforming the food industry, leading to a reformulation of products and the development of alternatives with improved nutritional value and lower environmental impact (Das et al., 2020; McClements et al., 2021). Consumers are increasingly demanding foods with lower levels of salt, fat, cholesterol, nitrites and calories (Guerrero et al., 2009). However, when modifying traditional recipes, nutritional improvements need to be balanced with sensory properties and consumer acceptance. Advances in food reformulation and novel processing technologies offer viable solutions to improve both health outcomes and sustainability.

One promising approach is the development of hybrid meat products and meat analogues that combine meat with sustainable ingredients such as legumes, grains, tubers, fruits, pulses, insects, algae, mushrooms, etc. Hybrid meat products are products in which part of the meat is replaced by more sustainable protein sources usually called replacers or extenders. On the other hand, meat analogues are non-meat products designed to replicate the taste, texture, and nutritional profile of conventional meat. Those alternatives are aimed to optimize nutrition, taste and sustainability while reducing the environmental footprint of food production (Grasso & Jaworska, 2020; Rocchetti et al., 2023; Tkaczewska et al., 2024). As part of future food strategies, such innovations not only support consumer health, but also contribute to long-term food security.

Mushrooms are gaining scientific interest for hybrid meat products due to their umami-enhancing properties, nutritional value, and functional properties (Dermiki et al., 2013). Composed of 90 % water, their dry matter contains 19–35 % protein, comparable to meat and soybeans, with all essential amino acids and a digestibility rate of

72–83 % (Zhang et al., 2017; Wang & Zhao, 2023). Studies confirm that mushroom-derived ingredients, such as stems and stem trimmings, can be effectively incorporated into various meat products, including chicken sausages, cooked sausages, and fermented pork sausages (Jo et al., 2019; Wan Rosli et al., 2015; Choe et al., 2018; Van Ba et al., 2017).

The aim of this paper is to explore the nutritional and technological potential of mushrooms in meat products, focusing on their protein content, bioactive compounds, and functional properties. It highlights their role as sustainable meat extenders, enhancing nutrition, sensory quality, and environmental sustainability to meet evolving consumer demands.

### **The contribution of mushrooms to human nutrition**

Fresh edible mushrooms contain about 90 % water. The remaining 10 % belongs to dry matter which is very variable between species. Previous research has shown that mushrooms are composed of 8–40 % protein, 3–28 % carbohydrate, 3–32 % fiber, 2–8 % fat, and 8–10 % ash, and this variability is due to the use of many different species (Wang et al., 2014). Şenilă et al. (2024) analyzed the chemical composition of widely consumed mushroom species and reported that four popular edible varieties (*Agaricus campestris* L., *Boletus edulis* Bull., *Macrolepiota procera* (Scop.) Singer, and *Russula cyanoxantha* (Schaeff.) Fr. collected contained 22–28 % protein and 2–5 % lipids on a dry weight basis. That protein content is comparable to meat and soybeans, with all essential amino acids and digestibility rates of 72–83 % (Bilal, 2010; Zhang et al., 2017; Wang & Zhao, 2023).

Mushrooms are low in fat, cholesterol-free, and rich in unsaturated fatty acids, particularly linoleic acid (Das et al., 2021; Liu et al., 2021). Due to their low concentration of fat and digestible carbohydrates, they are suitable for improving the nutritional profile of foods (Lakhanpal & Rana, 2005). Mushrooms possess remarkable bioaccumulating properties that make them an excellent source of essential minerals, including potassium, phosphorus, magnesium, calcium, iron, zinc, selenium, cobalt and manganese (Bilal, 2010; Kalač, 2013). These minerals play an important role in various physiological processes, such as bone health, enzyme function, oxygen transport and immune system support.

Mushrooms are also an excellent source of B vitamins, including thiamine, riboflavin, niacin and pantothenic acid, while UV exposure increases their vitamin D content (Das et al., 2021). However, they lack vitamins A and E but contain carotenoids and small amounts of vitamin C (Bilal, 2010). In addition, mushrooms also contain bioactive compounds such as functional polysaccharides, hydroxybenzoic acids, hydroxycinnamic acids, phenolic acids, chlorogenic acid, syringic acid, gallic acid, protocatechuic acids, vanillic acid, tannins, lignans, oxidized polyphenols, terpenoids and adenosine derivatives. These contribute to various health benefits and have anti-inflammatory, anti-diabetic, prebiotic and hepatoprotective effects (Ma et al., 2018; Abdelshafy et al., 2021; Yin et al., 2021; Zhang et al., 2021), and in general a positive therapeutic effect. Furthermore, it has long been known that polysaccharide-protein complexes and lectins in mushrooms have immunomodulatory and anti-tumor effects (Wang et al., 1996), they lower blood pressure (Tam et al., 1986) and inhibit angiogenesis (Jana and Acharya, 2020). Therefore, the use of mushrooms in meat products could bring benefits to consumers.

### Behind potential of mushroom use

The flavour of mushrooms is influenced by a combination of amino acids and volatile compounds that vary by species and contribute to their distinctive taste and aroma. These components play a crucial role in determining the sensory characteristics of different mushroom varieties and make them valuable for various culinary applications. Amino acids are central to the flavour of mushrooms, with glutamic acid and aspartic acid responsible for the umami flavour, while serine and alanine enhance sweetness. Conversely, histidine, leucine, isoleucine and phenylalanine impart bitterness to mushrooms, while arginine and proline have both sweet and bitter properties. In addition, cysteine and methionine impart mild sulphur notes that further enrich the flavour profile (Zhang et al., 2017; Wang & Zhao, 2023). Ribonucleotides, which are also abundant in mushrooms, enhance their characteristic spicy, bready and meaty flavour (Sogari et al., 2021).

The mushroom aroma is largely determined by volatile organic compounds (VOCs), especially alcohols with eight carbon atoms and ketones, which vary from species to species (Maga, 1981).

Among these, 1-octen-3-ol is the dominant compound that contributes significantly to the aroma of fresh mushrooms, especially in oyster mushrooms, where it accounts for almost 70 % of the volatile compounds (Jung et al., 2019). The aroma of shiitake (*Lentinula edodes* (Berk.) Pegler) is determined by 1-octen-3-ol and 1-octen-3-one, which give it an earthy scent, while the white button mushroom (*Agaricus bisporus* (J.E.Lange) Imbach) contains benzyl alcohol and benzaldehyde, which are responsible for its slightly metallic odour (Pyysalo, 1976). During cooking, heat treatment oxidises the lipids, producing ketones and alcohols that enhance the characteristic aroma of the mushroom. For example, heating *A. bisporus* increases the levels of 3-octanone (enhancing mushroom-like notes) and 1-octen-3-ol (creating a mild botanical aroma with a faint metallic undertone) (Shi et al., 2018). These flavour changes contribute to the complex sensory appeal of mushrooms in culinary applications.

Due to their umami flavour and meat-like texture, mushrooms are often used as a meat substitute or extender in hybrid meat products and can be an important ingredient in meat analogues. Consumers often accept mushroom-based products because they are very similar to meat in both taste and mouthfeel (Lang, 2020). Research suggests that the addition of mushrooms to meat products improves functional properties such as water holding capacity, cooking performance, texture, emulsion stability, juiciness and shelf life without compromising taste or structure. Pérez Montes et al (2021) emphasised that mushrooms serve as effective meat additives due to their fibre content, easily digestible proteins and fibrous nature, addressing both health and sustainability concerns associated with conventional meat consumption. Similarly, Patinho et al. (2021) found that the integration of mushrooms into meat-based recipes improves nutritional value, antioxidant activity and sensory quality, making them increasingly popular in the food industry.

With mushroom production on the rise, large-scale production of mushroom-based meat substitutes is possible. Mushroom proteins have several advantages over other non-meat protein sources:

1. Umami-rich flavour, which is generally more acceptable than the beany taste of plant proteins.
2. Fibrous structure that resembles the texture

of meat.

3. Nutraceutical properties that provide various health benefits.
4. Antimicrobial properties that help extend the shelf life of meat substitutes (Singh et al., 2023).

Mushroom varieties commonly used as meat substitutes include white button mushrooms, shiitake, portobello, chanterelle and enoki, which are often used as substitutes for beef, shrimp and chicken (Singh et al., 2021a). In addition, their high fibre content improves the texture, stabilisation, emulsification, thickening and gelling of foods (Das et al., 2021).

### Technological potential of mushrooms in meat applications

In addition to flavour, mushrooms improve the functional and technological properties of meat products by serving as a substitute for protein, fat, phosphate and salt. Thanks to their moisture- and fat-binding properties, which help to maintain the desired sensory properties, they are particularly popular as a fat substitute in beef burgers. Studies on mushroom-meat blends (e.g. burgers, tacos and patties) have shown that meat consumption can be significantly reduced without compromising texture or taste (Sogari et al., 2021).

Mushroom proteins are emerging as sustainable alternatives to conventional meat sources. Given the environmental impact of livestock farming, the search for cost-effective, resource-efficient protein sources is essential. Although mushrooms contain less protein by fresh weight than meat, they offer valuable functional properties, taste and culinary versatility (Lee et al., 2020). Some researchers advocate for increased use of mushrooms in meat substitutes, emphasising their role in improving nutritional value and sensory properties such as appearance, texture and flavour (Yuan et al., 2022). Consequently, mushroom-based meat products represent a beneficial, appealing and technologically feasible approach for sustainable and health-conscious food innovation.

### Mycoproteins as a sustainable meat alternative

Mycoprotein, derived from the fermentation of mushrooms, is a high-protein, low-fat ingredient with a fibrous, meat-like texture that makes it a key component in plant-based food formulations. It is mainly produced by the submerged fermentation of *Fusarium venenatum* Nirenberg

on a glucose-based substrate, which enables efficient large-scale production in high-metabolism bioreactors (Schweiggert-Weisz et al., 2020). Studies confirm that mycoprotein is safe, well tolerated and has minimal allergenic potential (Finnigan et al., 2019). Although its digestibility is lower compared to some other protein sources, its ability to mimic the texture and taste of meat makes it an attractive alternative for a partial or complete meat substitute (Singh et al., 2021a). Advances in biotechnology have increased production efficiency and reduced costs while improving the sensory and nutritional properties of mycoproteins (Finnigan et al., 2019).

Other fungal-based meat substitutes, e.g. from *Aspergillus oryzae* (Ahlburg) E. Cohn, are also widely used due to their sinewy, muscle-like structure. Today, mycoprotein is an important component of various plant-based alternatives, including minced meat, chicken substitutes, burgers, sausages, nuggets and ready meals, demonstrating its versatility in food innovation (Denny et al., 2008).

### Advances in mushroom-based meat analogues

Among the various processes for the production of meat analogues, extrusion remains the most widely used process due to its high efficiency, cost-effectiveness and scalability (Singh et al., 2021a). This process uses heat and pressure to denature heat-sensitive, nutrient-inhibiting compounds such as trypsin inhibitors and hemagglutinins while inactivating enzymes such as lipoxigenases, peroxidases and lipoxidases. Extrusion improves the digestibility of proteins by unfolding, cross-linking and restructuring proteins into fibrous aggregates that resemble muscle fibres. Operation at 140–180 °C facilitates protein polymerization, Maillard reactions, caramelization, hydrolysis and degradation of pigments, all of which refine the texture, colour and flavour of mushroom-based meat analogues (Zhang et al., 2019).

Extrusion has been successfully used in the development of mushroom-based meat substitutes to improve both texture and functional properties. For example, Kumar et al. (2012) demonstrated that replacing texturized soy protein with mushrooms significantly improved the sensory properties of plant-based nuggets. Similarly, Cho and Ryu (2021) developed extruded meat analogues by incorporating 4 %, 8 % and 12 % oyster mushrooms into a soy-wheat gluten-corn starch mixture (ratio

0.5:0.4:0.1). Using a twin-screw extruder at 170 °C, 55 % moisture content and a screw speed of 150 rpm, significant improvements in texture and antioxidant properties, including DPPH scavenging activity and retention of phenolic compounds, were observed. In addition, Mazlan et al. (2020) successfully formulated a mushroom soy protein meat analogue using a single-screw extruder.

In addition to extrusion, additive manufacturing technologies for mushroom-based meat substitutes are also being explored. 3D printing has been used to customise the shape and texture of mushroom analogues, resulting in improved physicochemical and sensory properties (Keerthana et al., 2020). However, the complex fibre networks in mushrooms pose a challenge as they can lead to material aggregation and clog printing nozzles. Nevertheless, 3D printing allows precise control of the nutrient composition and product structure, so that muscle fibre-like textures can be created.

4D printing goes one step further by allowing food to change shape, colour, taste or nutrient composition in response to external stimuli (Chen et al., 2022). This technique uses food-grade inks with shear-thinning properties that enable smooth extrusion and stable solidification after printing. Chen et al. (2022) successfully applied this method with shiitake mushrooms and mashed potatoes and showed how UV irradiation converted ergosterol to vitamin D2 in 3D printed food. This 4D printing approach not only facilitated the structural transformation of mushroom products but also improved vitamin D2 synthesis by optimising the irradiation surface.

With continued advances in extrusion and additive manufacturing, mushroom-based meat analogues are becoming increasingly customizable, nutritionally enriched and sustainable, positioning them as viable alternatives to conventional meat products.

### About consumer perception

Understanding consumer perceptions is critical to the successful development of hybrid meat products and meat analogues. Identifying the key motivators and barriers that influence consumer decisions helps guide innovation and market adoption (Boukid, 2021). Key factors influencing the consumption and purchase of hybrid meat products or meat analogues include taste, cost, brand perception, satisfaction, health benefits,

animal welfare and environmental impact (Boukid, 2021). Research shows that consumer priorities follow a specific hierarchy, with price being the most influential factor, followed by environmental concerns, taste, health benefits, organic certification and vegetarian suitability (Apostolidis & McLeay, 2016).

Demographic factors such as gender, age, geographical location and level of education also have a significant influence on purchasing behaviour. A cross-national study comparing the USA, China and India revealed different preferences: in the US, attractiveness, minimal dissatisfaction and enthusiasm were the strongest predictors of meat substitute purchases; in China, overall health, sustainability, attractiveness and taste played the most significant roles; whereas in India, wholesomeness, sustainability, necessity and enthusiasm were the most important determinants of purchasing behaviour (Rathore et al., 2019). These findings underline the strong correlation between dietary habits and consumers' willingness to adopt meat alternatives. Within this paradigm, three major consumer segments can be identified: "meat eaters" (who primarily consume traditional animal products), "meat reducers" (flexitarians who want to reduce their meat consumption) and "meat avoiders" (vegetarians and vegans who avoid meat altogether) (Apostolidis & McLeay, 2016). Edible mushroom-based meat analogues have the potential to appeal to all three groups as they offer a natural umami flavour, meat-like texture and high protein content, making them a viable alternative for omnivores, flexitarians, vegetarians and vegans alike (Singh et al., 2023).

However, further research is needed to optimise sensory properties (taste, flavour and texture), improve processing techniques and increase consumer acceptance of mushroom-based meat analogues. In addition, exploring the potential of medicinal mushrooms in meat alternatives could further increase their health benefits and market appeal (Singh et al., 2023).

### Challenges of using mushrooms in meat products and analogues

Despite their many benefits, mushrooms present a number of challenges when used in hybrid meat and analogous products, including low protein content when fresh, presence of anti-nutrients and toxins, texture limitations, short shelf

life, binding and emulsification limitations, flavour variability, allergenic potential, digestibility issues, cost, and scalability (Kok Kee et al., 2022).

Compared to soy, pea or wheat proteins, mushrooms have a relatively low protein content (approx. 2 to 4 % of fresh weight), which makes them less suitable as a primary protein source in meat alternatives. Furthermore, while chitin, a dietary fiber found in the cell walls of mushrooms, has positive biological functions, it also reduces digestibility, further limiting their effectiveness as a high-protein meat substitute (Vetter, 2007). Mushrooms also lack certain essential amino acids, making it difficult to achieve a complete protein profile, which is crucial for a plant-based diet (Reis et al., 2012).

A major disadvantage of fresh mushrooms is their short shelf life, as they are susceptible to microbial growth and enzymatic browning due to their high water activity (Castellanos-Reyes et al., 2021). To extend shelf life in processed foods, mushrooms often need to be dried, frozen or fermented (Singh et al., 2021a). Their high moisture content also affects the texture and firmness of meat alternatives, making it difficult to mimic the bite and elasticity of animal proteins such as myosin and actin (Beelman et al., 1987). To improve texture and firmness, processing techniques such as extrusion or blending with other plant proteins are required.

Although mushrooms contribute umami flavour, they also have a distinct earthy taste that not all consumers find pleasant. Their ability to absorb flavour can be both an advantage and a challenge, as improper seasoning or formulation can lead to undesirable flavour profiles in meat alternatives. Furthermore, even mycoprotein-based products have sensory limitations. A study by Chezan et al (2022) found that while European consumers recognize the benefits of mushroom-

based meat alternatives, their purchase intent remains limited due to concerns about the taste and perceived "naturalness" of mycoproteins.

Finally, large-scale mushroom cultivation requires a controlled environment and specialized substrates, which increases production costs. This economic factor has contributed to mushroom production declining or remaining at a low level in industrialized countries, while it continues to grow in regions such as India (Singh et al., 2021b). Furthermore, processing mushrooms into stable, textured meat analogues can be expensive as additional ingredients and processing steps are required (Okuda, 2022).

## Conclusion

Mushrooms are a valuable ingredient in hybrid meat products and meat analogues due to their nutritional value, umami flavour and fibrous nature. Their bioactive compounds, minerals and fiber promote health and functionality, while advances in processing technology improve texture and stability. However, challenges such as low fresh weight protein content, short shelf life and binding restrictions require innovative processing solutions. Consumer acceptance depends on taste, cost and health benefits, highlighting the need for continued research and product development. While mushrooms are not a complete meat substitute, they offer a sustainable, nutritious alternative that supports a healthier and more environmentally friendly food system.

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## Nutritivni i tehnološki potencijal gljiva za razvoj mesnih proizvoda

### Sažetak

Rastuća potražnja za održivim i nutritivno bogatim izvorima proteina povećala je interes za alternativne sastojke u mesnim proizvodima. Gljive su sve više prepoznate kao zamjena i dodatak mesu zbog svojih svojstava poboljšanja umami okusa, visokog sadržaja proteina (19–35 % suhe tvari), bioaktivnih spojeva i funkcionalnih karakteristika. One pružaju vlaknastu teksturu, esencijalne aminokiseline i razne zdravstvene koristi, uključujući poboljšano kardiovaskularno i probavno zdravlje. Također imaju manji ekološki otisak u usporedbi s konvencionalnom proizvodnjom mesa. Ovaj pregled analizira nutritivne doprinose gljiva, njihove tehnološke primjene u mesnim proizvodima te njihovu ulogu u hibridnim i biljnim alternativama mesa. Razmatraju se napreci i izazovi poput niskog sadržaja proteina u svježoj masi, ograničenja u teksturi i kratkog roka trajanja. Iako gljive same po sebi ne mogu u potpunosti zamijeniti meso, one daju važan doprinos razvoju održivih, nutritivno bogatih i potrošački prihvatljivih mesnih alternativa koje su u skladu s budućim trendovima prehrambenih inovacija.

**Glavne riječi:** gljive, hibridno meso, zamjene za meso, okus, tekstura, nutritivna svojstva

## Ernährungsphysiologisches und technologisches Potenzial von Pilzen für die Entwicklung von Fleischerzeugnissen

### Zusammenfassung

Die wachsende Nachfrage nach nachhaltigen und nahrhaften Proteinquellen hat das Interesse an alternativen Zutaten für Fleischerzeugnisse erhöht. Pilze werden aufgrund ihrer umami-steigernden Eigenschaften, ihres hohen Proteingehalts (19-35% des Trockengewichts), ihrer bioaktiven Verbindungen und ihrer funktionellen Eigenschaften zunehmend als Fleischersatz und -ergänzung anerkannt. Sie bieten eine faserige Textur, essenzielle Aminosäuren und verschiedene gesundheitliche Vorteile, einschließlich einer verbesserten Herz-Kreislauf- und Verdauungsgesundheit. Außerdem haben sie im Vergleich zur herkömmlichen

Fleischproduktion einen geringeren ökologischen Fußabdruck. In dieser Übersicht werden die ernährungsphysiologischen Beiträge von Pilzen, ihre technologischen Anwendungen in Fleischerzeugnissen und ihre Rolle in hybriden und pflanzlichen Fleischalternativen untersucht. Es werden Fortschritte erörtert und Herausforderungen wie der geringe Proteingehalt im Frischgewicht, Einschränkungen in Bezug auf die Textur und die kurze Haltbarkeit angesprochen. Auch wenn Pilze allein Fleisch nicht vollständig ersetzen können, leisten sie doch einen wichtigen Beitrag zur Entwicklung nachhaltiger, nahrhafter und für den Verbraucher akzeptabler Fleischalternativen, die sich an den künftigen Trends der Lebensmittelinnovation orientieren.

**Schlüsselwörter:** Pilze, Hybridfleisch, Fleischersatz, Geschmack, Textur, Nährwerteigenschaften

## Potencial nutricional y tecnológico de los hongos para el desarrollo de productos cárnicos

### Resumen

La creciente demanda de fuentes de proteína sostenibles y nutritivas ha impulsado el interés en ingredientes alternativos para la elaboración de productos cárnicos. Los hongos son cada vez más reconocidos como sustitutos y complementos de la carne debido a sus propiedades potenciadoras del sabor umami, su elevado contenido proteico (19–35% del peso seco), su riqueza en compuestos bioactivos y sus propiedades funcionales. Ofrecen una textura fibrosa, aminoácidos esenciales y diversos beneficios para la salud, incluyendo la mejora de la salud cardiovascular y digestiva. Además, presentan una menor huella ambiental en comparación con la producción cárnica convencional. Esta revisión analiza las aportaciones nutricionales de los hongos, sus aplicaciones tecnológicas en productos cárnicos y su papel en el desarrollo de alternativas cárnicas híbridas y de origen vegetal. Se discuten los avances alcanzados y se abordan los desafíos existentes, como el bajo contenido proteico en peso fresco, las limitaciones texturales y la corta vida útil. Aunque los hongos por sí solos no pueden reemplazar completamente la carne, están contribuyendo de manera significativa al desarrollo de alternativas cárnicas sostenibles, nutritivas y aceptadas por los consumidores, en consonancia con las tendencias futuras en innovación alimentaria.

**Palabras claves:** hongos, carne híbrida, análogos cárnicos, sabor, textura, propiedades nutricionales

## Potenziale nutrizionale e tecnologico dei funghi nello sviluppo di prodotti a base di carne

### Riassunto

La crescente domanda di fonti proteiche sostenibili e ad alto valore nutrizionale ha aumentato l'interesse verso l'integrazione di ingredienti alternativi nei prodotti a base di carne. I funghi stanno progressivamente guadagnando terreno come ingredienti sostitutivi e complementari della carne, grazie alle loro proprietà funzionali, tra cui la capacità di esaltare il gusto umami, l'elevato contenuto proteico (19–35% nella sostanza secca), la presenza di composti bioattivi e il contributo a livello sensoriale e strutturale. I funghi apportano una consistenza fibrosa simile alla carne, oltre a fornire aminoacidi essenziali e benefici nutrizionali che supportano la salute cardiovascolare e la funzionalità dell'apparato digerente. Inoltre, rispetto alla produzione convenzionale di carne, i funghi presentano un impatto ambientale notevolmente ridotto. Il presente lavoro esamina il contributo nutrizionale dei funghi, le loro potenzialità tecnologiche nei prodotti a base di carne e il loro ruolo nella formulazione di prodotti ibridi e di sostituti vegetali della carne. Sono inoltre considerati gli sviluppi recenti e le criticità ancora presenti, quali la bassa densità proteica nella massa fresca, le limitazioni nella texture e la scarsa conservabilità. Sebbene i funghi non possano ancora sostituire completamente le caratteristiche sensoriali, tecnologiche e nutrizionali della carne, essi rappresentano un valido alleato nello sviluppo di alternative sostenibili, ricche di nutrienti e accettate dal consumatore, in linea con le tendenze emergenti dell'innovazione alimentare.

**Parole chiave:** funghi, carne ibrida, sostituti della carne, gusto, texture, proprietà nutrizionali