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Properties of yeast extract in functional nutrition: A review of the literature

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Abstract. Yeast extract, obtained from the intracellular contents of yeast, mainly *Saccharomyces cerevisiae*, is a promising natural ingredient in functional foods. The relevance of its research was due to the growing global demand for sustainable, nutritious and functional components, as well as its ability to improve the taste of products. Yeast extract production often uses agro-industrial waste, such as spent brewer's yeast, making it an environmentally friendly and cost-effective alternative to traditional protein sources. The aim of this study was to systematise and analyse the available scientific evidence on the nutrient profile, functional properties and mechanisms of action of yeast extract and its bioactive components. Methods of analysis and synthesis of scientific literature data were used, covering the results of *in vitro* and *in vivo* studies in animals and clinical trials in humans. The main results showed that yeast extract is an exceptional source of high-quality protein with a complete amino acid profile that surpasses many traditional plant and some animal sources. It is also rich in B vitamins, including B12, and a wide range of minerals, making it valuable for dietary enrichment, especially for vegetarians and vegans. Studies have found that yeast extract contains biologically active compounds such as beta-glucans, mannan-oligosaccharides, nucleotides and glutathione, each of which has proven functional properties. The synergistic action of these components provides a comprehensive health effect that exceeds the effects of individual ingredients. In addition, the ability of yeast extract to enhance umami flavour and mask bitterness is a critically important functional attribute that contributes to consumer acceptance and the effectiveness of functional products. The practical value of the work lies in substantiating the widespread use of yeast extract in functional foods and dietary supplements to improve overall health and well-being, taking into account its safety profile and the need for further research to optimise dosages and bioavailability

Keywords: *Saccharomyces cerevisiae*; beta-glucans; mannan-oligosaccharides; nucleotides; glutathione; immunomodulation

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Introduction

Yeast, single-celled eukaryotic fungi, has been known to mankind for centuries, especially the species *Saccharomyces cerevisiae* (baker's or brewer's yeast), which is key in bread baking and alcoholic beverage production. *Saccharomyces cerevisiae* is an important source of functional food additives. Yeast extract is a natural food ingredient obtained from the intracellular contents of various yeast strains, mainly *Saccharomyces cerevisiae*. Z. Tao *et al.* [1] indicated that its production usually involves autolysis or enzymolysis, processes that break down yeast cell walls to release a rich mixture of soluble components. Various production methods have been developed to obtain yeast extracts with specific properties, including autolysis, plasmolysis, enzymatic hydrolysis, and mechanical disruption, as investigated in the work of F. Demirgül *et al.* [2]. Autolysis is the most common method, based on the use of yeast cells' own (endogenous) enzymes, incubating yeast at a temperature of 45-50°C at a controlled pH. According to research by F. Karslıoğlu *et al.* [3], one of the key aspects of production is the extraction method. Hydrolysis can be enzymatic (with additional enzymes) or acidic, with the enzymatic approach considered to be gentler. Mechanical methods such as grinding, high-pressure homogenisation or ultrasonic treatment are effective for releasing intracellular components but carry the risk of degrading heat-sensitive compounds.

The resulting extract is a complex matrix containing high concentrations of proteins, peptides and free amino acids (including essential and branched-chain amino acids), B vitamins (B1, B2, B6, B12, folate), various minerals (magnesium, iron, zinc, potassium, phosphorus, calcium), carbohydrates, lipids and nucleic acids [1]. H. Wang *et al.* [4] investigated the properties of yeast extract in their work, namely its ability to impart a savoury, umami taste (due to natural glutamates, 5´-GMP and 5´-IMP, as well as various amino acids and peptides) and modulate bitter tastes in food products, its usefulness goes far beyond its taste qualities. As shown in a study by M. Whatnall *et al.* [5], yeast extracts can significantly improve the taste properties of foods. Its rich and diverse biochemical composition positions it as a powerful functional ingredient capable of providing significant health benefits. As noted by Y. Fu [6], the growing demand for natural and sustainable ingredients has increased interest in yeast extract. An important advantage of yeast extract is its production, which often utilises agro-industrial waste such as spent brewer's yeast. This was pointed out by F.F. Jacob *et al.* [7]. It offers an environmentally friendly and cost-effective alternative to traditional protein sources, in line with the principles of the circular economy, providing valuable nutrients and improving waste treatment. The ability to recycle waste and create a valuable product highlights its strategic importance in modern food production, where sustainability and cost-effectiveness are key factors, as also noted in the work of T. Upcraft *et al.* [8].

With growing demand for natural, functional and sustainable food ingredients, research into yeast extracts and their components is becoming particularly relevant. Modern research confirms not only the taste but also the significant functional properties of yeast extracts, in particular their potential as a source of proteins, beta-glucans, mannan-oligosaccharides and nucleotides [3]. These properties determine their use in various fields, from dietary supplements to animal feed [1]. For example, a study by R. Pogranichniy *et al.* [9] showed that a probiotic feed supplement based on yeast ("Immunobacterin-D") has a positive effect on the productivity of cows during lactation, confirming the effectiveness of such components in veterinary practice. In addition, the production of yeast extracts from spent yeast contributes to the development of a circular economy and waste reduction [7]. Despite significant achievements, questions remain regarding the optimisation of methods for obtaining yeast extracts to maximise the preservation of biologically active components and the study of their complex effects on the organism. As noted by I. Teimouri *et al.* [10], continuous research is expanding understanding of the properties and applications of yeast extracts.

The aim of the current study was to comprehensively analyse and systematise the latest scientific data on the nutritional profile, functional properties and mechanisms of action of yeast extract, in particular *Saccharomyces cerevisiae*, and its key bioactive components. The objectives of the study were to analyse the chemical composition and nutritional value of yeast extracts, systematise their functional properties, and justify the prospects for using the extract to create functional foods and dietary supplements.

Forty-four peer-reviewed scientific articles were selected for analysis. The search for sources was conducted in the scientometric databases Scopus, Web of Science, PubMed, and the Google Scholar search engine. The inclusion criteria covered publications that highlighted the nutrient profile, production methods, functional properties, mechanisms of action of bioactive components (beta-glucans, mannan-oligosaccharides, nucleotides, glutathione), areas of application, and safety aspects of yeast extract. The search was conducted using the keywords: "yeast extract", "functional food", "*Saccharomyces cerevisiae*", "beta-glucans", "mannan-oligosaccharides", "nucleotides", "glutathione" and "immunomodulation". Particular attention was paid to relevant data, mainly published between 2015 and 2025, covering the results of *in vitro* and *in vivo* studies on animals and clinical trials on humans. The methodology consisted of systematising and comparatively analysing the information obtained. The data was structured into thematic blocks: nutrient composition, detailed consideration of the functional properties of each key bioactive component, practical application in various fields, and potential risks. The synthesis method was used to form generalised conclusions about the complex effect of yeast extract on human health and to identify promising areas for future research.

Nutrient profile of yeast extract

Yeast biomass is a significant natural source of nutrients, rich in protein (including enzymes, peptides and all essential amino acids), carbohydrates, B vitamins and trace elements, with a low lipid content [1, 2, 10]. It can replace common allergens in food products. Regarding the allergenicity of yeast extract itself, it is important to note that it is generally considered safe and has "generally recognised as safe" (GRAS) status in many countries, including the United States (FDA), as confirmed in the Agency Response Letter [11]. However, scientific studies by X. Zonna *et al.* [12] and B. Sendid *et al.* [13] indicate the possibility of individual hypersensitivity or, more rarely, true allergy to yeast, in particular *Saccharomyces cerevisiae* and its extracts. There have been reported cases of allergic reactions, ranging from gastrointestinal disorders and skin rashes to, in very rare cases, anaphylaxis, are often associated with sensitisation to certain yeast proteins, such as enolase, or with cross-reactivity with other fungi. In addition, yeast extract produced from spent brewer's yeast may contain traces of gluten (from barley), which is an important consideration for individuals with coeliac disease or gluten sensitivity. Although yeast extract is sometimes associated with histamine intolerance, studies show that the extract itself may not contain high levels of histamine and that the problem may be related to other factors or contaminants.

When assessing the body's needs, protein plays a central role in the diet, being a fundamental structural and functional element of cells. Its importance as a nutrient lies in its supply of nitrogen and specific amino acids [6]. Although raw materials and food products are common sources of protein and amino acids, yeast protein biomass demonstrates a potentially higher protein content compared to traditional sources such as plant and animal proteins. G. Martin *et al.* [14] emphasise that the amount of protein in yeast biomass is usually equal to or greater than that in meat or soy protein and exceeds the protein content of milk. Thus, the average protein content in yeast can be 29-65% of dry weight, while in meat it is about 45% and in soybeans 35%. As noted by S. Lee *et al.* [15], this makes yeast extract an important component for overcoming protein deficiency and also highlights the high nutritional value of yeast proteins.

Yeast extracts are an important source of B vitamins, including thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B7) and folic acid (B9). The amount of these vitamins may vary depending on the type of yeast and the specifics of production. Some products are additionally enriched with vitamin B12, which is especially valuable for vegetarians and vegans, as this vitamin is mainly found in animal products. B vitamins are critical for energy metabolism, nervous system function and many other physiological functions. Given their water solubility and inability to accumulate, regular consumption of B vitamins with food is essential. In this context, yeast extracts can be a convenient way to provide the body with these important nutrients, especially for certain population groups, according to research by E. Lee *et al.* [16]. The presence of B vitamins, especially B12, and a wide range of minerals indicates that yeast extract may be a strategic ingredient for fortifying foods and supplements, helping to address common dietary deficiencies in certain population groups.

Yeast extracts contain a wide range of minerals and trace elements, including potassium, sodium, calcium, magnesium, iron, zinc, selenium, copper and phosphorus, as confirmed by research conducted by M. Mirzaei *et al.* [17]. Research by A. Ritala *et al.* [18] shows that yeast biomass is richer in nitrogen and ash than other microorganisms (fungi, algae, bacteria). The ash content is usually 5-10%, varying depending on the cultivation conditions. Thus, the presence of these minerals makes yeast extracts a valuable source of important micronutrients for the body, extending their significance beyond just improving taste.

The approximate nutrient content per 100 g of yeast extract may include: protein 45-70 g, significant amounts of B vitamins (B3 68.2-127.5 mg, B5 4.4-20.2 mg, B6 3.1-55.0 mg, B7 99.0-139.2 mcg, B9 1.4-5.8 mcg, B12 0.03-0.4 mcg) and minerals (potassium 1-2100 mg, sodium 1-3380 mg, magnesium 1.2-180 mg, iron 0.22-4.0 mg, zinc 0.13-4.2 mg, selenium 0.03-27.6 mcg), their amount varies depending on the production conditions and yeast culture [1]. The high protein content, which is transformed into free amino acids and peptides, including a complete set of essential amino acids, makes extracts a valuable nutrient. As T. Linder [19] pointed out in his work, the amino acid profile is similar to that of meat broth, and glutamic acid provides umami flavour. Thus, the lysine content in *Saccharomyces cerevisiae* protein is 65 mg/g, which is higher than in wheat (28 mg/g) and comparable to eggs (63 mg/g). In addition to the main nutrients, the extracts contain biologically active compounds: polypeptides, nucleotides, beta-glucans (with immunomodulatory properties), glutathione (antioxidant), mannans, chitin and ribose, which give them additional functional properties.

Functional properties and mechanisms of action

Yeast extract is a rich source of biologically active components that give it unique functional properties and determine its wide range of potential applications. Each of these components – from complex polysaccharides to essential amino acids and antioxidants – plays a key role in supporting various body systems, as confirmed by numerous scientific studies. Understanding the specific mechanisms of their action at the cellular and systemic levels is fundamental to the development of highly effective functional foods and dietary supplements aimed at improving health and well-being.

Beta-glucans

Beta-glucans are a heterogeneous group of non-starch polysaccharides consisting of D-glucose monomeric units linked by β-glycosidic bonds. Their biological activity depends largely on the specific source, molecular weight, degree of branching, and types of glycosidic bonds. Beta-glucans obtained from yeast, in particular *Saccharomyces cerevisiae*, are characterised by a β-(1.3) backbone with β-(1.6) side chains. This specific structural conformation is largely responsible for their potent immunomodulatory properties. In contrast, cereal beta-glucans (e.g., from oats and barley) predominantly contain β-(1.3) and β-(1.4) bonds and are mainly associated with metabolic benefits such as cholesterol reduction and glucose regulation. Fractions with higher molecular weight and specific branching frequencies (0.20-0.33) are usually correlated with greater biological activity.

According to studies by E.J. Murphy *et al.* [20] and N.N.M. Habibullah *et al.* [21], understanding the source of beta-glucans is critical to their targeted application. If the product is aimed at supporting immune health, beta-glucans derived from yeast would be the scientifically sound choice. Conversely, for cardiovascular health (lowering cholesterol) or blood glucose control, cereal beta-glucans would be more appropriate. This understanding allows for the creation of highly targeted and effective functional foods.

Yeast beta-glucans are recognised by the immune system as "pathogen-associated molecular patterns" (PAMPs), triggering a strong immune response. As shown in a study by P. Vuscan *et al.* [22], *in vitro* they bind to immune cell receptors (Dectin-1, CR3, TLRs), activating macrophages, NK cells, neutrophils, enhancing phagocytosis and cytokine secretion. Some studies suggest the induction of a "trained immune response." *In vivo* studies in animals have shown modulation of immune responses, increased resistance to infections, and antibody titres. This was pointed out by M. Maturana *et al.* [23]: in dogs, yeast products increased beneficial intestinal bacteria, which may indirectly affect immunity.

Convincing clinical evidence in humans has confirmed the immunomodulatory effects of yeast beta-glucans. A study conducted by a group of scientists led by K. Zhong *et al.* [24] showed that oral administration, usually at doses of 250 mg daily for at least 4 weeks, reduced the frequency and duration of upper respiratory tract infections (URIs). Research by N.N.M. Habibullah *et al.* [21] also confirmed a reduction in cold symptoms and an improvement in mood and fatigue in athletes. It has been demonstrated that the cell walls of brewer's yeast increase the level of immunoglobulin A (IgA) antibodies (critical for mucosal immunity), prevent a decrease in white blood cell count, increase the activity of natural killer cells, and reduce fatigue in humans. Their 12-week randomised, double-blind, placebo-controlled clinical trial demonstrated the efficacy of yeast beta-glucans (1.3/1.6) at reduced doses (120 mg and 204 mg) on symptoms of respiratory infections, fatigue, immune markers, and gut health in adults experiencing moderate stress. In turn, a study by K. Zhong *et al.* [24] also confirmed the immunomodulatory properties of beta-glucans.

In addition to immune and metabolic effects, yeast beta-glucans also exhibit significant antioxidant, antitumour and antimicrobial properties, as shown in the work of G. Gauterio *et al.* [25]. They function as prebiotics, promoting the growth of beneficial intestinal bacteria, which has a positive effect on the intestinal microflora and the overall condition of the digestive system. This effect on the intestinal microbiota is important for maintaining overall health. In addition, beta-glucans have been shown to have wound healing potential, which can accelerate regeneration processes by stimulating cell proliferation and collagen synthesis, especially in hard-to-heal ulcers. They also promote the binding of mycotoxins, helping to detoxify the body by adsorbing these harmful substances. These diverse properties highlight the multifunctionality of yeast beta-glucans in supporting health and their potential for use in functional foods and pharmaceuticals.

Mannan-oligosaccharides

Mannan-oligosaccharides (MOS) are low-molecular-weight carbohydrates (mainly composed of mannose) derived from the cell walls of *Saccharomyces cerevisiae*. A distinctive feature of MOS that differentiates them from certain other oligosaccharides is their resistance to digestion by host enzymes in the upper gastrointestinal tract, allowing them to reach the large intestine intact. They act primarily through pathogen agglutination and immunomodulation. *In vitro* studies have shown that MOS promote the growth of *Bifidobacterium* and *Lactobacillus* species and stimulate the production of short-chain fatty acids (SCFAs), as noted by W. Zhao *et al.* [26]. *In vivo* studies in animals have demonstrated that MOS bind to pathogens (*Salmonella, E. coli, Clostridia*), preventing their adhesion and colonisation, as reported by M. Kamal *et al.* [27]. They also improve intestinal morphology, modulate the gut microbiota (for example, by reducing the *Firmicutes/Bacteroidetes* ratio in mice), alleviate obesity and metabolic syndrome, and lower cholesterol levels.

Although direct clinical data on the effects of mannan-oligosaccharides (MOS) in humans are still emerging, existing studies on postbiotics derived from *Saccharomyces cerevisiae* extracts show significant potential. Results from a randomised pilot trial by I. Pinheiro *et al.* [28] demonstrated that a yeast fermentate (EpiCor) can effectively reduce gastrointestinal discomfort, including bloating and distension, in individuals suffering from constipation. The authors attributed this effect to positive modulation of the gut microbiota, including an increase in beneficial *Bifidobacterium* populations. The mechanisms underlying these changes are partly explained by *in vitro* studies, such as the work of C. Duysburgh *et al.* [29], which demonstrated that a postbiotic derived from *Saccharomyces cerevisiae* alters microbial metabolism in the distal colon, thereby generating immunomodulatory potential. The immunomodulatory action of such postbiotics is further supported by research from N. Kango *et al.* [30], while a study by R. Singh *et al.* [31] found that a yeast-based postbiotic was effective in reducing symptoms of colds and influenza in healthy children, indicating a systemic effect on immune function. Moreover, MOS exhibit pronounced anti-inflammatory properties by modulating intestinal inflammatory responses, as observed in various animal studies [27].

They can suppress the production of pro-inflammatory cytokines and activate anti-inflammatory pathways, thereby supporting the integrity of the intestinal barrier. These oligosaccharides also enhance the immunological functions of animals by stimulating cellular, humoral, and mucosal immunity through interactions with immune cells associated with gut-associated lymphoid tissue (GALT).

Nucleotides

Nucleotides are the fundamental building blocks of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), making them indispensable for all cellular processes associated with genetic information, including cell division, protein synthesis, and gene expression. Beyond their genetic roles, nucleotides are central to cellular energy metabolism, serving as components of adenosine triphosphate (ATP) – the cell's primary energy currency. They also function as key signalling molecules (for example, cyclic AMP and cyclic GMP) in a variety of intracellular and intercellular signalling pathways, including those that regulate immune responses.

Exogenous intake of nucleotides becomes important during periods of rapid growth, stress, or illness, when endogenous synthesis is insufficient – particularly for immune and gastrointestinal cells, as noted by J. Gene-Morales *et al.* [32]. *In vivo* supplementation with nucleotides supports growth and immunity by promoting the proliferation of T and B lymphocytes, NK cells, and macrophage activity [16]. Given their critical functional roles, the European Commission has approved the use of nucleotides in infant nutrition. Clinical trials have provided compelling evidence of their health benefits. Studies have shown that infants fed formula enriched with nucleotides exhibited higher production of natural killer (NK) cells compared with breastfed infants. In adult women, nucleotide supplementation (1.0 mg/day for four weeks) resulted in a twofold increase in T lymphocytes (CD3+, CD4+, CD8+), indicating an enhancement of cellular immunity [32]. According to A. Singhal *et al.* [33], randomised controlled trials in infants consistently demonstrated that the addition of nucleotides (approximately 31 mg/L) promotes greater weight gain and improved head growth (head circumference) from birth to 8 weeks.

Nucleotides accelerate tissue repair following surgery by playing a key role in cellular regeneration and DNA/RNA synthesis for the restoration of damaged structures. They also support muscle recovery and growth through enhanced protein synthesis, making them beneficial for physically active individuals and those recovering from exercise or injury. Of particular interest is their contribution to neuroprotection and brain development, as nucleotides play a crucial role in the formation of neuronal connections and in processes related to learning and memory. This also suggests potential in mitigating cognitive decline in older adults by supporting nervous system health [32]. Thus, nucleotides are multifunctional compounds that sustain vital physiological processes throughout the human lifespan and across different states of health and activity.

Glutathione

Glutathione (GSH) is a tripeptide (glutamine, glycine, cysteine) and one of the most powerful endogenous antioxidants. It exists in reduced (GSH) and oxidised (GSSG) forms, and the GSH/GSSG ratio is a critical indicator of cellular redox status and a marker of various diseases and ageing processes. It neutralises reactive oxygen and nitrogen species (such as free radicals and hydrogen peroxide), and its deficiency leads to increased oxidative stress, which is associated with the pathophysiology of numerous chronic diseases. J. Richie *et al.* [34] demonstrated that, in addition to directly eliminating free radicals, GSH plays a central role in detoxification processes by conjugating with various electrophiles and maintaining the activity of key antioxidant enzymes such as glutaredoxins and glutathione peroxidases.

Oral supplementation with GSH increases blood GSH levels and reduces markers of oxidative damage in patients with type 2 diabetes, especially in older individuals, where a decrease in HbA1c (a key long-term marker of blood glucose levels) and an increase in fasting insulin, indicating its potential as an adjunctive therapy to traditional antidiabetic treatments, as pointed out by A. Al-Temimi *et al.* [35] in their study. Low GSH levels are closely associated with various liver diseases, including hepatitis, cirrhosis, and metabolically associated fatty liver disease, and it has been shown that in such cases, GSH supplementation improves blood protein, enzyme, and bilirubin levels.

Chronic inflammation, characteristic of autoimmune diseases (e.g., rheumatoid arthritis, lupus), exacerbates oxidative stress. GSH helps alleviate this stress by modulating the immune response and directly protecting cell mitochondria from free radical damage [35]. This helps reduce tissue damage and maintain cellular health in conditions of chronic inflammation. Although direct absorption of intact GSH is limited, oral supplementation has positive results. This is possible due to the absorption of amino acid precursors (especially cysteine), which are necessary for the synthesis of glutathione in cells, as well as the stimulation of endogenous GSH synthesis by the body itself. Thus, even despite the peculiarities of absorption, glutathione supplementation can effectively replenish its stores and support the antioxidant system.

The synergistic action of yeast extract components such as beta-glucans, mannan-oligosaccharides, nucleotides and glutathione provides a comprehensive health effect that exceeds the effects of individual ingredients, as demonstrated by H. Han *et al.* [36]. For example, beta-glucans and MOS work together to support the immune system and gut health, while nucleotides enhance cellular repair and glutathione provides antioxidant protection. This multi-component matrix allows yeast extract to have a more powerful and comprehensive effect on the body than would be possible from isolated compounds.

The use of yeast extract in various industries

The wide range of functional properties of yeast extract determines its versatile application in various fields. Thanks to its rich biochemical composition and versatility, yeast extract is widely used not only as a food supplement, but also in pharmaceuticals, animal husbandry and agriculture, demonstrating high efficiency in improving product quality and maintaining health. This makes it a strategic component in the development of innovative products that meet modern consumer demand for natural, healthy and functional solutions.

In the food industry, yeast extract is widely used as a flavour enhancer, particularly to impart umami and savoury notes. It also masks unwanted flavours and bitterness, which is particularly valuable when creating products with reduced salt, sugar and fat content, helping product developers maintain flavour appeal, as demonstrated by M. Ciudad-Mulero *et al.* [37], Ş. Yılmaz [38] and A. Alim *et al.* [39]. Yeast extract is used in soups, sauces, snacks, meat and vegetarian products, seasonings, and as a substitute for monosodium glutamate. Due to its nutrient content, it also serves to enrich products with protein, B vitamins and minerals. Its use as a functional ingredient contributes to the creation of products that are not only tasty but also healthy. A well-known example of the widespread use of yeast extract in the food industry is the Australian paste Vegemite, developed in 1922. This thick, dark brown mixture, made from yeast extract supplemented with vegetable extracts and spices, is distinguished by its unique salty, bitter umami taste [5]. This flavour profile is due to the natural presence of significant amounts of free amino acids and nucleotides, which are key components of yeast extract.

Yeast extract is a valuable component in pharmaceuticals and dietary supplements due to its immunomodulatory, anti-inflammatory and antioxidant properties. The beta-glucans and MOS contained in the extract are used to boost immunity, support gut health and prevent infectious diseases [21, 24, 27]. Nucleotides are key to tissue repair, cell growth and immune function support, especially under conditions of stress or rapid growth, making them important for infant formulas and restorative preparations [32, 33]. Glutathione, as a powerful antioxidant, is used to reduce oxidative stress and support detoxification processes in the body [34, 35]. These components make yeast extract attractive for the development of functional products aimed at improving overall well-being, increasing the body's resistance and supporting metabolic health.

In animal husbandry, yeast extract is an effective supplement for improving animal productivity and health. Adding it to feed improves immunity, reduces morbidity and promotes better nutrient absorption. In addition, the presence of proteins, amino acids and B vitamins contributes to better weight gain and overall health of animals. For example, J. Sun *et al.* [40] found that yeast extract improves growth performance and antioxidant capacity in young flounder. This multifaceted effect makes yeast extract a valuable ingredient in the production of feed for farm animals, aquaculture and pets.

Yeast extract is also used in agriculture to improve plant growth and protection. The internal components of yeast cells are rich in various amino acids that can form complexes with trace elements, improving their bioavailability to plants. Unlike other sources that contain only a few amino acids, yeast extract obtained from certain strains of *Saccharomyces cerevisiae* provides a balanced supply of amino acids in a form that is easily absorbed by plants. A study by M. Vargas Perucca *et al.* [41] has shown that it provides precise nutrition for crops, quickly overcomes nutrient deficiencies, reduces stress from herbicides, maintains yield potential, and protects the soil and the environment. N. Gatti *et al.* [42] investigated the effect of a biostimulant obtained from seaweed and yeast extracts on the secondary metabolism of different apricot varieties and proved that it had a positive effect on the biosynthesis of key biologically active compounds, such as polyphenols, flavonoids, proanthocyanidins and anthocyanins, in both the flesh and skin of apricots. Thus, the multifaceted properties of yeast extract and its bioactive components make it not only an effective nutritional biostimulant, but also an environmentally sustainable solution for optimising crop productivity and increasing their resistance to stress factors.

Risks and limitations of yeast extract use

Yeast extract has a high content of nucleic acids (RNA), which can be metabolised into purines. Excessive consumption of purines can increase blood uric acid levels, which is a risk factor for the development of gout. This is noted by W.S. Jeong *et al.* [43]. However, their study showed that the increase in uric acid levels from yeast extract is less pronounced than from meat or seafood. It should also be noted that the purine content in yeast extracts varies significantly depending on the yeast strains and processing methods. This requires manufacturers to control the nucleic acid content in products and inform consumers, especially those who are prone to gout or hyperuricaemia.

Yeast extract is not generally considered a major allergen. However, in some cases, people with increased sensitivity to yeast or its components may experience allergic reactions. According to EURaSYP, yeast extract is not subject to mandatory labelling as an allergen because it does not contain proteins that cause allergic reactions. It should be distinguished from active yeast. However, when manufacturing products, it is important to consider the individual sensitivity of consumers and the possibility of cross-reactions in rare cases.

Some yeast extracts may contain significant amounts of sodium, which may be a problem for people on a low-sodium diet. However, as noted by Z. Tao *et al.* [1], there are also low-sodium yeast extracts on the market. The use of yeast extract can reduce the overall salt content in foods due to its ability to enhance umami flavour, which can compensate for sodium reduction without compromising taste [38].

Research by H. Li *et al.* [44] showed that the use of yeast extract can cause the excitation of neurogenic and myogenic motor patterns in the large intestine of rats. Interestingly, this effect was similar to that of monosodium glutamate and inosine monophosphate. Although this study was conducted on animals, it highlights the need for further study of the effects of yeast extract on the human gastrointestinal tract, especially in high doses. Such studies may help to better understand potential side effects or mechanisms of action beyond taste perception.

Yeast extract has "Generally Recognised as Safe" (GRAS) status in the United States, allowing it to be used as a food ingredient without prior FDA approval [11]. In the European Union, its regulatory status depends on its primary function in a food product: it can be classified as a food ingredient with nutritional properties or as a flavouring. If its primary function is to impart or modify taste and/or smell, it falls under EU regulations on flavourings. Importantly, yeast extract obtained by traditional methods is not a food additive but a natural ingredient, which distinguishes it from synthetic flavour enhancers such as monosodium glutamate [39].

Despite certain risks and limitations that have been considered, such as the potential impact on uric acid levels in susceptible individuals, rare allergic reactions, sodium content, or possible effects on gastrointestinal motility at high doses, yeast extract is generally recognised as a safe ingredient. Its natural origin, the possibility of reducing the salt content in products, and its regulatory status as a natural ingredient rather than a food additive underscore its advantages. Therefore, when used responsibly and with consumer information, yeast extract remains a valuable and safe ingredient in various industries.

Conclusions

A review of scientific evidence, covering reliable *in vitro* and *in vivo* studies and increasingly convincing clinical trials in humans, clearly substantiates the significant and growing role of yeast extract and its key bioactive components in functional nutrition. Yeast extract, as a natural, sustainable and nutritious ingredient, provides a unique combination of β-glucans, mannan-oligosaccharides, nucleotides and glutathione. Each of these components provides distinct but often synergistic health benefits, allowing for a more comprehensive and powerful effect on the body than individual ingredients alone. These benefits range from powerful immune modulation and significant improvements in gut health to metabolic regulation and crucial support for growth and recovery in various physiological states. In particular, studies have shown that β-glucans activate immune cells such as macrophages and NK cells, increasing the body's resistance to infections. Mannan-oligosaccharides have been shown to improve intestinal morphology, modulate its microbiota, and bind pathogens, promoting a healthy digestive system. Nucleotides have been found to be critical for immune cell proliferation and accelerated tissue repair, which is especially valuable during rapid growth and after injury. Glutathione, as a central antioxidant, effectively combats oxidative stress, supporting overall cellular integrity and detoxification processes. Although considerations such as nucleic acid content require careful formulation, the overall profile of yeast extract confirms it as a valuable, multifunctional ingredient for the development of innovative functional products aimed at improving overall human health and well-being.

Despite compelling evidence, several areas require further research to fully unlock the potential of yeast extract in functional nutrition. Further clinical trials in humans are needed to study the full range of benefits for the immune system and other health parameters, namely: determining optimal dosages, studying the bioavailability of exogenous glutathione, gaining a deeper understanding of the molecular mechanisms of structural differences in beta-glucans and their impact on biological activity, and integrating an understanding of the effects of yeast components on metabolism and their immunomodulatory effects. Addressing these issues will enable the development of more targeted and effective functional foods. These research gaps are strategic priorities for future scientific research. Addressing them will not only deepen the understanding of the mechanisms of action of yeast extract, but also enable the development of more targeted, effective and scientifically sound functional foods, contributing to progress in this field.

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References

[1] Tao Z, Yuan H, Liu M, Liu Q, Zhang S, Liu H, et al. Yeast extract: Characteristics, production, applications and future perspectives. J Microbiol Biotechnol. 2023;33(2):151–66. DOI: 10.4014/jmb.2207.07057

[2] Demirgül F, Şimşek Ö, Bozkurt F, Dertli E, Sağdıç O. Production and characterization of yeast extracts produced by *Saccharomyces cerevisiae*, *Saccharomyces boulardii* and *Kluyveromyces marxianus*. Prep Biochem Biotechnol. 2021;52(6):657–67. DOI: 10.1080/10826068.2021.1983833

[3] Karslıoğlu F, Ertunç S, Yilmazer Hitit Z, Akay B. Investigation of extraction method effect on yeast beta glucan production. Eurasian J Bio Chem Sci. 2021;4(2):51–5. DOI: 10.46239/ejbcs.734046

[4] Wang H, Wang W, Zhang S, Hu Z, Yao R, Hadiatullah H, et al. Identification of novel umami peptides from yeast extract and the mechanism against T_1R_1/T_1R_3. Food Chem. 2023;429:136807. DOI: 10.1016/j.foodchem.2023.136807

[5] Whatnall M, Clarke ED, Bucher T, Collins CE. Happy little Vegemites™! An analysis of the contribution of yeast extract spreads and tomato-based sauces to nutrient intake adequacy in Australia. J Hum Nutr Diet. 2024;37(1):292–307. [DOI: 10.1111/jhn.13255](https://doi.org/10.1111/jhn.13255)

[6] Fu Y. Yeast extract as a more sustainable food ingredient: Insights into flavor and bioactivity. Adv Food Nutr Res. 2025;114:97–147. [DOI: 10.1016/bs.afnr.2024.09.002](https://doi.org/10.1016/bs.afnr.2024.09.002)

[7] Jacob FF, Hutzler M, Methner FJ. Comparison of various industrially applicable disruption methods to produce yeast extract using spent yeast from top-fermenting beer production: Influence on amino acid and protein content. Eur Food Res Technol. 2019;245:95–109. [DOI: 10.1007/s00217-018-3143-z](https://doi.org/10.1007/s00217-018-3143-z)

[8] Upcraft T, Tu WC, Johnson R, Finnigan T, Van Hung N, Hallett J, et al. Protein from renewable resources: Mycoprotein production from agricultural residues. Green Chem. 2021;23(14):5150–65. [DOI: 10.1039/D1GC01021B](https://doi.org/10.1039/D1GC01021B)

[9] Pogranichniy R, Lytvynenko V, Vergeles O. Effect of the probiotic feed additive "Immunobacterin-D" on the productivity of black speckled cows during lactation. Ukr J Vet Sci. 2023;14(1): 90–108. [DOI: 10.31548/veterinary1.2023.90](https://doi.org/10.31548/veterinary1.2023.90)

[10] Teimouri I, Naderi-Ahranjani R, Babaei K, Tadayyon S, Taheri E, Didar Khosrowshahi N, et al. Yeast extracts: Production, properties and application. In: 6th national conference on strategic research in chemistry and chemical engineering with an emphasis on indigenous technology in Iran. Tehran: ISC; 2020. 2916 P.

[11] Agency response letter GRAS notice No. GRN 000604 – FDA [Internet]. 2016 April 27 [cited 2025 June 30]. Available from: https://www.fda.gov/food/gras-notice-inventory/agency-response-letter-gras-notice-no-grn-000604

[12] Zonna X, Banta C, Hossein-Javaheri N. The association between Crohn's disease and patient response to yeast: A review of the literature. Gastroenterol Insights. 2024;15(4):1064–74. [DOI: 10.3390/gastroent15040073](https://doi.org/10.3390/gastroent15040073)

[13] Sendid B, Cornu M, Cordier C, Bouckaert J, Colombel JF, Poulain D. From ASCA breakthrough in Crohn's disease and Candida albicans research to thirty years of investigations about their meaning in human health. Autoimmun Rev. 2024;23(2):103486. [DOI: 10.1016/j.autrev.2023.103486](https://doi.org/10.1016/j.autrev.2023.103486)

[14] Martin GJO, Chan S. Future production of yeast biomass for sustainable proteins: A critical review. Sustain Food Technol. 2024;2(6):1592–609. [DOI: 10.1039/D4FB00164H](https://doi.org/10.1039/D4FB00164H)

[15] Lee S, Kim E, Jo M, Choi YJ. Characterization of yeast protein isolates extracted via high-pressure homogenization and pH shift: A promising protein source enriched with essential amino acids and branched-chain amino acids. J Food Sci. 2024;89(2):900–12. [DOI: 10.1111/1750-3841.16918](https://doi.org/10.1111/1750-3841.16918)

[16] Lee E, Park HY, Kim SW, Sun Y, Choi JH, Seo J, et al. Enhancing supplemental effects of acute natural antioxidant derived from yeast fermentation and vitamin C on sports performance in triathlon athletes: A randomized, double-blinded, placebo-controlled, crossover trial. Nutrients. 2023;15(15):3324. [DOI: 10.3390/nu15153324](https://doi.org/10.3390/nu15153324)

[17] Mirzaei M, Mirdamadi S, Ehsani M, Aminlari M, Hoseini E. Characterization of yeast protein enzymatic hydrolysis and autolysis in Saccharomyces cerevisiae and Kluyveromyces marxianus. J Food Biosci Technol. 2015;5(2):19–30.

[18] Ritala A, Häkkinen ST, Toivari M, Wiebe MG. Single cell protein-state-of-the-art, industrial landscape and patents 2001-2016. Front Microbiol. 2017;8:2009. [DOI: 10.3389/fmicb.2017.02009](https://doi.org/10.3389/fmicb.2017.02009)

[19] Linder T. Beyond agriculture – how microorganisms can revolutionize global food production. ACS Food Sci Technol. 2023;3(7):1144–52. [DOI: 10.1021/acsfoodscitech.3c00099](https://doi.org/10.1021/acsfoodscitech.3c00099)

[20] Murphy EJ, Rezoagli E, Major I, Rowan NJ, Laffey JG. β-Glucan metabolic and immunomodulatory properties and potential for clinical application. J Fungi (Basel). 2020;6(4):356. [DOI: 10.3390/jof6040356](https://doi.org/10.3390/jof6040356)

[21] Habibullah NNM, Shahar S, Ismail M, Ibrahim N, Kamaruddin MZA, Tang SGH, et al. Efficacy of yeast beta-glucan 1,3/1,6 supplementation on respiratory infection, fatigue, immune markers and gut health among moderate stress adults in Klang Valley of Malaysia: Protocol for a randomised, double-blinded, placebo-controlled, parallel-group study. BMJ Open. 2025;15(1):e084277. [DOI: 10.1136/bmjopen-2024-084277](https://doi.org/10.1136/bmjopen-2024-084277)

[22] Vuscan P, Kischkel B, Hatzioannou A, Markaki E, Sarlea A, Tintoré M, et al. Potent induction of trained immunity by *Saccharomyces cerevisiae* β-glucans. Front Immunol. 2024;15:1323333. [DOI: 10.3389/fimmu.2024.1323333](https://doi.org/10.3389/fimmu.2024.1323333)

[23] Maturana M, Castillejos L, Martin-Orue SM, Minel A, Chetty O, Felix AP, et al. Potential benefits of yeast Saccharomyces and their derivatives in dogs and cats: A review. Front Vet Sci. 2023;10:1279506. [DOI: 10.3389/fvets.2023.1279506](https://doi.org/10.3389/fvets.2023.1279506)

[24] Zhong K, Liu Z, Lu Y, Xu X. Effects of yeast β-glucans for the prevention and treatment of upper respiratory tract infection in healthy subjects: A systematic review and meta-analysis. Eur J Nutr. 2021;60(8):4175–87. [DOI: 10.1007/s00394-021-02566-4](https://doi.org/10.1007/s00394-021-02566-4)

[25] Gauterio G, Silvério S, Egea M, Lemes A. β-Glucan from brewer's spent yeast as a techno-functional food ingredient. Front Food Sci Technol. 2022;2:1074505. [DOI: 10.3389/frfst.2022.1074505](https://doi.org/10.3389/frfst.2022.1074505)

[26] Zhao W, Chen L, Tan W, Li Y, Sun L, Zhu X, et al. Mannan oligosaccharides promoted skeletal muscle hypertrophy through the gut microbiome and microbial metabolites in mice. Foods. 2023;12(2):357. [DOI: 10.3390/foods12020357](https://doi.org/10.3390/foods12020357)

[27] Kamal M, Zhu L, Abd El-Hack M, Arif M, Li F, Cheng Y. Functional roles of mannan and chitosan oligosaccharides on animal health and nutrition: A review. Carbohydr Polym Technol Appl. 2025;10:100764. [DOI: 10.1016/j.carpta.2025.100764](https://doi.org/10.1016/j.carpta.2025.100764)

[28] Pinheiro I, Robinson L, Verhelst A, Marzorati M, Winkens B, den Abbeele PV, et al. A yeast fermentate improves gastrointestinal discomfort and constipation by modulation of the gut microbiome: Results from a randomized double-blind placebo-controlled pilot trial. BMC Complement Altern Med. 2017;17(1):441. DOI: 10.1186/s12906-017-1948-0

[29] Duysburgh C, Miclotte L, Green JB, Watts KT, Sardi MI, Chakrabarti A, et al. *Saccharomyces cerevisiae* derived postbiotic alters gut microbiome metabolism in the human distal colon resulting in immunomodulatory potential *in vitro*. Front Microbiol. 2024;15:1358456. DOI: 10.3389/fmicb.2024.1358456

[30] Kango N, Jana UK, Choukade R, Nath S. Advances in prebiotic mannooligosaccharides. Curr Opin Food Sci. 2022;47:100883. DOI: 10.1016/j.cofs.2022.100883

[31] Singh RG, Garcia-Campayo V, Green JB, Paton N, Saunders JD, Al-Wahsh H, et al. Efficacy of a yeast postbiotic on cold/flu symptoms in healthy children: A randomized-controlled trial. Pediatr Res. 2024;96(7):1739–48. DOI: 10.1038/s41390-024-03331-z

[32] Gene-Morales J, Juesas A, Saez-Berlanga A, Alcala-Diaz M, Garcia-Rios A, Fuentes-Jimenez F, et al. Dietary nucleotides enhance neurogenesis, cognitive capacity, muscle function, and body composition in older adults: A randomized, triple-blind, controlled clinical trial. Nutrients. 2025;17(9):1431. DOI: 10.3390/nu17091431

[33] Singhal A, Kennedy K, Lanigan J, Clough H, Jenkins W, Elias-Jones A, et al. Dietary nucleotides and early growth in formula-fed infants: A randomized controlled trial. Pediatrics. 2010;126(4):e946–53. DOI: 10.1542/peds.2009-2609

[34] Richie JP, Nichenametla S, Neidig W, Calcagnotto A, Haley JS, Schell TD, et al. Randomized controlled trial of oral glutathione supplementation on body stores of glutathione. Eur J Nutr. 2015;54(2):251–63. DOI: 10.1007/s00394-014-0706-z

[35] Al-Temimi A, Al-Mossawi AE, Al-Hilifi SA, Korma SA, Esatbeyoglu T, Rocha JM, et al. Glutathione for food and health applications with emphasis on extraction, identification, and quantification methods: A review. Metabolites. 2023;13(4):465. DOI: 10.3390/metabo13040465

[36] Han H, Tian L, Dong YJ, Han Y, Wang X, Cheng Q, et al. Dietary yeast extract prevents alcoholic liver disease in mice via correcting gut dysbiosis and improving intestinal barrier function. Food Sci Hum Wellness. 2024;14:9250146. DOI: 10.26599/FSHW.2024.9250146

[37] Ciudad-Mulero M, Barros L, Fernandes A, Berrios JDJ, Cámara M, Morales P, et al. Bioactive compounds and antioxidant capacity of extruded snack-type products developed from novel formulations of lentil and nutritional yeast flours. Food Funct. 2018;9(2):819–29. DOI: 10.1039/C7FO01730H

[38] Yılmaz ŞEB. Utilization of yeast extract as a flavor enhancer and masking agent in sodium-reduced marinated shrimp. Molecules. 2024;29(1):182. DOI: 10.3390/molecules29010182

[39] Alim A, Yang R, Song H, Liu Y, Zou T, Zhang Y, et al. The behavior of umami components in thermally treated yeast extract. Food Res Int. 2018;120:534–43 DOI: 10.1016/j.foodres.2018.11.002

[40] Sun J, Li Y, Tang Q, Liu J, Hu Y, Ding Z, et al. Effects of yeast extract supplemented in diet on growth performance, intestinal health, and antioxidant capacity of juvenile turbot (*Scophthalmus maximus*). Front Physiol. 2024;15:1329721. DOI: 10.3389/fphys.2024.1329721

[41] Vargas Perucca MF, Mestre Furlani MV, Vergara Alvarez SC, Maturano YP, Petrignani DB, Pesce V, et al. Residual brewer's *Saccharomyces cerevisiae* yeasts as biofertilizers in horticultural seedlings: Towards a sustainable industry and agriculture. Front Ind Microbiol. 2024;2:1360263. DOI: 10.3389/finmi.2024.1360263

[42] Gatti N, Maghrebi M, Serio G, Gentile C, Bunea VV, Vigliante I, et al. Seaweed and yeast extracts as sustainable phytostimulant to boost secondary metabolism of apricot fruits. Front Plant Sci. 2025;15:1455156. DOI: 10.3389/fpls.2024.1455156

[43] Jeong WS, Kong HR, Kim SY, Yeo SH. Exploring the health benefits of yeast isolated from traditional fermented foods in Korea: Anti-inflammatory and functional properties of Saccharomyces and non-Saccharomyces strains. Microorganisms. 2023;11(6):1503. DOI: 10.3390/microorganisms11061503

[44] Li H, Ji Y, Luo H, Huizinga JD, Chen JH. Ingesting yeast extract causes excitation of neurogenic and myogenic colonic motor patterns in the rat. J Cell Mol Med. 2024;28(10):e18343. DOI: 10.1111/jcmm.18343

Властивості дріжджового екстракту у функціональному харчуванні: огляд літератури

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Анотація. Дріжджовий екстракт, отриманий з внутрішньоклітинного вмісту дріжджів, переважно *Saccharomyces cerevisiae*, є перспективним природним інгредієнтом у функціональному харчуванні. Актуальність його дослідження зумовлена зростаючим світовим попитом на стійкі, поживні та функціональні компоненти, а також його здатністю покращувати смакові якості продуктів. Виробництво дріжджового екстракту часто використовує агропромислові відходи, такі як відпрацьовані пивні дріжджі, що робить його екологічно чистою та економічно вигідною альтернативою традиційним джерелам білка. Метою цієї роботи було систематизувати та проаналізувати наявні наукові докази щодо нутрієнтного профілю, функціональних властивостей та механізмів дії дріжджового екстракту та його біоактивних компонентів. Було використано методи аналізу та синтезу даних наукової літератури, що охоплювали результати досліджень *in vitro* та *in vivo* на тваринах та клінічних випробувань на людях. Основні результати показали, що дріжджовий екстракт є винятковим джерелом високоякісного білку з повним амінокислотним профілем, який перевершує багато традиційних рослинних та деякі тваринні джерела. Він також багатий на вітаміни групи B, включаючи B12, та широкий спектр мінералів, що робить його цінним для збагачення раціону, особливо для вегетаріанців та веганів. Дослідження виявили, що дріжджовий екстракт містить біологічно активні сполуки, такі як бета-глюкани, манан-олігосахариди, нуклеотиди та глутатіон, кожна з яких має доведені функціональні властивості. Синергічна дія цих компонентів забезпечує комплексний вплив на здоров'я, що перевершує ефекти окремих інгредієнтів. Крім того, здатність дріжджового екстракту посилювати смак умамі та маскувати гіркоту є критично важливим функціональним атрибутом, що сприяє прийняттю споживачами та ефективності функціональних продуктів. Практична цінність роботи полягає в обґрунтуванні широкого застосування дріжджового екстракту у функціональних харчових продуктах та дієтичних добавках для покращення загального здоров'я та добробуту, з урахуванням його профілю безпеки та необхідності подальших досліджень для оптимізації дозувань та біодоступності

Ключові слова: *Saccharomyces cerevisiae*; бета-глюкани; манан-олігосахариди; нуклеотиди; глутатіон; імуномодуляція