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ISSN 2667-5803

DergiPark AKADEMİK

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FHTI

JOURNAL OF FOOD HEALTH AND TECHNOLOGY INNOVATIONS

DECEMBER VOL 5, NO 11 (2022)

Editor
Prof. Dr. Özlem TOKUŞOĞLU

Journal of Food Health and Technology Innovations
December Vol 5, No 11 (2022)

TÜBİTAK ULAKBİM

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OPEN ACCESS JOURNAL

ISSN 2667-5803

FHTI Journal of Food Health and Technology Innovations
December Vol 5, No 11 (2022)

Research Article

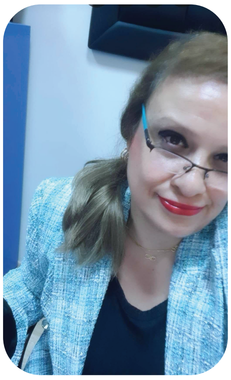
EDITORIAL NOTE

Dear authors, reviewers and readers of Food, Health and Technology Innovations (FHTI).

It gives me great pleasure to welcome you to the second year and volume 5th (number 11) edition of Food Health and Technology Innovations for which I have acted as Editor in Chief..

Food Health and Technology Innovations (FHTI) is an international open access, peer-reviewed scientific research journal by DergiPark Ulakbim that provides rapid publication of articles in all disciplines of food science including food chemistry, food microbiology, food quality, food shelf life; food technology including conventional and innovative food processing; food engineering; nutrition including consumer nutrition and clinical nutrition; and their connected basic sciences including biochemistry, molecular biology, analytical chemistry, organic chemistry and connected applied sciences such as bioengineering, biomedical engineering, industrial engineering, mechanical engineering, material science, nanotechnology, nano sciences; health sciences including cancer science, cancer biology, hematology, oncology, surgery with clinical nutritive applications.

I would like to point out that the policy of top priority of FHTI is especially to put forward and to reveal the innovations and inspiring outputs for food, health and innovative technology applications. FHTI offers an exceptionally fast publication schedule including prompt peer-review by the experts in the field and immediate publication upon acceptance. Not only my deputy editorial concept but also the all editorial board aims the fast reviewing and evaluation of the submitted articles for the forthcoming issues. Our journal distinction is to make difference in this inspection point. In the context, Journal of Food, Health and Technology Innovations will continue to publish high quality researches on basic sciences and applied sciences..



Original research articles form the bulk of the content, with systematic reviews an important sub-section. We will encourage all authors to work to these standards. Such emphasis on methodological rigour is vital to ensure that conclusions reached from publications contained in the journal are valid and reliable. Peer review processing remains a vital component of our assessment of submitted articles to FHTI.

I would like to say that there is strong consensus which accepted articles are often improved by peer review after referees' comments and criticisms are dealt with; this explicit appraisal process also helps to engender trust of the reader. It is predicated that the criticisms of evaluating process containing publication delaying, unreliability of decision making as overly conservative approach. Besides, weaknesses can be managed by an effective and active editorial office, and I believe they are outweighed by the benefits. Lastly I should thank all our submitting authors, who have toiled in the production of their work, and have chosen Food Health and Technology as the journal they would like to publish in.

Have a great Publishing with FHTI…

Professor, Ozlem Tokusoglu, PhD
Editor in Chief
Food Health and Technology Innovations

Ozlem Tokusoglu, Professor Dr.
Editor in Chief, FHTI Journal, Ulakbim Tübitak Dergipark, Ankara

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DergiPark AKADEMİK

Review Article

Promising Tools for Food Safety and Quality: Biosensors

Deniz BAŞ[1]* Ebru DENİZ[2]

Abstract

Food safety is a critical concern for modern society. In order to ensure that the food sold to customers is safe, authorities around the world impose restrictions and make new legal arrangements. To protect both consumers and manufacturers, it is essential to continuously track the food production and processing, and to get fast and reliable results. Rapid test methods, including biosensors, play a vital role in this process. Biosensors, offer a range of benefits when used in food safety and quality applications. However, they also have some limitations and challenges. This review aims to explore the use of biosensors in food safety and quality, and to discuss the advantages, disadvantages, and potential of these technologies.

Keywords: biosensors, food safety, food quality, quality control

TÜBİTAK ULAKBİM

1 Department of Food Engineering, Faculty of Engineering, Çankırı Karatekin University, Çankırı, 18100, Turkiye
http://orcid.org/0000-0003-1494-681X
*Corresponding Author: denizbas@gmail.com
2 Ebru DENİZ's e-mail: denizzebru@gmail.com

Introduction

Safe food is the food that is good quality in compliance with physical, chemical and microbiological regulations, maintains its nutritional value, and does not harm the consumer when consumed. In this context, the status of being chemically and microbiologically safe has gained more importance in recent years, and methods of detection, evaluation and analysis for food safety have become more interesting.

Food safety is a process that requires consistent measures and adequate monitoring from the field to the table. This process consists of steps such as raw material procurement, food processing, obtaining the final product, and storage. In order to track the parameters that determine the food safety and quality at each stage of the process, many analyses must be carried out. This huge demand of analyses requires laboratories with high investment and operating costs and trained personnel to carry out these analyses. On the other hand, it is essential to obtain low-cost and reliable results in a short time. In recent years, legal regulations and increasing concerns related to food safety and quality have allowed for the popularity of rapid analysis methods, such as biosensors, developed through innovative and advanced technology-based interdisciplinary studies.

In the last decade, the scientific literature on the applications of biosensors for food safety and quality control grew enormously. In addition to this highly growing literature, the global food and agriculture biosensors market in year 2021 was valued at 6 billion US$ and is predicted to reach 12.40 billion US$ by the year 2030 (1). This study aims to overview the applications of biosensors for food safety and quality control, discuss their advantages and disadvantages. In addition to these, without ignoring the importance of conventional methods in food analysis, the future of biosensors and the importance of the contributions of food science and technology experts to this field tried to be emphasized.

Biosensors

Food analysis includes instrumental analysis, which encompasses conventional chromatographic and spectroscopic methods, and cultural counting methods used in microbiological analysis. These methods are reliable and quite sensitive, but they require high investment and operating costs, and are time-consuming methods that require a certain level of expertise (2). Research and quality control laboratories with high-cost investments have access to these capabilities, but it is not always possible to invest in instruments and experts in the industry. In other words, analytical methods that can be performed quickly with portable devices and do not require personal skill are desired for use in industry. At the same time, when small and medium-sized enterprises are considered, the analysis investment and operating costs may cause a financial shortage. These special circumstances and current conditions make it necessary for businesses to use fast, reliable, accessible, low-cost analysis methods that do not require expertise (2-4). Therefore, the development/improvement of fast and innovative analysis methods that will be complementary to or even alternatives to conventional analysis methods has become a necessity.

The aforementioned fast and innovative analysis methods can be examined under two underlying categories; nucleic acid and protein-based methods. Nucleic acid-based methods are based on polymerase chain reaction (PCR), loop-mediated isothermal amplification (LAMP) and CRISPR-Cas strategies. Protein-based methods include enzyme-linked immunoassays (ELISA), lateral flow systems and enzymatic/catalytic sensing systems. Biosensor and bioanalysis systems developed using the methods mentioned above, as well as miniature laboratories (lab-on-a-chip, LOC) and micro total analysis systems (µTAS), can be referred to as fast and innovative analysis systems. When these systems are considered in terms of production and measurement systematics, they can all be examined under the heading of biosensor and bioanalysis methods, and that they do not differ from each other in principle. At this point, a detailed examination of the concepts of biosensors and bioanalysis will give sufficient information about the working principles of these methods. The differences between the methods stem from the architectural structures and production technologies rather than the measurement method.

Bioanalysis is a general concept used for measurement and analysis methods that can be examined in a wide category, including imaging systems, where biological interactions or biochemical processes play a role in the analysis of the target molecule, at least one of the target or recognition molecule is a biological molecule. A biosensor, on the other hand, is defined as an analytical device that is integrated into a physicochemical transducer through an interface of any bioanalysis method and mostly has a compact architecture (5). A biosensor consists of two main parts, namely the recognition layer and the transducer. The recognition layer is the analytical interface of the biosensor, and obtained by immobilization or adsorption any biomolecule such as antibody, aptamer, nucleic acids, protein, enzyme or carbohydrate. And after the interaction of this layer with the target analyte, a signal in proportion to the target concentration is formed by the transducer (6). Although transducer with different characteristics are present, frequently used transducers are electrochemical and optical signal processing systems.

The above-mentioned analysis systems or methods, including biosensors, have been developed initially for medical diagnosis to meet the strong needs in healthcare system. Nowadays, these methods have become so practical that they have been adapted for industries such as the environment, agriculture, and food, creating a wide range of use and market. The use of these methods for food safety and quality brings important advantages for the food industry and public health. However, the complex nature of food matrix also brings various disadvantages due to the physicochemical properties of food. Despite these disadvantages, the applications of biosensors in the field of food safety and quality control are as follows.

- Chemical contaminants: pesticide residues, herbicides, veterinary drug residues, environmental contaminants (7-11),
- Microbial contaminants(12, 13),
- Allergens (14-16),
- Natural toxins: mycotoxins, seafood toxins, pathogenic toxins (17-22)
- Process contaminants: polycyclic aromatic hydrocarbons (PAHs), biogenic amines(23-27),
- Food component analysis (28-30),
- Process quality and control (31-35).

When these applications are considered in detail, it can be seen that various recognition layers can be used and measurements can be made in two different ways, either directly or indirectly. As an example for indirect sensing mechanism, the inhibition of enzymes or microorganisms that are present in the recognition layer is determined for the presence of chemical contaminants. The most significant and practical application of the indirect sensing is the inhibition of the acetylcholine esterase enzyme. Since some pesticides are the natural inhibitors of this enzyme, many pesticide biosensing methods have been developed based on this principle. Thus, in the presence of acetylcholine esterase inhibiting pesticides, the decrease in enzyme activity allows the pesticide concentration to be determined quantitatively.

In the determination of microbiological contaminants, allergens and toxins, antibodies or aptamers specific to the target analyte are used as the recognition element. While it is possible to make direct measurements with surface plasmon resonance, mass-sensitive and impedance systems, indirect sensing mechanism is prefered in electrochemical (amperometric, voltammetric) and optical systems since most of the target moelcules are either electrochemically or optically inactive. Direct measurements are performed by measuring the signal change after the interaction of the target analyte with its counterpart on the recognition layer, and a response directly proportional to the target analyte concentration is obtained. On the contrary, indirect measurements are performed by using an enzyme or fluorescent dye-labeled secondary antibody/aptamer in addition to the antibody/aptamer used in the recognition layer. Since the amount and/or presence of these secondary biomolecules will be defined by the target, quantitative analysis of the target analyte can be possible by measuring the specific signal of the label on the secondary antibody/aptamer. Direct sensing strategies are simplier and they do not require cost increasing labels or secondary recognition biomolecules and they can be performed with less operational procedures. Some food components can also be measured by catalytic methods based on the electrochemical and/or optical mesaurement systems. It is possible to perform quantitative analyses by using the enzymatic reaction specific to target component. The best-known example is the glucose biosensor, in which the amount of hydrogen peroxide formed as a result of the reaction catalyzed by the glucose oxidase enzyme is measured electrochemically (36).

Advantages and Disadvantages of Biosensors

Biosensors have several advantages over conventional methods such as chromatographic, spectroscopic, and culture-based microbiological analyses. These include low investment costs, ease of use without requiring specialized knowledge, speed, and portability. While chromatographic and spectroscopic systems (such as LC-MS-MS and GC-MS) are highly sensitive, they also have high analysis and investment costs, which limits their widespread use.

Additionally, these methods and devices require skilled, qualified personnel to be used effectively. In this regard, DNA, aptamer, and immunoaffinity-based (e.g. ELISA) rapid analysis methods and biosensor systems/methods emerge as potential alternatives to conventional food analysis methods. While rapid test/analysis methods such as ELISA and lateral flow kits are widely used, they have significant disadvantages such as limited success in their application to automation, requiring personal skill, being time-consuming, and being expensive for multiple analyses. On the other hand, biosensors have advantegeous features such as being simple, user-friendly, fast (short response time), real-time, suitable for automation, miniaturizable, and therefore portable, as part of their existential philosophy. In addition to these features, biosensors are systems with high selectivity, specificity and accuracy.

In parallel with developments in the field of nanotechnology, biosensor systems that can be miniaturized and thus made portable by the integration of nanostructures and the use of microfluidic technologies in biosensor systems allow fast and real-time analysis since they can be used anywhere because they have low power consumption. Thus, being able to perform analysis independently from the laboratory provides important conveniences in the realization of today's production and inspection processes. The potential to be miniaturized and made portable offers another important advantage. By performing analysis in small volumes, less sample and reagents are needed and this allows a significant reduction in the analysis and production costs. This economic benefit provides an increase in access and demand and is important for individuals, institutions and organizations, especially developing countries, who do not have access to expensive analytical devices.

Finally, their ease of use or adaptability to automation reduces the need for specialized personnel, reducing operational and analysis costs.

Biosensors are currently unable to provide the lower limit of detection values of methods such as LC and/or LC-MS in some analyzes. In addition, a decrease in analysis performance can be observed due to the complex structure of the food matrix and textural properties. It should be emphasized that the disadvantageous situation caused by the complex structure of the food matrix is only important for field analysis, but from the point of view of established laboratories, it should not be considered as a disadvantage in the presence of inexpensive basic equipment such as shredders and centrifuges.

Future Perspectives of Biosensors

In addition to the abovementioned advantages, many factors are effective in the increase in demand for the use of biosensors. These factors include the desire of professionals in the supply chain to improve competition conditions due to developments in regulation, and the interest of conscious consumers in food safety. Having low operating and investment costs, allows the commercial use of affordable analysis devices. The fact that the devices are easy to access and their use does not require a certain expertise enables the new generation conscious consumer to control personal food safety. At this point, it seems inevitable that biosensors that can be used for food safety, such as personal glucose meters, which are widely used in blood sugar measurement and accepted as the ancestor of biosensors, will be shaped in line with the needs of conscious consumers whose number is increasing. In addition, it is thought that food analysis applications of biosensors will gain importance with the adaptation of microfluidic technologies and micro-total analysis (µTAS) systems, which are still being developed for clinical diagnosis. It is anticipated that these systems based on microfluidic technology and miniaturized analysis platforms can be integrated into smart phones and/or tablets without the need for a power source or computer, and fast and reliable on-site analysis will be beneficial in terms of food safety and quality control. As a result, in addition to the advantages of biosensors and their high commercial potential as emphasized in market reports (12.40 billion US$ market size by the year 2030), it is thought that new technologies will be introduced and significant developments will be achieved with the increasing interest of scientists engaged in research and development in food science and technology. Besides these, combining biosensors with the smartphones (37) and the artificial intelligence (38) will enhance the accuracy, real-time monitoring capabilities, and will allow easy decision-making. So there is still room for improvements in this field and huge marketplace.

Conclusion

It is an undeniable fact that biosensors, which have features such as adaptability to automation, short analysis time and portability and do not require expertise, are an important alternative to labor-intensive and time-consuming food analysis methods.

However, since instrumental methods such as liquid chromatography and mass spectroscopy cannot provide the low limit of detection values they have, they should not be considered as an alternative but as a complement to them. Although most of the studies on biosensors are for clinical diagnosis and diagnosis, it should not be neglected that there has been an interesting increase in biosensor studies on food safety and quality in the last 10 years. It is thought that the above-mentioned disadvantages will be overcome and the performance of biosensors in food analysis will increase with the contributions of food science and technology experts to this field.

Acknowledgement

This article is based on a previous review article that have been previously published in the journal “Gıda” in 2015 (https://dergipark.org.tr/tr/download/articlefile/665583). The article has been revised, adapted and updated according to Creative Commons Attribution 4.0 CC BY-NC licence (39).

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https://dergipark.org.tr/tr/pub/food
OPEN ACCESS JOURNAL
ISSN 2667-5803

FHTI Journal of Food Health and Technology Innovations
December Vol 5, No 11 (2022)

DergiPark AKADEMİK

Review Article

NUTRITIONAL VALUE AND HEALTH BENEFITS OF TABLE OLIVES

Dr. Ferişte ÖZTÜRK GÜNGÖR[1*] Ayşen YILDIRIM[2*] Dr. Şahnur IRMAK[1*]

Abstract

Table olives are the main fermented foods in Mediterranean countries and constitute an important part of the Mediterranean diet and also the diet of many non-olive-producing countries. Due to consumers' increasingly demand to incorporate foods into their diets that can help boost or maintain health, as well as help prevent some diseases, interest in table are increased resently. Table olive is a healthy food with high nutritional value consist primarily of water, fat and carbohydrates. Olives are an excellent source of oleic acid, also known as omega 9 or monounsaturated fatty acids (MUFA). And they are a good source of fiber, amino acids, the potent antioxidant vitamin E, iron, copper and other minerals. Moreover, olives are a rich dietary source of phenolic compounds that are linked to powerful antiinflammatory, antibiotic, antimicrobial, antiviral and antinociceptive effects. The disease-preventing effect of table olives is mainly attributed to its unique fatty acid profile and to the presence of some minor components such as tocopherols, carotenoids, phospholipids, triterpenic acids and biophenols. As part of a well-balanced, nutritious diet olives and olive products also provide added protection against many chronic diseases. Olive benefits have been demonstrated for the cardiovascular system, respiratory system, nervous system, musculoskeletal system, immune system, inflammatory system, and digestive system. In this review, it was focused on the active compounds present in table olives and also the contribution of these compounds to the human health was examined in detail.

Keywords: Table olive, health, nutritional value, active compounds.

TÜBİTAK ULAKBİM

1Olive Research Institute Bornova/İZMİR
2İzmir İl Kontrol Laboratuvarı Bornova/İZMİR
*feriste@gmail.com

Introduction

Olive is the fruit of an evergreen olive tree that grows in the temperate climate of the Mediterranean region (46, 19, 14). Olive tree fruits are the raw material for a number of products, specifically olive oil and table olive (9). Table olive is probably one of the most important and most widely recognized fermented vegetable of the food industry and its elaboration is widespread around the world and represents an important economic source for the producing countries (1). The Turkish National Olive and Olive oil Council (IOOC) (2022) estimates that the table olive's production reached approximately 753.000 tones in the 2022/2023 season.

In the last decades olive products have been attracting increasing interest, due mostly to reports on their health promoting effects. Due to rising awareness about the beneficial effects of optimal nutrition and functional foods among todays's health conscious cosmopolitan societies, the worldwide consumption of olives and olive products has increased significantly, especially in high-income countries such as the United States, Europe, Japan, Canada and Australia, resulting the rapid development of olive-based products (12).

Table olives are important part of a well-balanced, nutritious diet (13), consisting primarily of water, fat, carbohydrates, protein, fiber, pectin, biophenols, vitamins, organic acids, mineral elements (2,12,24,49) and pigments (12).

In this review, it was focused on the active compounds present in table olives and also the contribution of these compounds to the human health was examined in detail.

Nutritional Characterization of Table Olives

From a nutritional point of view, table olives are well-known sources of compounds with beneficial relevance. These benefits are associated with their fatty acids content, mainly monounsaturated fatty acids, and to minor constituents such as tocopherols, phenolic compounds and phytosterols (49). Composition of the olive fruit epicarp are given in Table 1.

Table 1. Composition of the olive fruit epicarp (11).

Components	%
Moisture	60-75
Oil	10-25
Reducing sugar	3-6
Non-reducing sugar	≤ 0.3
Mannitol	0.5-1.0
Fiber	1-4
Protein	1-2
Ash	< 1.0
Organic acid and its salts	0.5-1.0
Phenolic compounds	2-3
Pectic substances	≤ 0.6
Other compounds	3-7

Sugars are the main soluble components in olive tissues and play an important role, providing energy for metabolic changes. The main simple sugars in raw olive flesh are glucose, fructose, sucrose and mannitol (sugar alcohol) (32). Both soluble reducing and non-reducing sugars have an important role in oil biosynthesis. In table olive processing sugars act as a carbon source to microorganisms for producing secondary metabolites responsible for good characteristics and a distinctive flavour of the commodities. In addition to the free reducing sugars, olive flesh is also rich in numerous glycosides, which can be a supplementary source of carbohydrates for olive fermentation when hydrolyzed (24). Olives are also calorie-dense, having a fat content of approximately 20% (150 kcal/100 g) (25).

Protein conten of the fresh pulp is relatively low, generally between 1 and 3%, and remains almost constant during growth and ripening of the fruits. Arginine, alanine, aspartic acid, glutamic acid and glycine constituted approximately 60% of the free amino acids (Garrido Fernández et al., 1997). The protein content is low (1 g ⁄ 100 g), but nutritional quality is high for the presence of essential amino acids (23).

High levels of monounsaturated fatty acids (mainly oleic acid) which have health benefits and are important for human nutrition play an important role in the nutritional value of table olives (2). The major fatty acids in table olives are oleic, palmitic, stearic, linoleic and palmitoleic acids (44, 51, 26) reported that the most abundant fatty acids in decreasing order of presence in commercial table olives are C18:1, C16:0, C18:2 n-6, and C18:0. The ranges expressed as grams of fatty acids per 100 g of edible portion, for different nutritional fractions are as follows: saturated fatty acids, 2.07-5.99; monounsaturated fatty acids, 5,67-19.42; polyunsaturated fatty acids, 0.52-3.87; and trans-fatty acids, 0.08-0.44. According to current dietary guidance for healthy nutrition, polyunsaturated fatty acids to saturated fatty acids (PUFA/SFA) ratio above 1.5 is associated with good health (38). (44) found PUFA/SFA ratios for processed Meski and Picholine olives 1.7 and 1.6, respectively at the cherry stage. These values showed that Meski and Picholine processed olives had a good health effect.

Phenolic substances are common to many plants, and have evolved as an antioxidant defense to environmental stress resulting from a variety of oxidizing and potentially harmful free radicals (46). Phenolic compounds are of great importance for the olive fruit, being responsible for important characteristics and properties, such as color, taste and texture (30). Table olives contain simple and complex phenolic compounds (at least 30 different phenolic compounds) in amounts ranging between 100 and 350 mg/100g of e.p. (the same quantity of 1kg of extra virgin olive oil) (24). Olive biophenols can be categorized in four major subgroups: (i) phenolic acids and alcohols, (ii) flavonoids, (iii) lignans, and (iv) secoiridoids. The last sub-group include the most characteristic and concentrated phenols in olive fruits (13). Although the phenolic compounds show variations in both quality and quantity, oleuropein, hydroxytyrosol, tyrosol, and verbascoside comprise the main phenols in olive (48). Oleuropein and hydroxytyrosol are naturally occurring phenolic compounds in olive fruits. While oleuropein is present in high amounts in unprocessed olive fruit, hydroxytyrosol is more abundant in the processed fruit. Oleuropein is responsible for the bitter taste of immature and unprocessed olives (45). A plethora of studies have been published concerning the antioxidant activity of oleuropein and its derivatives; the antimicrobial, antiviral, anti-atherogenic and anti-inflammatory activity of oleuropein have also been reported. In a clinical study, it has been shown that olive intake increases polyphenols and total antioxidant potential (TAP) in plasma, thus indicating that olive polyphenols have good bioavailability, which is in accordance with their antioxidant efficacy (21). Owen et al. (2003) reported that consumption of approximately 50 g (approximately 10 table olives) black olive pericarp would provide that about 400 mg of phenolic substances to the daily dietary intake. The percent of wet weight for phenolics in black and green olives was reported as 0.082 and 0.118, respectively (46).

Phenolic compounds also have importance such as residue forming, enzymatic browning substrate, enzyme inhibitor and purity control criteria. The phenolic fraction of the olive fruit is a complex structure. Phenolic fraction quality and component level are closely related to the development and ripening process of the fruit, depending on the season. Table olives and olive oils are known as a valuable source of "functional foods" with the phenolic antioxidant substances they contain (10, 30,49). In the study conducted on Turkish olive varieties, it was determined that olive varieties (Gemlik, Domat, Uslu, Ayvalık and Eşek olives) were rich in phenolic components (17).

Table olives are also rich in natural antioxidants such as vitamins. Of the vitamins found in green table olives, tocopherols are present in relatively high amounts. Assuming the α-tocopherol content as that reported by USDA one serving of 100 g of edible portion of treated green olives can provide about 25% of the RDA of vitamin E (33). They provide also small amounts of B group vitamins as well as liposoluble vitamins such as pro-vitamin A. The vitamin C content is low. (27) found a wide range of values for vitamin B_6 in commercial table olives (0–69.3 µg/ 100 g edible portion).

Other important components of table olives are mineral substances (51) and fresh olives are rich in minerals (5). Minerals have important functions in the body, and they are essential for healthy growth and life.

Mineral substances in table olives are important from nutritional and toxicological point of view (51). The macro elements are phosphorus, potassium, sodium, calcium, magnesium and sulphur and microelements (trace elements) are boron, copper, iron, manganese and zinc. As correspond to a brined product, Na was the most abundant element (18,144–5706 mg kg^{-1}). However, olives can also be a good source of Ca (337–850 mg kg^{-1}), K (82–1180 mg kg^{-1}), Mg (51–197 mg kg^{-1}), and P (57–144 mg kg^{-1}). Fe concentrations were also high in ripe olives (58–131 mg kg_1) but significantly lower in green and directly brined (3.5– 7.7 mg kg^{-1}). Microelements Cu (1.7–11.0 mg kg^{-1}), Zn (1.5–3.6 mg kg^{-1}), and Mn (0.2–1.5 mg kg^{-1}) had concentrations similar to other plants (27).

Dietary fiber (DF) is related to the biochemical changes of cell wall polysaccharides during olive fruit ripening and post harvest processing (9). Table olives are a good source of dietary fibre, which in addition, has a high digestibility rate (18, 28). Olive DF components in whole fruit include peçtin (which is composed of three pectic polysaccharides: arabinans, homogalacturonans and rhamno-galacturonans), hemicelluloses (which is rich in xylans, xyloglucans, glucuronoxylans as well as mannans), cellulose and lignin (Galanakis, 2011). In European Union countries (Reg. CE 1924/2006 and Reg. UE 116/2010) it is possible to write on the label the claim "source of fibre" if the product contains at least 3g of fiber/100g of e.p. Values of dietary fiber in table olives ranged from 2 to 5 g/100 g edible portion (e.p.) (28), so they can be considered as a source of fibre (24). In the research made by Jimenez et al. (2000), the content of dietary fibre was around 12% of the fresh weight, although in dried samples this percentage increased to around 20%.

Organic acids (oxalic, succinic, malic, citric and lactic) are one of the minor components of olive fruit and their amount is 1.5% of the fleshy part (11, 7).

Olive fruits are rich in oleanolic and maslinic acids (triterpenic acids) and the olive triterpenic acids have been attributed with anti-oxidant, anti-hyperglycemic, anti-microbial and anti-cancer activity (39,49).

Table olives are a food with a high nutritional value thanks to the balanced budget of the fatty acids, in which the MUFA predominate, and their consumption contributes to the anti-oxidant dietary fibre, vitamins and minerals assumption. Table olives are rich sources of a wide range of essential micronutrients, essential fatty acids, and biologically-active phytochemicals containing antioxidant compounds and phenolics which promote health benefits (41). Their postulated health benefits seem to be intrinsically linked to the high monounsaturated fat content (4) and to minor constitutes like tocopherols and phenolic compounds (33).

Health Benefits of Table Olives

Compared to other foods, some positive effects of fermented foods in terms of human health have been proven. Positive changes occur in nutritional value as a result of fermentation in various foods, and especially an increase in the amount of essential amino acids (50). Phenolic compounds as food ingredient; They are important with their contribution to human health, their role in the formation of taste and odor, their effects on color, and their antimicrobial and antioxidant effects.

Table olives are very important components of the Mediterranean diet (2,49). Mediterranean diet mainly consists of olive fruit consumption and its products and possesses inarguably beneficial effect on the human health; therefore, studies in olive fruit have attracted the interest of researchers from different scientific disciplines. Epidemiological studies showed that this dietary pattern reduces cancer risk (breast and colon) (48, 20) being in addition protective against cardiovascular and other chronic diseases (13).

Numerous epidemiological surveys have shown an inverse relationship between the intake of fruits and the incidence of coronary heart disease and certain cancers. Many constituents of these dietary components such as polyphenols might contribute to their protective role (49). The consumption of table olives provides a large amount of natural antioxidants which play a major role in the antioxidant activity and in the prevention of many diseases (47). Because table olives are mainly composed of monounsaturated fatty acids, the consumption of table olives can prevent and reduce the risk of cardiovascular diseases, regulate cholesterol levels, stimulate transcription of LDL-cholesterol receptor mRNA and reduce breast canser risks (44,51). It is well-known that the decreased incidence of cardiovascular disease in the Mediterranean area has been partly attributed to the consumption of olive products (8).

Weight loss and management

In an animal study conducted at the University of California at Irvine, researchers found that when dietary intake of oleic acid (abundant in olives) reached the small intestine, it triggered the production of oleoylethanolamide (OEA), a fatty hormone. This hormone is one of many that send a hunger-curbing message to the brain to stop eating. In this study, protein and carbohydrates did not have the same effect, nor did saturated fat. Human studies are needed, but this may help explain how MUFA affects appetite (43, 15).

Anti-cholesterol action

Because table olives are mainly composed of monounsaturated fatty acids, the consumption of table olives can regulate cholesterol levels (51). Both monounsaturated fats and polyphenols found in olives help prevent oxidation of cholesterol, and hence have a remarkable protective and preventive effect against atherosclerosis and related cardiovascular dseases, such as stroke and heart attact.

Antioxidant and anticancer activities

Interest in phenolic compounds is related primarily to their antioxidant activity. They show an important biological activity *in vivo* and may contribute to prevent diseases related to oxygen radical formation when this exceeds the antioxidant defense capacity of the human body. The antioxidant quality of phenolic compounds is mainly due to their redox properties, which allow them to act as reducing agent, hydrogen donators, and singlet oxygen quencher (34). Both olives and olive oil contain substantial amounts of other compounds seemed to be anticancer agent (e.g. squalene and terpenoids) as well as the peroxidation - resistant lipid oleic acid. Habitual high intakes of table olives will provide a continuous supply of antioxidants, which may mediate their effects by reducing oxidative stress via inhibition of lipid peroxidation, thereby inhibiting formation of DNA adducts, factors that are linked to a host of diseases including cancer (36,37) investigated the mechanisms of maslinic acid present in the protective wax-like coating olives with regard to its inhibitory effect on the growth of HT29 colon cancer cell. Their results show that maslinic acid has the potential to provide significant natural defence against colon-cancer.

Diabetes and cardiovascular disease

Monounsaturated fatty acids are recognized as a heart healthy fat and are associated with reducing low-density lipoprotein (LDL) cholesterol levels, but maintaining or increasing high-density lipoprotein (HDL) cholesterol. MUFA also help to normalize blood clotting. Research has shown that MUFA benefits insulin and blood sugar levels, and are particularly beneficial to those who suffer from type 2 diabetes. Type 2 diabetes is also a major risk factor for cardiovascular disease.

Bone health

In animal models, table olives have shown some benefits on bone healths, which is thought to be at least partially the result of minor antioxidant compounds (25). A number of preclinical data demonstrate that polyphenolic compounds derived from olive may protect bone mass, especially in the presence of inflammation (40).

Skin health

Olive polyphenols, being free radical scavengers, contribute positively towards skin health by preventing the oxidative damage linked with the formation of wrinkles and other such disorders such as skin dryness and hyperproliferation.

The antioxidant and antimicrobial activity of some of the most typical biophenols contained in table olives is revealed through biomimetic experiment on the scavenging effect of chain-propagating lipid peroxyl radicals within membranes, and for human skin protection (42).

Conclusion

Olive and its products have become even more valuable since their health benefits have come under light. Consumption of table olives is important from a nutritional point of view due to their contribution of essential fatty acids and mineral substances, phenolic content, protein and dietary fibre to the body. There are reports of various health benefits of consuming table olives such as prevention of coronary heart disease, some cancertypes, and inflammation, due to its highly monounsaturated fatty acid profile and phenolics content. It has been claimed that consuming 5–10 table olives a day might cover the daily intake of polyphenols. Table olives are an important component in the dietary habits of Turkish people. By being consumed at breakfast, not only like an aperitif, as in Turkey and Greece, table olives can be a basic food of the other Mediterranean Countries' diets.

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https://dergipark.org.tr/tr/pub/food
OPEN ACCESS JOURNAL

ISSN 2667-5803

FHTI Journal of Food Health and Technology Innovations
December Vol 5, No 11 (2022)

DergiPark AKADEMİK

Review Article

Functional Properties and Health Benefits of Cruciferous Vegetables

İbrahim CANBEY1, Aycan YİĞİT ÇINAR2*, Elif YILDIZ3, Ozan GÜRBÜZ1

Abstract

In recent years, the trend of consumption foods high in fiber and low in calories has been increasing due to consumers demands for a healthy and balanced diet. Hence, the vegetables-rich dietary regimes are becoming progressively important all over the world. The vegetables in Cruciferae (Brassicceae) family have worldwide consumption and popularity since scientific investigations confirm these vegetables are related to lower incidences of many chronic diseases such as type-2 diabetes, osteoporosis, obesity, cardiovascular disease and cancer. Beside on essential nutrients that promote the body, member of cruciferous vegetables have also contain healthy beneficial phytochemical compounds including carotenoids, anthocyanins, flavonoids, antioxidant enzymes, sulfur containing glucosinolates, coumarins, tocopherols and terpenoids. It is known that these compounds have anti-inflammatory, antimicrobial, antioxidant, antiobesity, cardioprotective, and gastroprotective activities. Pharmacological effects and nutritionally valuable compounds enhance the popularity of the plants in Brassicaceae family and lead to future functional food applications

Keywords: Cruciferous vegetables, health benefits, glucosinolates, sulforaphane

TÜBİTAK ULAKBİM

1Bursa Uludag University, Faculty of Agriculture, Department of Food Engineering, 16059, Nilufer, Bursa, Turkiye
2Bursa Technical University, Faculty of Engineering and Natural Science, Department of Food Engineering, 16310, Bursa, Turkiye
3Bursa Uludag University, Keles Vocational School, Food Processing Department, 16740, Keles, Bursa, Turkiye

*Corresponding author: aycan.cinar@btu.edu.tr

Introduction

The Cruciferae (or Brassicaceae) family contains 300 genera (*Brassica*, *Camelina*, *Crambe*, *Sinapis*, and *Thlaspi*) including approximately 4000 species. Among these genus, especially *Brassica* species, such as particularly *Brassica oleracea*, *B. rapa* L., and *B. napus* are economically significant around the world (1-5). The most common known vegetables in Brassicaceae are broccoli, Brussel sprout, cabbage, canola, cauliflower, collard green, kale, mustards, oilseed rape, radish, and turnip (6,7). It is known that the regular consumption of these group vegetables are mainly supporting to human health particularly in the reducing of chronic diseases risks, including type-2 diabetes, osteoporosis, obesity, cardiovascular disease, and cancer. Owing to health promoting effects, Brassicceae vegetables are becoming progressively important and widely used in cuisine both cooked and fresh cut (6,8-11). The vegetables in Cruciferae, the species of *Brassica* such as; cauliflower, cabbage, broccoli, and Brussels sprouts are efficient at decreasing cancer risk (12,13). The Brassicaceae family have significant phytochemicals, which are mainly alcaloids, carotenoids including *β*-carotene and lutein, glucosinolates, phenolics such as flavonoids, phenolic acids, polyphenols (14), glucosides, terpenoids, and tocopherols (6,15-17). Also, the other biologically important compounds of vegetables in Brassicaceae are shown in Figure 1 (6).

The health-promoting effects of cruciferous vegetables are related to the compounds common known antioxidants such as ascorbic acid, carotenoids, glucosinolates, phenolics, and tocopherols (18). From these compounds, especially glucosinolates found in high concentration in broccoli, cauliflower, mustard, radish, and white cabbage are more healthy phytochemicals. Sulforaphane, breakdown metabolite of glucosinolates (e.g., isothiocyanate) formed by the activating of myrosinase from glucoraphanin exhibits anticarcinogenic effects (19-21). The enzyme myrosinase is inactivated with heat treatment, such as cooking and steaming of vegetables (6). Microbiome in gut displays a significant role in the metabolisms of the compounds, glucosinolates and also isothiocyanates (e.g., sulforaphane) (22). Regarding to gut microbiome, the cruciferous vegetables procure the balance of intestinal flora and hence, the compounds in the family should be investigated up-close for future studies (11).

2. Biologically healthy compounds in cruciferous vegetables and their functional properties

The recent studies, both in vitro and in vivo, have concentrated on the compounds promoting human health in the cruciferous vegetables (23,24). The biological properties and effects of Brassicacea on health originate from their main compounds, including ascorbic acid, carotenoids, glucosinolates, phenolics, and tocopherols. The biological activity and complementary mechanisms of their activities are shown in Figure 2 and Table 1, respectively (6,25-29).

As shown in Table 1, the compounds of Brassicaceae have different mechanisms of the biological activities. Ascorbic acid is a highly concentration compounds found in especially leafly-stalk vegetables such as broccoli, Brussel sprouts, cabbage, cauliflower, kale, tronchuda (30). This compound exhibits to play a great role in the protection of mycocardium and prohibiting of LDL-induced overexpression in the vascular endothelial growth factor (31,32). The content of this compound in *Brassica* species depends on some factors such as cultivar of vegetable, fertilization with sulphur and handling conditions (33-36).

The other important compound carotenoids, particularly *β*- and *γ*-carotene, and *β*-cryptoxanthin are both pigments and the precursors of vitamin A (37). The colors of orange-yellow and yellow are originated from carotenoids including lutein, zeaxanthin in cruciferous vegetables (6,8,38). Also, flavonoids and anthocyanins are the other color sources in these plants (6). Owing to contain double bonds carotenoids are in charge of scavenging of free radicals and also removing of singlet oxygen. It is known that *β*-carotene in serum level is the higher, the risk of diseases such as cancer, cardiovascular, myocardial infarction is lower. Furthermore, metabolic syndrom factors correlate with negatively with *β*-cryptoxanthin and *β*-carotene levels in serum (39,40). It is important that these vegetables are a regular part of their daily diet due to protection of body health.

The main characteristic phytochemicals are sulfur-containing compounds, including glucosinolates and s-methyl cysteine sulfoxide found in cruciferous vegetables (41-43). The glucosinolates are classified into three groups as shown in Figure 3. Depending on the variety, vegetables contain a distinctive variety of glucosinolates. The broccoli contain different form of glucosinolates, such as glucobrassicin, glucoraphanin, and neoglucobrassicin. Also, glucoraphanin is the well-known compund in broccoli (42,44,45) (Figure 4). On the other hand, glucobrassicin, gluconasturtin and glucotropaeolin are the most abundant compounds of Brussels sprouts, turnip and cress, respectively (13,46).

The glucosinolates are biologically inactive as long as they are not physically damaged, such as cutting, crumbling and smashing. In the case of physical effect, disjuncting from the cell of plants, the compound releases from ruptured cells and then are hydrolysed to isothiocynates by enzyme myrosinase, *β*-thioglucosidase (19,20,47,48). After hydrolysis, the unpleasant and pungent smell of the the breakdown product, which is characteristic smell of broccoli and cauliflower, is felt by sense of smell. On the other hand, the aromatic constituents in glucosinolates group are glucobarberin, gluconasturtiin, glucosibarin, glucosinalbin, and glucotropaeolin (49).

In general, these sulfur-containing compounds have allelopathic, bactericidal, fungicidal, and nematocidal functions and properties (50). The hydrolysis compounds, the isothiocyanates are also protective benefits on health. The most common chemopreventive compounds in cruciferous vegetables are ascorbigen, benzyl isothiocyanate, indoles 3,3-diindolylmethane, indole-3-carbinol, phenethyl isothiocyanate, sulforaphane. (21,47,48,51).

Due to these compounds, the vegetables in cruciferous vegetables have health benefits not only in prohibiting chronic diseases, but also in decreasing the risk of cancer types. *In-vitro* studies confirm that the broccoli extracts have been determined to have inhibitor effects on breast cancer cells owing to breakdown products, such as indoles, isothiocyanates, sulforaphane after hydrolysis of glucosinolates (19,21,42). Metabolites of isothiocyanate, indoles and also other compounds in the cruciferous vegetables display a great role in protection from cancer (21,52).

The other significant phytochemicals in Brassicaceae is phenolic compounds, including anthocyanins, hydroxycinnamic acids, flavonoids. These components provide color and taste to several fruits and vegetables and also containing biological activities and effects, such as inhibition of oxidation in LDL cholesterol, scavenging of free radicals and thus neutralizing of reactive oxygen species (53). Besides, it is known that support the restriction of adipose growing and incrementation of glucose uptake in adipocytes and cells in muscles by GLUT4, glucose transporter (54,55). The phenolics in cruciferous vegetables are hydroxycinnamic acids (e.g., caffeic, ferulic, and synapic acids) (56-59) and flavonoids (e.g., glycosylated isorhamnetin, kaempferol, and quercetin) with strong antioxidant activities and have various biological properties including immunomodulator, preventing cancer (60,61). Besides, it was reported that both quercetin and epicatechin may advance the production of insulin in rat islets (62). Furthermore, the leaf of turnip (*Brassica rapa*) extracts, a good source of flavonoids and tannins, exhibited anti-hyperglycemic activity in diabetic rats (63).

3. Conclusion

The Cruciferae (or Brassicaceae) family is rich source of phytochemicals, including ascorbic acid, carotenoids, glucosinolates, phenolics, terpenoids, tocopherols, etc. The cruciferous vegetables have recently increased in popularity worldwide due to these bioactive compounds have health-promoting effect, such as anticancer, antiinflammatory, antiobesity, antioxidant, antitumor, and neuroprotective. The amount and diversity of these compounds may vary depending on the variety, agricultural process, environmental factors, germination, and physical treatment such as cutting, smashing. The bioactive compounds in the cruciferous vegetables possess health benefits both in prohibiting chronic diseases and in decreasing the risk of cancer types. Since, cruciferous vegetables family is are a great source of bioactive compounds, consumption of these vegatables promotes body functions and may prevent disease. Thus, it may provided to select both non-pharmacological and cost-effective approaches for human health.

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Tables

Table 1. The mechanism of the compounds activities in cruciferous vegetables (64)

Compounds	Activity Mechanisms	References
Ascorbic acid	The reducing and neutralizing of reactive oxygen species, preventing of LDL oxidation	(31,65)
Carotenoids	Scavenging of the radicals and removing of single oxygen	(39)
Glucosinolates	Hedging of invasion effect in cancer cell (in vitro), regulating the enzymes activities in phases I and/or II	(19,66)
Phenolics	Neutralizing of reactive oxygen species, inhibition of oxidation in LDL-cholesterol, chelating of metal ions redox active	(53)

Figures

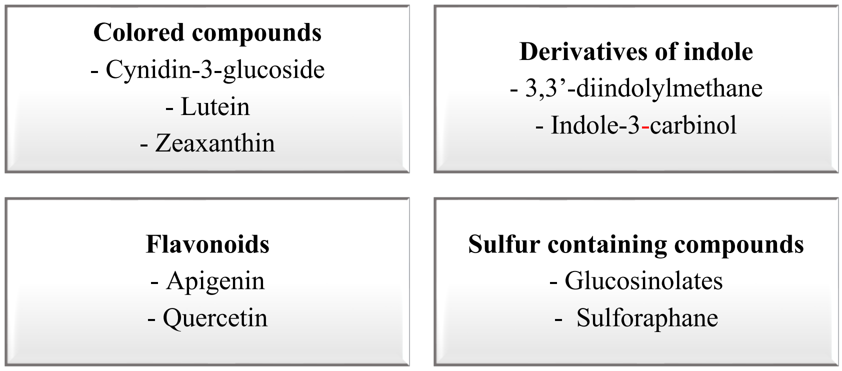

Figure 1. Biologically important compounds in cruciferous vegetables (6)

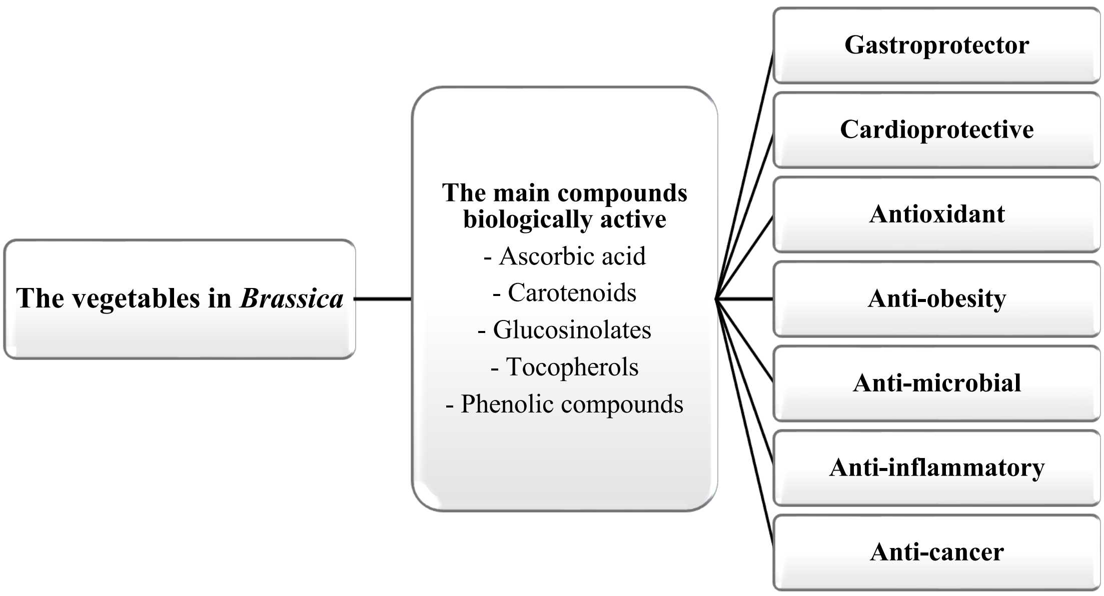

Figure 2. The main biological activities of the major compounds in the cruciferous vegetables (6)

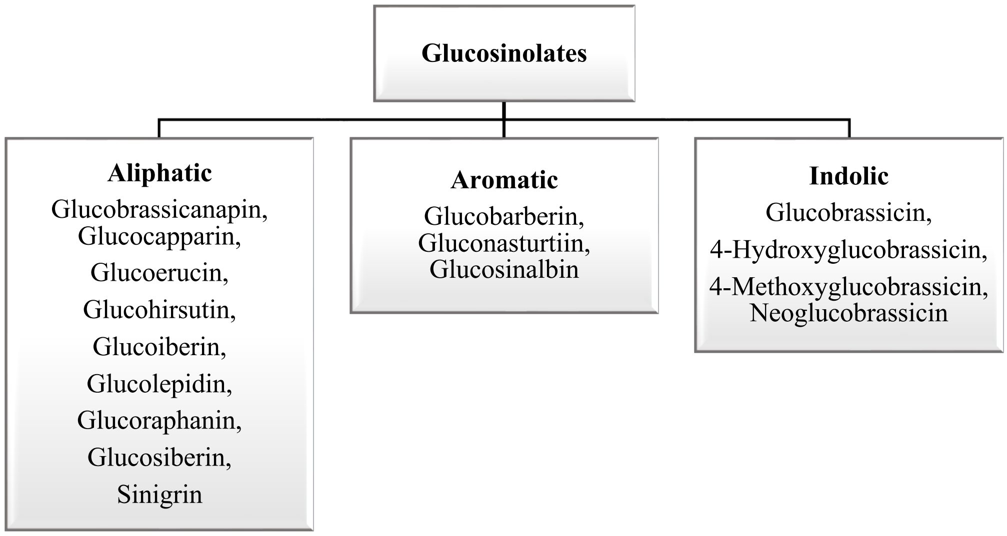

Figure 3. The classification of glucosinolates (49)

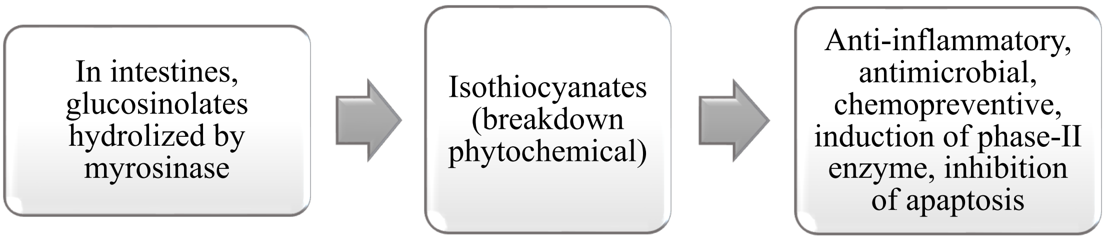

Figure 4. The biological effects of isothiocyanates (21,47,48,51)

https://dergipark.org.tr/tr/pub/food
OPEN ACCESS JOURNAL
ISSN 2667-5803
FHTI Journal of Food Health and Technology Innovations
December Vol 5, No 11 (2022)
DergiPark AKADEMİK
Review Article

Elmalı Söğle Tulum Cheese

Seval Sevgi KIRDAR[a,b],

Abstract

In recent years, the trend of consumption foods high in fiber and low in calories has been increasing due to consumers demands for a healthy and balanced diet. Hence, the vegetables-rich dietary regimes are becoming progressively important all over the world. The vegetables in Cruciferae (Brassicceae) family have worldwide consumption and popularity since scientific investigations confirm these vegetables are related to lower incidences of many chronic diseases such as type-2 diabetes, osteoporosis, obesity, cardiovascular disease and cancer. Beside on essential nutrients that promote the body, member of cruciferous vegetables have also contain healthy beneficial phytochemical compounds including carotenoids, anthocyanins, flavonoids, antioxidant enzymes, sulfur containing glucosinolates, coumarins, tocopherols and terpenoids. It is known that these compounds have anti-inflammatory, antimicrobial, antioxidant, antiobesity, cardioprotective, and gastroprotective activities. Pharmacological effects and nutritionally valuable compounds enhance the popularity of the plants in Brassicaceae family and lead to future functional food applications

Keywords: Cruciferous vegetables, health benefits, glucosinolates, sulforaphane

TÜBİTAK ULAKBİM

aMehmet Akif Ersoy University Burdur Food, Agriculture and Livestock Vocational Higher Education School Food Processing Department , Burdur, TURKEY
bMehmet Akif Ersoy University Healt Sciences Institute, Burdur, TURKEY
Phone: +90 2482132274

Email: skirdar@mehmetakif.edu.tr

Introduction

Culture encompasses all material and spiritual values that are shaped by historical processes in societies and passed down through generations. Traditional foods, which vary according to a country's culture, lifestyle, and economic conditions, are very important in revealing cultural riches. Traditional foods have been produced for centuries using traditional raw materials and/or having a traditional composition or a traditional production method; They are natural, publicly accepted, and time-tested products. Turkey is a very rich country in terms of traditional foods with its geographic location, rich natural resources, and historical and cultural heritage. traditional foods; the share of Geographical Indication (GI) registration is very important in distinguishing it from its peers and protecting it against unfair competition, ensuring continuity in quality and production conditions, increasing its value, and branding (4).

Cheese, which is used in various dishes, gives flavor to each dish by giving it its unique taste. Cheese, which is used in appetizers, main courses, breakfast, desserts, and salads, is an indispensable food product on Turkish tables. Cuisine is a culture, and cheese is an important part of this culture. Cheese, one of the essentials of world cuisine, contributes to a country's cultural richness. In every region of our country, which has a central position in East-West culture, we have different types of cheese in different structures, shapes, and flavors. We have many types of cheese, with different technological processes used as a production method and the breed of the animal from which the raw milk is taken, as well as climatic and regional differences. It has been esti-mated that of the cheeses produced in Turkey 60% are White Cheese, 17% Kashar Cheese, 12% Tulum and Mihaliç Cheese and that the remaining 11% of production is made up by other local cheeses (14,15)

According to the data of the Turkish Statistical Institute (TUIK), 756,646 tons of cheese were produced in Turkey in 2020. While 729,539 tons (96.4%) of this is cow cheese, 27,108 tons (3.6%) is composed of other cheeses (made from sheep, goat, buffalo, and/or mixed milk). Assuming an average of 13% cheese yield (including soft and hard types of cheese), it can be calculated that approximately 24% of the total amount of milk produced in our country (22,960,379 tons) is processed into cheese. According to 2020 data, approximately 16.6% of the cheeses produced are soft type (125.556 tons), 30.1% medium soft type (228.026 tons), 21% hard type (158.819 tons), 30.7% medium hard type (232.419) tons, 1.3% extra-hard type (9.573 tons), and 0.3% cheese made from curd (1.252 tons) (22).

The aim of this paper is to review the production technology of Sögle Tulum cheese during ripening in antic wells.

2. Söğle Tulum Cheese

According to the Turkish Food Codex, Tulum cheese is a cheese with characteristic features specific to its variety, produced by coagulating the curd obtained by coagulating with rennet, crumbling and salting after fermentation, then tightly pressing it on a packaging material suitable for food contact or leather overalls, and presenting it to the market after maturation has been defined (3).

The methods used to make the types of cheese that are produced in Croatia, Bosnia and Herzegovina, Montenegro, and Turkey differ just little from one another. It is made in the mountainous regions of Turkey's East and Central Anatolia, Bosnia and Herzegovina's various mountainous regions, and Croatia's Dinara region. Due to a scarcity of wood for the manufacture of storage and transportation equipment, nomadic sheep breeders most likely began using lamb skins for cheese storage and movement from mountains to valleys very early in history. This cheese is made from sheep, cow, goat, buffalo, and their blends of milk. The fundamental distinction of this sort of cheese is that it ripens in a lamb skin, known locally and regionally by names such as tulum (Turkey), miina (Croatia), and mjeh (Bosnia and Herzegovina). It can be compared to a bag or sack constructed from the entire skin of a goat or lamb. The cheese's distinctive sensory qualities—a pronounced peppery taste and odor—are most likely the result of two or three months of anaerobic ripening in the skin. The maturation process is carried out in places such as caves, obruk (cave-like small natural structures) or cellars (13,18,20)

Tulum cheese is one of the most popular and widely consumed traditional cheeses in Turkey. Tulum cheese is manufactured throughout the country with the exception of the Thrace region, particularly in tiny family businesses in rural and urban areas where milk cannot be processed in modern facilities. Each region of the country produces tulum cheese using its unique traditional techniques. In Turkey, tulum cheese is produced using both dry and salty processes (12). Tulum cheese has a white or cream color and a high fat content.and a crumbly, semi-hard texture; it is dispersible in the mouth and has a buttery and pungent flavor (8).

The name tulum means “goat’s or sheep’s skin bag” in Turkish, which is the bag used for packaging and ripening (11). Tulum, also called "Tulkuk" or "tuluk," is obtained from sheep, goat, kid, or lamb skin. Tulum made of lamb skin in Konya is called "cheese bağanası ", and in the Burdur region, baguette made of lamb or kid skin is called "bağalak" or "bağana. In Mus, the goatskin into which Çökelek Cheese is pressed is called Avrinç; in Sparta, Ilikme; and in Tunceli, Tomas. In Eastern Anatolia (Erzincan, Erzurum, Agri, Kars) and the Western Taurus Mountains in particular, leather skins are used; while in Middle Anatolia (Sivas, Yozgat, Kayseri, Kirsehir, Nigde), earthenware containers are predominate. The following Tulum Cheeses are renowned Afyon, Karaman, Kayseri, Tokat, Isparta, Sütçüler, Kargi, Mut, Cihanbeyli, Ermenek, Korkuteli Deri, Konya Küflü, Giresun Yaglidere Küflü, Giresun Aci, Karaburun Lorlu Keçi Tulumu, Çepni, Pasinler Lorlu Tulum, Armola, Divle, Erzincan Savak, Akseki Çimi, Serto, and Karin Kaymagi ".(1,2, 5, 7, 10,12, 17, 19, 21, 23-26,28). In terms of Salamura (Brined) Tulum Cheeses, Izmir Teneke Tulum, and Bergama Deri Salamura Tulum Cheese are famous on a national scale (16). It is possible to divide the Tulum cheeses produced in Turkey into two main groups. The first covers the dry Tulum cheeses produced mainly in Eastern, South Eastern, and Middle Anatolia; the second, the cheeses known as brined Tulum from the Aegean region. These two groups of Tulum Cheese are completely different from one another in terms of structure, flavor, and aroma (14).

Overalls filled with Tulum cheeses are prepared from kid, milk lamb, sheep, and goat skins. The leathers to be used as overalls are mostly preferred in the autumn; they are obtained from animals slaughtered after the bottom hair has been removed. These skins are abundantly salted with fine salt after being freed from meat and similar residues and tightly coiling with the hairy part out. In this case, they are left for about a week, opened and dried by hanging them in an airy place, and stored in dry conditions until they are used (27).

Prepared leathers are soaked in clean water before they are to be used; their lower parts are sewn up; holes and tears are repaired, and no open space is left on the neck of the skin other than a small mouth. In some regions, in order to identify and repair the holes in the skin, the overalls are first inflated, and the holes are marked with a matchstick. If the holes are small, they are closed with hooks; if they are large, they are closed with special reels made of wood. After the repaired overalls are inflated with air, they are thoroughly washed with plenty of water and soap and brushed if necessary. It is hit several times with a thick stick so that the weak hairs on the skin fall off. The overalls are now ready for the cheese. Cheeses are packed in the hairless part of the bag. However, in some regions, the outer part is used after the hair is clipped and shaved with a razor (9, 27).

In Table.1, the most well-known local names and ways to make traditional Tulum cheeses from the Mediterranean region are listed. These cheeses are made from cow, sheep, or goat milk, or a combination of these milks, and are sold in different types of packaging.

Elmalı Söğle Tulum cheese, one of the local Tulum cheeses of the Mediterranean region, has a significant consumption potential and is produced with the knowledge, skills, and possibilities of the local people (Figure.1). However, the milk that is used in the manufacturing of sole cheese is not used in the creation of any of the other varieties of tulum cheese. sole cheese is considered to be a type of tulum cheese. Therefore, due to the composition of the milk that is used in the production of Söğle tulum cheese as well as some differences in the method that is used to produce it (for example, ripening in antic wells located on the Söğle plateau(Kızlarağası) for three months. İt has its own characteristics that set it apart from other types of tulum cheese (20).

Elmalı Söğle Tulum cheese has a different production technique than other Tulum cheeses, and the maturation stage is done in antic wells. This cheese is produced mostly from raw goat's milk in the spring. The milk is fermented, the clot formed is broken up and transferred to cloth bags to remove the whey, and it is left to wait until it completely releases its water. Next, the cheese is first shredded with a grater, then by hand, and then salted. Crumbled and salted goat cheese is stuffed into goat skins that weigh between 70 and 90 kilograms. By pressing with a wooden stick called "Keskiç," the mouth ofthe skin is tied, and at 10 meters deep, 2 meters wide, at an altitude of 3086 m, it is filled with special products that have survived from antiquity to the present day. It is left in the wells for four months to mature. The most important feature that distinguishes this cheese from other similar cheeses is that the ripening stage is carried out in antic wells (20).

Conclusion

Protecting the diversity of traditional dairy products and bringing them into technology is of great importance for the development of milk technology. It is inevitable to examine and develop the technologies of local dairy products, which are produced locally but remain in a closed home economy and are even forgotten due to changing conditions, to determine their characteristics and to switch to commercial production.

The production technology of Söğle Tulum cheese should be improved and standardized, its registration should be taken, the registration of CIs; the creation of a database of properties and compositions; the creation of a cheese route; and its recognition with gastronomy tourism should be increased.

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Table.1. The local Tulum cheeses of the Mediterranean region

Provience	Region	Cheese name	References
Antalya	Akseki,Serik, Manavgat	Çimi tulum cheese	Kamber 2005
	Korkuteli	Korkuteli Tulum cheese	Kamber 2005
	Korkuteli-Elmalı-Söğle	Söğle Tulum cheese	Ünsal 2007
	Antalya	Çoban Tulum Cheese	Gönç et al. 1974
Isparta	Atabey, Barla, Yalvaç	Isparta Tulum Cheese	Kamber 2005
Isparta-Antalya	Isparta Antalya plateaus	Dolaz Cheese	Şimşek and Sağdıç 2006, Okur et al. 2010
Kahramanmaraş	Kahramanmaraş	Kahramanmaraş Tulum Cheese	Çetinkaya 2005
Mersin-Antalya-Isparta-Burdur	Toros plateaus	Yörük Cheese	Kamber 2005

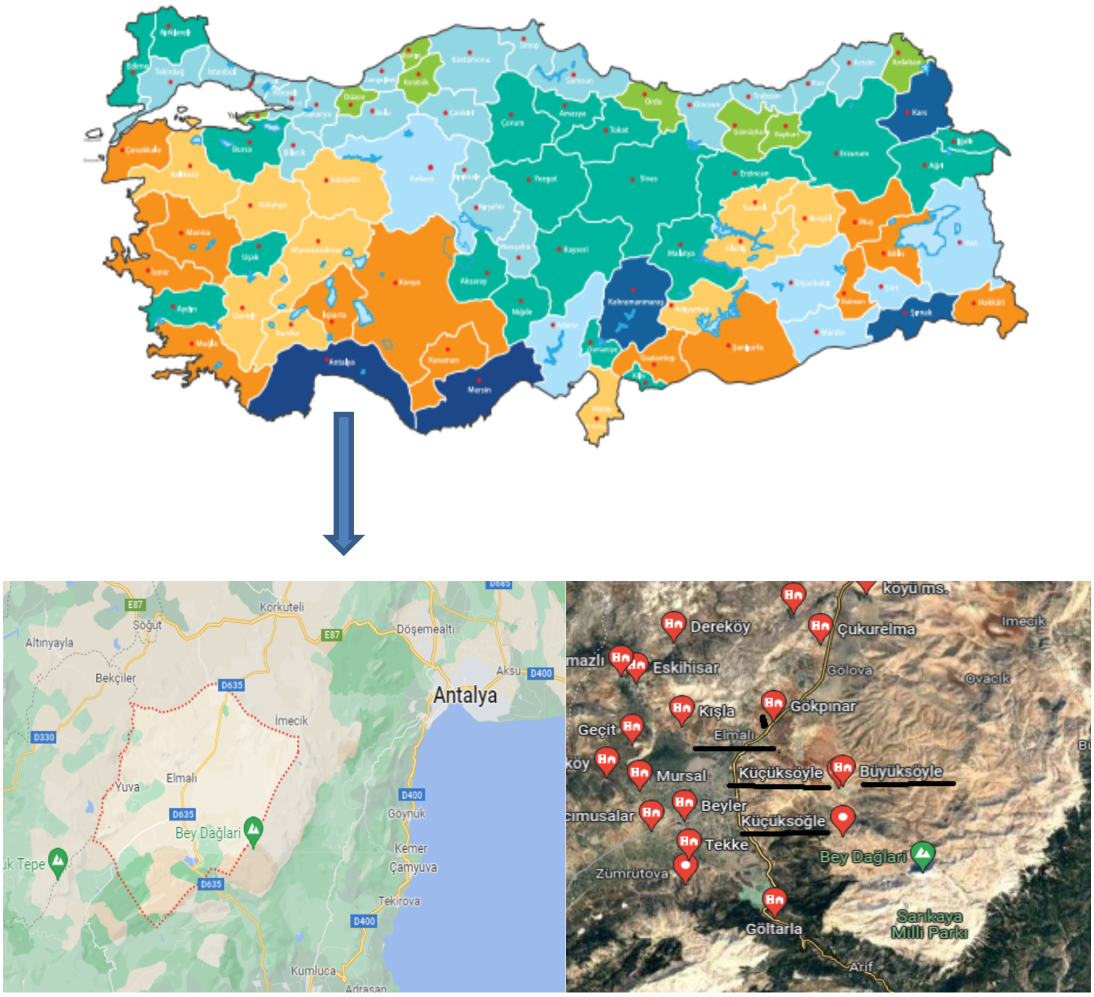


Figure 1. Region where Söğle Tulum cheese is produced

 ISSN 2667-5803

a-Milking

b-Boiling and add to rennet

c-Transfer to curd bag

d-Grating and Shredding

e-Salting

f-Stuffing in 4 year old goat skin

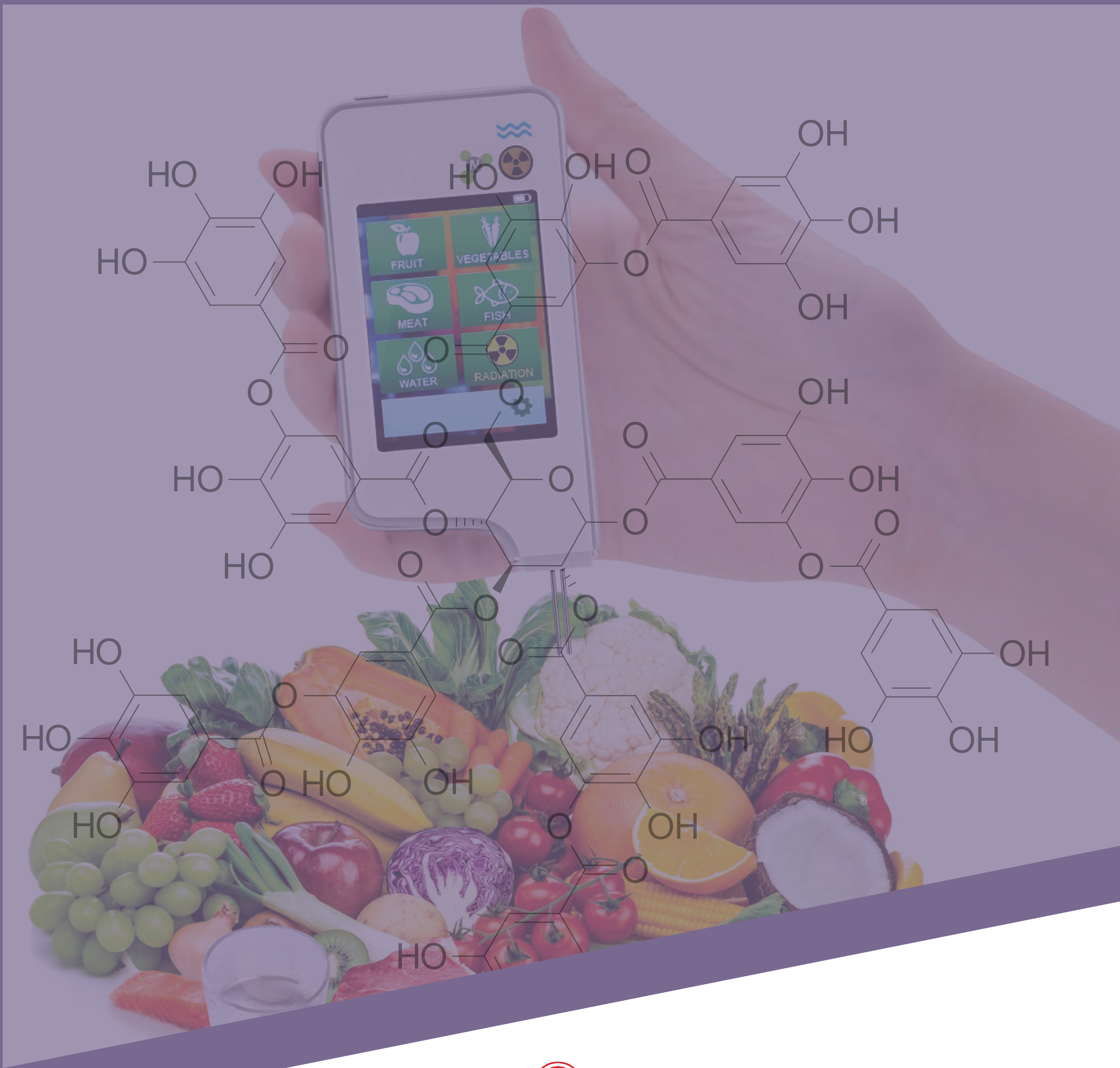
g-Crumbled and salted goat cheese is filled with goat skins that weigh between 70 and 90 kilos of cheese by pressing with a wooden stick called 'Keskiç' and the skin of the skin is tied.

h-It is left in special wells that are 10 meters deep, 2 meters wide, and at an altitude of 3086 m, which have survived from ancient times. Here it is matured for 3-4 months.

I- matured for 4 months from the ancient well

j- Söğle Tulum Cheese

Figure.2. Production process steps



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JOURNAL OF FOOD HEALTH AND TECHNOLOGY INNOVATIONS

DECEMBER VOL 5, NO 11 (2022)

ISSN 2667-5803