Nutraceuticals and Bioactive Compounds: Milk, Royal Jelly, and the Healing Power of Medicinal Plants

Editor
Recep ASLAN

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Content

PREFACE

We pleased to present an overview of the book “Some Traditional Functional Foods: Milk, Royal Jelly, Medicinal and Aromatic Plants." This work explores the nutritional, therapeutic, and cultural significance of various functional foods, including milk, royal jelly, and selected medicinal and aromatic plants. These substances have been integral to human diets for centuries and are increasingly recognized for their potential health benefits. The book provides a comprehensive review of their traditional uses, scientific basis, and modern-day applications.

Traditional Functional Foods: Definition and Importance

The concept of functional foods refers to foods that provide health benefits beyond basic nutrition. They are believed to play a role in the prevention and management of various health conditions, promoting overall wellness. Traditional functional foods, such as milk, royal jelly, and medicinal plants, have been used for centuries in various cultures for their presumed therapeutic properties. This book delves into these foods, examining both their historical roles and the scientific evidence supporting their use.

Milk: A Multifaceted Nutritional Powerhouse

Milk has long been considered a cornerstone of human nutrition, providing a rich source of proteins, vitamins, and minerals. The book highlights the diverse forms of milk consumed around the world, from cow and goat milk to alternative sources such as camel and buffalo milk.

Key topics covered include:

- **Nutritional Composition:** The essential nutrients in milk, including calcium, protein, and vitamins, which support bone health, muscle function, and immune defense.
- **Health Benefits:** Emerging research on milk's role in managing conditions like osteoporosis, hypertension, and lactose intolerance.
- **Cultural Significance:** Milk's role in traditional diets and its use in various cultural rituals and health practices.

Royal Jelly: The Elixir of Life?

Royal jelly, a secretion produced by worker bees to nourish the queen bee, has long been revered for its alleged health-promoting properties. This chapter explores royal jelly from both a biological and cultural perspective.

Topics of interest include:

- **Composition and Nutrients:** Royal jelly's rich composition, including proteins, lipids, vitamins, and antioxidants.
- **Health Benefits:** Potential therapeutic uses of royal jelly, including its reported anti-inflammatory, antimicrobial, and immune-boosting effects. Some studies suggest that royal jelly may have a role in improving skin health, cognitive function, and hormonal balance.

- **Scientific Investigations:** Analyzing the evidence for royal jelly's purported benefits and addressing the gaps in research that require further exploration.

Medicinal and aromatic plants form a vital part of traditional medicine systems across the world. The book delves into several key plants that have been studied for their functional properties.

While many of these functional foods have deep roots in traditional diets, there is increasing interest in their role within modern nutrition. The book addresses how these foods can be integrated into contemporary health paradigms, including:

- **Dietary Supplements and Functional Foods:** The growing trend of encapsulating natural products like royal jelly and medicinal herbs in supplements.
- **Food Fortification:** The process of adding bioactive compounds from plants or dairy to processed foods in order to enhance their functional properties.
- **Personalized Nutrition:** The potential for functional foods to be part of personalized health strategies, tailored to the individual's genetic, environmental, and lifestyle factors.

In conclusion, "On Some Traditional Functional Foods: Milk, Royal Jelly, Medicinal and Aromatic Plants" provides a rich and multi-dimensional examination of these functional foods, offering insights into their historical significance, scientific validation, and contemporary applications. The integration of traditional knowledge with modern scientific research presents exciting possibilities for enhancing human health and well-being. As

we move forward, it is crucial to continue exploring these functional foods while respecting cultural traditions and ensuring sustainable practices.

I encourage you all to explore this book for a deeper understanding of the intersection between nutrition, tradition, and science in the realm of functional foods.

Editor
Prof. Dr. Recep ASLAN

CHAPTER I

Bioactive Food Elements From The Perspective of Biochemistry

Zeyneb KARAKUŞ[1]

Introduction

Functional foods are defined as food products that offer health benefits beyond their basic nutritional content. The basic issues regarding the relationship between functional foods and health, medicine, physiology and biochemistry can be listed as follows (Egbuna & Tupas, 2020):

- Alternative and New Protein Sources
- History and Classification of Nutraceuticals
- Bioactive Carbohydrates, Biological Activities, and Sources
- Bioactive Peptides and Their Natural Sources
- Cereals and Grains as Functional Food in Unani System of Medicine
- Aloe Species: Valuable Sources of Functional Bioactives

[1] Assistant Professor, Afyon Kocatepe University, Çay Vocational School, Chemical Technology Program

- Dietary Supplements: Health Effects, Regulation and Their Industry
- Effect of Germination Processing on Bioactive Compounds of Cereals and Legumes
- Fats and Oils: Sources of Bioactive Molecules
- Fruits and Vegetables and Their Biochemical and Phsiyological Effects
- Functional Foods and Human and Animal Health
- Milk and Milk Products as The Funcional Foods
- Honey and It's Ingredients as Functional Food
- Microbial Proteins as a Potential Source of Protein
- Mushroom as a Nutraceutical, Mineral, Proximate Constituents, Bioactive Component
- Seafoods as A Nutritional and Health Benefits Food Sources
- Classifications, Biosynthesis and Bioactivities of Polyphenols
- Prebiotics, Probiotics, Synbiotics, Postbiotics: Importance in the Diseases Management
- Types, Sources and their Functions of Vitamins, Minerals

The foods called "functional" may include added supplements or other ingredients designed to enhance overall health outcomes. Functional foods have been on the agenda since the 1980s as a new concept. Considering the chemical content of foods and their effects on physiology, it is actually not a new phenomenon; Aristotelian physicians are known to have said "let food be your medicine and medicine be your food". As technological development processes make it possible to better recognize foodstuffs and to obtain new food products, eating habits and the

view of food are changing (Anonymous, 2019; Sharma et al., 2021). The end of the Cold War period has provided the opportunity for sustainable development, paved the way for an increase in the level of education, easier access to information, increased coverage and influence of media tools, the removal of the borders of international relations and trade, and raised living standards on a global scale. As a result, the relationship between food and health has become an important field of study. As a result, expectations from the food industry and the food market have completely changed. In today's conditions, rational utilization of foods has become an important field as scientific studies reveal the relationship between nutrition and health concretely and the protective and therapeutic functional properties of foods become clearer (Coşkun, 2005).

Today, foods can be studied both for the macro and micronutrients they contain and for their cumulative functional effects. In recent years, the food-induced increase in health problems has created a heavy burden for economies, and increasing health expenditures accelerate the trend towards nature and nature. These developments have made the functional components in existing products more recognizable and new food forms have been introduced through engineering science. At this point, it is predicted that the bioactive components of some foods may provide preventive medicine function and may be a remedy for health problems (Khalaf et al., 2021).

Despite the findings and approaches in this direction, it would still not be correct to see functional foods as an elixir of life. In order to benefit from the functional effects of foods, a smart and balanced lifestyle and eating habits are a prerequisite. This review

aims to make the concept of “functional food” more widely and accurately recognized due to its medical importance (Khalaf et al., 2021; Anonymous, 2024).

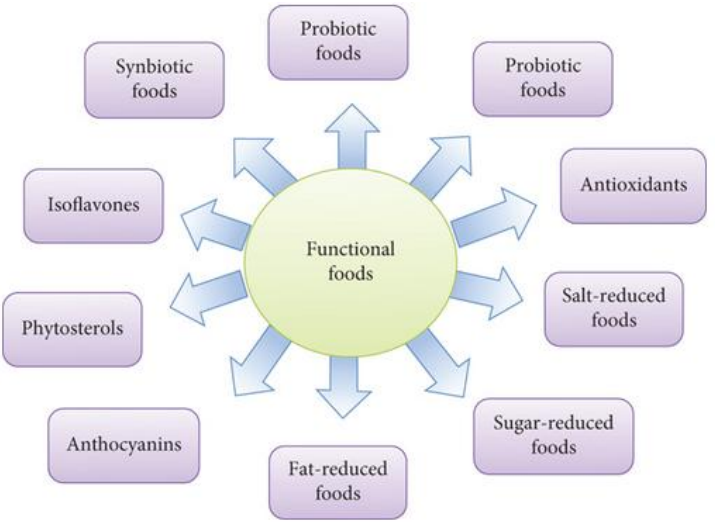

Figure 1: Basic functional foods and its branches

(Khalaf et al., 2021)

Functional foods are crucial for human and animal health, serving as a primary source of essential nutrients and offering potential benefits beyond basic nutrition. These foods, including various fruits, vegetables, grains, fish, dairy products, and meats, are naturally considered major contributors to a functional diet. In addition to these conventional sources, recent studies have highlighted the inclusion of tea and chocolate as functional foods, owing to the presence of bioactive compounds that offer health benefits (Khalaf et al., 2021).

A balanced diet is fundamental to maintaining both mental and physical health throughout an individual's life, as it ensures the proper functioning of the human body. Functional foods, in particular, play a significant role in supporting bodily functions by meeting basic nutritional requirements while also providing protective effects against malnutrition-related diseases. Furthermore, they can help eliminate harmful substances from the body, contributing to overall well-being. ResearchS suggest that functional foods can be defined as food products that enhance the body's metabolic rate without interfering with normal physiological functions, thereby promoting a stable physical state. In the modern era, functional foods are particularly important for providing the energy needed to support healthy growth and development (Savcıgil, 2003; Anonymous, n.d.).

Moreover, functional foods have the potential to modulate the immune system, reducing the risk of chronic conditions such as cardiovascular diseases, osteoporosis, obesity, and cancer. By offering these protective benefits, functional foods contribute to the promotion of long-term health. Examples of functional foods include vitamins, fortified products, dietary fibers, minerals, peanuts, fruits, and seeds from various grains (Dündar, 2001; Evcimen & Aslan, 2015; Anonymous, 2019b; Sharma, Mishra & Senapati, 2021).

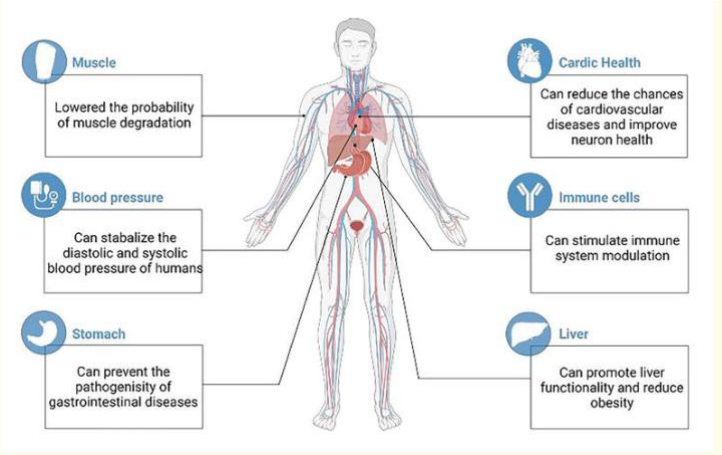

Figure 2: Basic pyhsiological effects of foods

(Anonymous, 2023)

Functional Food, Nutraceutical, Bioactive Component Concepts

Since the role of the diet-gene-lifestyle triad has been recognized, the concept of "functional food" has been on the agenda as a result of the search for a food that fully includes the goals of healthy living (Dayısoğlu, Gezginç & Cingöz, 2014). In fact, every food is functional in some way. However, the findings that diet, which is thought to provide the nutrients necessary for normal body functions, may play a role in 60% of death cases and 70% of cancer cases have led to the process of safe and functional food. For this reason, the common theme of nutrition and food disciplines today is gene, mind and body health and food safety. One of the most important trends of research and technology in the field of food is not only to investigate whether a food causes harm or not, but also to determine how the food affects the functions and health of the individual and how it can prevent common risks such as diabetes, cardiovascular diseases, bone and joint disorders and cancers

(Mehenktaş & Bayaz, 2004; Chang et. al., 2022). Food safety is one of the important articles of the National Security Policy Document, which is a deep constitution for our country (Anonymous, 2019c). In today's world, where food safety is ensured at a significant level as a result of the contributions of science, communication and technology, the food industry is locked on the goal of practicing the idea of "let food be our medicine and medicine be our food". This approach emphasizes nutrients as functional life supports and makes the utilization of nutrients targeted and specific with a perspective that sees tomato as lycopene, salmon as omega-3 fatty acids, onion and garlic as sulfides (Coşkun, 2005; Dayısoğlu, Gezginç & Cingöz, 2014). A functional food can be a natural food containing a functional bioactive nutrient, as in the example of "tomato-lycopene", or a food to which one or more functional factors have been added, such as "iodized salt, eggs containing omega-3", or a food to which an undesirable ingredient has been modified, such as reduced sodium salt. Again, "yogurt-protein-bioactive peptide" example, functional foods with increased bioavailability are produced by modifying some food components. Foods can also be made functional by adding phenolic substances, antioxidants, probiotics, prebiotics, postbiotics, antibiotics, vitamins, polyunsaturated fatty acids, sulfur components, phytoestrogens, dietary fibers and plant sterols, which are bioactive molecules with proven effects (Savcıgil, 2003; Mehenktaş & Bayaz, 2004; Dayısoğlu, Gezginç & Cingöz, 2014) For example, the most widely used functional food elements in recent years are antioxidants. The role of phenols in foods as strong antioxidant substances in the organism has increased the inclusion of these compounds in the formulations of natural products and their widespread use in

functional food development. It has been reported in many studies that these compounds regulate blood cholesterol levels with their antioxidant effects and are effective in preventing osteoporosis and cancer (Savcıgil, 2003; Mehenktaş & Bayaz, 2004; Coşkun, 2005). Phenolic compounds, which are widely used in the functionalization of foods, have also been shown to inhibit pathogenic bacterial load and infections (Savcıgil, 2003; Egbuna & Tupas, 2020).

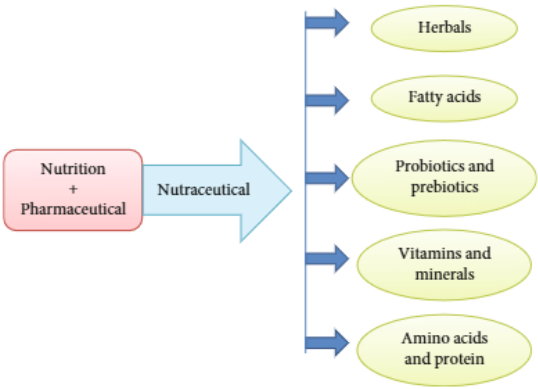

Figure 3: The consept of basic nutraceuticals

(Khalaf et al., 2021)

Although there is not yet a precise and generally accepted definition offunctional food, those that can contribute to health by positively affecting physiological processes in addition to the basic nutritional functions of foods used in normal nutrition, and nutritional components consisting of bioactive chemicals with this feature are approached as functional foods (Mehenktaş & Bayaz, 2004; Egbuna & Tupas, 2020; Anandharamakrishnan & Subramanian, 2023). Functional foods are classified as follows according to the chemical structures of their bioactive components (Sharma, Mishra & Senapati, 2021; Anonymous, n.d.).

- Isoprenoid derivatives (terpenoids)
- Phenolic substances
- Fatty acids and structural lipids
- Carbohydrates and derivatives
- Substances containing amino acids
- Microorganisms (probiotics)
- Prebiotics and synbiotics
- Minerals

Examples and Categories of Functional Foods

Functional foods can be broadly classified into two primary categories: conventional and modified (Sharma, Mishra & Senapati, 2021; Anandharamakrishnan & Subramanian, 2023).

1.Conventional Functional Foods

These refer to natural, whole foods that are inherently rich in essential nutrients, such as vitamins, minerals, antioxidants, and healthy fats. Examples include:

- Fruits: Berries, kiwis, pears, peaches, apples, oranges, bananas.
- Vegetables: Broccoli, cauliflower, kale, spinach, zucchini.
- Nuts: Almonds, cashews, pistachios, macadamia nuts, Brazil nuts.
- Seeds: Chia seeds, flaxseeds, hemp seeds, pumpkin seeds.
- Legumes: Black beans, chickpeas, navy beans, lentils.

- Whole Grains: Oats, barley, buckwheat, brown rice, couscous.
- Seafood: Salmon, sardines, anchovies, mackerel, cod.
- Fermented Foods: Tempeh, kombucha, kimchi, kefir, sauerkraut.
- Herbs and Spices: Turmeric, cinnamon, ginger, cayenne pepper.
- Beverages: Coffee, green tea, black tea.

2. Modified Functional Foods

These are products that have been enhanced through fortification with additional nutrients, designed to improve their health-promoting properties. Examples include:

- Fortified fruit juices
- Fortified dairy products, such as milk and yogurt
- Fortified plant-based milk alternatives, including almond, rice, coconut, cashew milk
- Fortified grain products, such as bread and pasta
- Fortified cereals and granola
- Fortified eggs

In addition to studies stating that any food that can positively affect health, fitness, physical performance and psychology is a "functional food" (Gray, Armstrong & Farley, 2003), there are also approaches that define foods and beverages that positively affect health by supporting physiological processes as a result of a functional component added to food or process modification or biotechnology applications, help prevent the occurrence of diseases or pathologies, and increase physical, cognitive and mental

performance as functional foods. In addition, foods that have been shown to be preventive against chronic diseases are also considered functional foods (Mehenktaş & Bayaz, 2004; Sharma, Mishra & Senapati, 2021). In addition to the adequacy, diversity and effectiveness of the nutrients it contains, "functional food" is defined as nutrients that are good for one or more body functions, reduce the risk of disease, are not in the form of drugs, capsules or tablets, and whose effects have been scientifically approved. In addition, functional foods can also be created by adding functional ingredients to traditional foods through biotechnology to support health or prevent disease or assist in treatment. Foods can be given qualities that increase physical and mental performance, reduce the risk of cardiovascular diseases, cancer, hypertension, cholesterol, diabetes, ulcers, and support the basic physiological functions of the organism and the immune system. Enriched foods created by increasing the existing nutrient content, foods with increased value created by adding a new nutrient or component, foods created by changing existing components and supported foods constitute functional foods. Since functional food is related to the relationship of food with health and physiology, these foods are also called "health foods, medical foods, regulatory/balancing foods, foods for special nutritional purposes and pharmacological foods" (Coşkun, 2005; Dayısoğlu, Gezginç & Cingöz, 2014; Khalaf et al., 2021). In the functional food approach, the physiological roles of nutrients in regulating the organism are more important than the macro and micronutrients they contain. Therefore, foods that contribute to health and physiological processes beyond their basic nutritional properties are called functional foods. A functional food can be a natural traditional foodstuff that has not undergone any processing,

or it can be any foodstuff that has been produced by enriching it with a functional nutrient or that has been modified by bioengineering and genetic intervention and can be taken in the daily diet (Dayısoğlu, Gezginç & Cingöz, 2014; Anandharamakrishnan & Subramanian, 2023; Anonymous, 2023). A functional food is expected to be able to protect physical and mental health, prevent or delay the onset of a disease or symptoms of old age, and even provide tissue repair and disease treatment. With its bioactive nutrients and energy potential, a functional food should support the immune system, provide metabolism and weight control, regulate cholesterol levels and blood pressure, reduce cardiovascular risks, suppress cancer formation, regulate sugar and insulin metabolism, and support mental and physical performance. All these mean that these foods are foods that effectively improve quality of life (Mehenktaş & Bayaz, 2004).

The studies first initiated in Japan resulted in the establishment of an official Functional Food Working Group and the licensing of hundreds of foods with FOSHU (Foods for Specified Health Use) licenses in line with the studies and reports of this group, and the process gained momentum by becoming globalized. Studies have revealed in which health problems the bioactive content of foods that have received this license play an active role (Table 2) (Mehenktaş & Bayaz, 2004).

Nutraceuticals are concentrated tablet, powder or liquid forms of important bioactive components isolated and purified from foods. Nutraceuticals, which are tablet or capsule forms of conventional food forms, are formed from the words “nutrition” meaning nutrition and “pharmaceutical” meaning pharmacy. Nutraceutical is the common name of non-toxic, food extract

supplements whose benefits have been scientifically demonstrated in the treatment or prevention of diseases (Anonymous, 2007). “Functional foods” and ‘nutraceuticals’ are often confused and used interchangeably in public use. Rosemary, tomato, garlic, flaxseed, ginko bloba, St. John's wort, ginseng, echinacea, soybean extracts used for the prevention or treatment of certain diseases are defined as nutraceuticals (Coşkun, 2005; Egbuna & Tupas, 2020; Anonymous, 2023). However, there are also researchers who include concepts belonging to food groups such as nutraceuticals, pharmaceuticals, pharmaceutical foods and engineered foods in the definition of functional food (Mehenktaş & Bayaz, 2004). Although both nutraceuticals and functional foods are used to describe foods or food components that provide health, fitness and performance as well as basic nutrition, nutraceuticals describe both conventional foods and nutrients and nutrients in forms such as tablets and capsules. Functional food is in the form of traditional food forms. Nutraceuticals are non-toxic food extracts that have been scientifically shown to contribute to the treatment and prevention of diseases, while functional foods are nutrients that reduce the risk of disease and have a positive effect on health. In practice, nutraceuticals and functional foods can be used interchangeably due to their overlapping properties (Dayısoğlu, Gezginç & Cingöz, 2014; Egbuna & Tupas, 2020).

Bioactive compounds are chemical compounds found naturally in animal and plant foods and seafood. Research on the identification of bioactive chemicals in foods and their effects on health and physiology suggests that one of the most important factors that make a food “functional” is the bioactive components contained in that food. Prebiotics in dairy products, thymoquinone in black

cumin, lycopene in tomatoes, beta glucan in oats, catechins in tea, quarsetin in grape seeds, isothiocyanates in broccoli, conjugated linoleic acids in meat, omega 3 fatty acids in fish are examples of bioactive components. Plant bioactive components are referred to as "phytochemicals" and animal bioactive components are referred to as "zoochemicals" (Coşkun, 2005; Özer & Güven, 2008; Vattem & Maitin, 2016,). Isoflavans in dried beans, legumes and soybeans; ellagic acid found in fruits such as grapes, raspberries, apples and strawberries; phytates found in plants such as lupins and soybeans as well as whole grains such as rice, wheat, millet, corn and oats; indoles in broccoli, brussels sprouts, cabbage, cauliflower, turnips, kale, turnip leaves, mustard leaves, ginseng, sesame oil, bitter gourd, ivy gourd, green vegetables, grains and tubers; flavonoids, the dominant bioactive component of vegetables and fruits such as carrots, citrus fruits, strawberries, apples, raspberries, broccoli, ginko bloba, black and green tea, parsley, soybeans, cereals, cabbage, squash, potatoes, tomatoes, cucumbers; terpenes, which are highly concentrated in fruits such as citrus fruits, cherries, cherries; phenolic acid, a powerful ingredient in all green vegetables as well as nuts such as hazelnuts, walnuts, carrots, cherries, cherries, apples, strawberries, raspberries, broccoli, oranges, tomatoes and whole grains; coumarins, which are abundant in celery, parsley and tea polyphenols; polyphenols in hops, green tea and grape varieties; lycopenes, which are prominent in tomatoes, watermelon and grapefruit; glycyrrhizin in licorice; isothiocyanates in sources such as cress, radish and cabbage; carotenoids, glycosinolates, phytosterols, saponins, terpenes, phytoestrogens, flavones, protease inhibitors, phenolic acids in citrus fruits, carrots, fibrous green vegetables, tomatoes, spinach, cauliflower, chives, white and red

radishes, grapes, kiwi, pineapple, eggplant, celery, chicory, southerner, fennel roots and leaves; sulfites in garlic, onion, chives, leek, leek, pineapple, and broccoli are the main bioactive nutrients that make these foods functional (Tables 1 and 2) (Dündar, 2001; Evcimen & Aslan, 2015; Anonymous, n.d.).

Table 1. Bioactive components considered to be functional and their effects

Cancer inhibitors	Promoters of serum lipid profile	Antioxidants	Antiinflammatories	Bone preservatives
Capsaicin	Glucan	CLA	Linoleic acid	CLA
Genistein	Tocotrienol	Ascorbic acid	EPA	Soy protein
Daidzein	Tocotrienol	Carotene	DHA	Genistein
φ-tocotrienol	MUFA	Polyphenols	Capsaicin	Daidzein
-tocotrienol	Quersetin	Tocopherols	Quersetin	
CLA	3 fatty acids	Tocotrienols	Curcumin	
Lactobacillus acidophilus	Resyeratrol	Indole-3-carbinol	Calcium	
Sphingolipids	Tanins	φ-tocopherol		
Limonen	Sitosterol	Ellagic acid		
Diallyl sulfide	Saponins	Lycopene		
Ajoen		Lutein		
φ-tocopherol		Glutatione		
Enterolactone		Hydroxytyrosol		
Glycyrrhizin		Luteolin		
Equol		Oleuropein		
Ellagic acid		Catechins		
Lutein		Gingerol		
Carnosol		Chlorogenic acid		
L. bulgaricus		Tannins		

(Anandharamakrishnan & Subramanian, 2023; Anonymous, n.d.)

Other terminologies that may be encountered in the functional food concept are as follows:

- Dietary supplements
- Fortified foods

- Special diet foods
- Medicinal foods
- Nutritional supplements
- Therapeutic supplements
- Designer foods
- Superfoods

Physiological Expectations From Functional Foods

The aging of the population almost all over the world, but especially in developed societies, has revealed that it is better and more economical to prevent disease, which has made lifestyle and smart nutrition understanding, and thus functional foods attractive (Dündar, 2001; Sharma, Mishra & Senapati, 2021). Studies on the relationship between nutrients and health have shown the contribution of foods in the prevention and treatment of diseases (Coşkun, 2005; Egbuna & Tupas, 2020). Thousands of functional nutrients such as carotenoid pigment and antioxidant lycopene in tomatoes, omega-3 fatty acids in fish and krill are found in foods that make up daily diets. A conscious dietary preference that emphasizes and prioritizes functional nutrients can be effective in the fight against cancers, cardiovascular problems, chronic diseases such as diabetes, alleviation of menopausal symptoms, prevention of osteoporosis, protection of eye health and psychosomatic diseases (Table 2). All these benefits have significantly increased the functional food market in our country as well as in the world, especially in the last decade, and many companies have started to produce functional foods in parallel with the increasing health awareness and demand for functional foods. Expectations from the

functional foods and nutrients produced can be listed as follows (Coşkun, 2005; Anandharamakrishnan & Subramanian, 2023):

1) In addition to providing normal nutrition, the foodstuff should help to sustain and improve physical and mental health.

2) Its nutritional qualities and contribution to health must be proven by scientific studies, and this evidence must be accepted by nutrition disciplines and medical platforms.

3) The standard for the appropriate daily intake of the functional food or nutrient should be established by medical and nutritional science authorities.

4) The food must be unquestionably recognized as safe in terms of its ingredients.

5) The physical, microbiological, biochemical properties and quantities and qualities of the nutrients in the foodstuff should be concretized.

6) Functional properties through process modification or biotechnology applications

There should be no loss of nutritional properties and nutritional values of the foods that have been added.

7) In order for a food to be considered a functional food, it must be a foodstuff that can be used frequently and widely in the daily diet, not a foodstuff that is rarely used.

8) The form of the food should be in the form in which it is naturally used in diets, not in the form of nutritional supplements such as tablets, syrups and capsules. However, despite this approach,

it was accepted in Japan in 2001 that functional foods can also be in forms such as pills and capsules.

9) The food or food component must not be a substance used as a medicine.

10) Functional ingredients in foods need to be either essential macronutrients or essential micronutrients that have a positive impact on health.

11) The phytochemicals and zoo-chemicals contained in the food should be essential or essential components that positively affect physiology.

Potential Physiologic Effects of Functional Foods

Functional foods are associated with a wide range of health benefits, which can be broadly categorized as follows:

1. **Prevention of Nutrient Deficiencies**

Functional foods are often rich in essential nutrients, such as vitamins, minerals, healthy fats, and dietary fiber. A diet that incorporates a variety of functional foods can help ensure an adequate intake of these nutrients, thereby reducing the risk of deficiencies. For instance, the introduction of iron-fortified wheat flour in Jordan resulted in a marked reduction in the prevalence of childhood iron deficiency anemia, demonstrating the potential of fortified functional foods to address specific nutrient deficiencies in populations (Egbuna & Tupas, 2020).

2. **Disease Prevention**

Many functional foods are abundant in antioxidants, which have been shown to neutralize harmful free radicals, thus mitigating cellular damage and potentially lowering the risk of chronic diseases

such as cardiovascular disease, cancer, and diabetes. Furthermore, foods rich in omega-3 fatty acids, such as certain fish and plant-based oils, have been found to possess anti-inflammatory properties, contributing to improved cardiovascular health and reduced inflammation (Egbuna & Tupas, 2020; Sharma, Mishra & Senapati, 2021).

3. **Promotion of Growth and Development**

Certain nutrients are essential for the healthy growth and development of infants and children. The consumption of nutrient-dense functional foods, in combination with fortified options, can support the specific nutritional needs of this vulnerable population. For example, fortified cereals containing B vitamins, particularly folic acid, are vital for fetal development, as inadequate folic acid intake during pregnancy has been linked to an increased risk of neural tube defects (Dündar, 2001).

Nutrition Supporting Physiological Biochemistry: Smart Nutrition

In today's world where mind and mind products are prioritized, "smart nutrition" is a new diet and lifestyle; it means nutrition that prioritizes mental health and mental performance. This nutritional approach is necessary for individual fitness and well-being, as well as being very important for an environment of universal love and peace (Chang et al., 2022). Scientific studies have shown that nutritional approaches that value mental health, such as the "omega diet", support the heart and neurons (Guiné et al., 2023). In addition to the neurons that are the functional elements of the mind, protecting the liver, which forms the body's biochemistry, and the heart, which is the functional organ of feeling and vitality, is a

characteristic aspect of nutrition for the mind. Diets that will provide neurons with enough blood, energy and oxygen for brain usage capacity and synaptic activity are within the scope of smart nutrition. The brain is the expression of individual peace, universal love and peace in humans. In order for the brain to perform these duties, it is essential to carefully protect the structures of neurons and support cells and to support synaptic activity processes. In order to transfer the high abilities and characteristics of the brain to the new generations with genes, it is our universal responsibility to benefit from the functional food perspective and eat for the mind. Diets and lifestyles that pose a risk to neuron structure and functionality are risks for organismic and cellular health as well as for world peace. Living in peace definitely requires high intelligence. Physical health is also directly affected by nutrients. For example, chronic food-related poisoning and intoxications, which manifest themselves with symptoms of weakness, joint pain, intestinal irregularities, waking up feeling tired, difficulty remembering, memory weakness, wrong decision-making, reflex disorders and premature aging, are risks for the body as well as for mental health and are an important tissue-damaging environment with their carcinogenic, teratogenic, metagenic and allergenic effects. Functional foods, with their preventive and protective properties against all these risks, are foods that can be preferred for smart nutrition (Dündar, 2001; Sharma, Mishra & Senapati, 2021; Chang et al., 2022).

Functional Foods From History To Today Today With Medical Perspective

In civilizations such as Egypt, India and China, there is an approach of "you are what you eat" (Dündar, 2001; Anonymous, 2019a). The teachings of Islam have also given importance to the

relationship between life and nutrition starting from the stage of intention, and have guided foods that support physical and mental health by naming them as "clean, healthy food". Foods such as black cumin and honey have been defined as healing, meat and milk have been defined with their functional properties, food hygiene has been suggested, scientific boundaries have been set for food sources, plants and animals, scientific and principled definitions and suggestions about food have been presented with verses and hadiths in periods when laboratory facilities were not yet available. All these data are also an indication that foods can be used effectively for a healthy and protected life (Egbuna & Tupas, 2020; Anonymous, 2023). Due to the demand for the use of natural plants and spices used as food for health and healing purposes, the "Silk Road", which is the most active route in the world, has been an important cause of peace and wars for centuries. This route, known for its cinnamon, ginger, turmeric and cardamom trade and extending from India to Europe, was started by the Chinese before Christ. The effect of the functional foods of that day, spices, in history can be considered an indication that the perception of functional food dates back thousands of years (Anonymous, 2019a, 2019b). Since the term "functional food" began to be used in the 1980s, we have more information about the effects of nutrients and food components. As the findings showing the relationship between eating habits and health became more concrete, functional food research became widespread, and the results obtained transformed into the production of modern nutraceuticals and functional foods and bioactive components (Anonymous, 2019a; Sharma, Mishra & Senapati, 2021). The nutritional approach that supports physiological cycles and increases the quality of life has attracted attention and has been

accepted. For this reason, the nutraceutical, functional food and bioactive components industry has become a very important area. Incorporating a diverse range of functional foods into the diet can optimize nutritional intake, prevent nutrient deficiencies, and support overall health. Both conventional and modified functional foods are integral to achieving a well-rounded and balanced diet, thereby contributing to enhanced health outcomes. The consumption of these foods enables individuals to fill nutritional gaps and foster better health throughout their lifespan. There is a need for new studies that will reveal the contributions of functional foods more clearly and specifically. In addition to known foods and functional ingredients, foods that have not yet been discovered should also be included in these studies. Increasing conditions such as cardiovascular diseases and the increase in obesity necessitate the highlighting of the functional properties of foods. The media should take a leading role in creating awareness about functional foods and raising awareness.

Functional foods used in traditional cuisine should be presented consciously and should be used without losing their functionality by being processed less. The saying "Those who do not eat raw die" should not be ignored. The presentation of any functional food with expressions such as miracle food should be avoided, and nutraceutical and bioactive ingredients should not be highlighted with unscientific data.

In the event that harmful elements are found in a food, presentation of the food as "functional food" by referring only to the ingredients with functional benefits contradicts the basic principles of the definition of functionality, and care should be taken when

labeling a food as functional. For example, it is controversial to present wine as a functional food while ignoring its harmful content because it contains resveratrol.

Adulteration products, which pose a widespread threat to food safety, should be prevented from harming the perception of functional food. For example, additives for color and grain appearance in rye bread or whole wheat bread, which are functional foods, question the perspective of functional food in practice. Similar adulteration practices can sometimes be carried out using scientific instruments. The biggest risk to establishing the perception of functional food is the threat of food safety. This new dietary trend can be quickly reversed if the necessary precautions are not taken and implemented.

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CHAPTER II

Approach To Milk As a Functional Food

Zeyneb KARAKUŞ[1]

Introduction

Smart nutrition is an important health concept for the physiological and biochemical needs of every age. Antioxidants are among the priority nutrients of this concept. The effect of nutrients on health, vitality and performance has been better recognized, especially in the last thirty years when the food industry has developed rapidly. The concepts of antioxidant and hypernutrition have led to a change in classical approaches in the discipline of nutrition. The World Health Organization reports that people spend a significant portion of their time and economic opportunities to solve the problems caused by their unhealthy and unconscious nutrition. The high budget opportunities allocated to food support for health have focused the attention of the medical and food disciplines on natural but high-quality products. The search for more economical and less risky ways to protect health and live a healthy

[1] Assistant Professor, Afyon Kocatepe University, Çay Vocational School, Chemical Technology Program

life has also led to the production of new products through R&D processes and the rediscovery of some natural products. For example, high-quality foods such as milk and eggs are attracting attention again due to their natural antioxidant content and accessibility. This review aims to address milk from a current perspective, review the perception about milk, bring up the fact that milk is an important antioxidant food and energy drink in addition to its high nutritional value, and eliminate misperceptions. Milk is an indispensable antioxidant for health and vitality, and is a nutritious and balancing food and energy drink for every age group and every period of life. Despite this, its consumption in Turkey lags behind many European countries due to the lack of sufficient awareness. Antioxidants attract great attention in medical disciplines due to their effects in preventing the damage caused by atoms and molecules known as free radicals in tissues. Apart from those taken in the form of medicine, antioxidants taken through diet and as nutritional supplements have become an important expense item for the health economy. The protective effects of antioxidant products are frequently emphasized in maintaining health, vitality, performance and eliminating diseases. Plants are known as powerful antioxidants due to the antioxidant substances they carry, such as phenolic compounds, flavonoids and lycopenes. However, awareness is not sufficient for animal antioxidants. Vitamins, peptides, amino acids, carotenoids, enzymes such as superoxide dismutase, catalase, glutathione peroxidase and macromolecules such as albumin in animal products are important antioxidants. Milk, a product with high natural antioxidant potential and nutritional value, is a white liquid composition. It contains protein, carbohydrates, fat group as nutrients, calcium, phosphorus, potassium, zinc as minerals, and

vitamins A, B, D, E and K as vitamins. 91% of the milk produced and consumed is provided by cows, and the Netherlands, Germany, America, France, England, Russia, Poland and Turkey are at the top of the list in milk production, which increases every year. The perception of milk, which is a strategic food for smart nutrition, as a product specific to childhood years needs to change. As an important antioxidant, milk consumption should be encouraged at every age, every season, and every period of life.

Milk

When milk is mentioned all over the world, cow's milk is understood. This is because a significant portion of drinking milk, dairy products and dairy products are made from cow's milk. Milk is a liquid food that contains more vital nutrients than many foods. The components it contains are organic and inorganic substances necessary for the development, survival and repair of the organism. For these features, nutritional physiologists define milk as a basic food (Metin, 2012; Armas, 2016). However, the approach that perceives milk as the basic food only for the neonatal period and childhood is very common. For this reason, we often come across expressions that support this misperception such as "a baby, his mouth smells of milk". Again, due to this perception, milk is among the least sold products in high school and university canteens and sometimes it is not even offered for sale. As an important element of animal foods, milk is an important antioxidant with its proteins, fats, carbohydrates, vitamins, minerals, electrolytes and liquid (Velioğlu & Öğünç, 2011). Milk is the food of all times, antioxidant food additive and energy drink with its high value milk protein due to its essential amino acids, fatty acid composition and milk fat, mineral

substances and vitamins such as calcium, magnesium, phosphorus and riboflavin (Karakaya, 2016). One of the unique qualities of milk is the nutrients such as lactose, milk fat, casein, lactoglobulin and lactoalbumin1 synthesized by the mammary glands and found only in milk (Fox, 1992; Metin, 2012). Milk is both an antioxidant and a humoral defense due to its rich antibody content, and a food that provides detox (Gök, 2006; Taşkın, 2011).

The figure illustrates key signaling pathways and cellular processes involved in the regulation of milk protein synthesis in the bovine mammary gland. These include: the regulation of ion and cation transmembrane transport, which is crucial for the transport of calcium phosphate into milk via casein micelles, thereby preventing the formation of calcified proteinaceous deposits that contain amyloid fibrils; and hormonal and neuronal signaling, particularly the coordinated actions of prolactin (PRL), glucocorticoids (GC), and insulin (INS), which regulate milk protein composition. Notably, prolactin-inhibiting hormone (PIH), corticotropin-releasing hormone (CRH), and adrenocorticotropic hormone (ACTH) also play significant roles in these regulatory mechanisms.

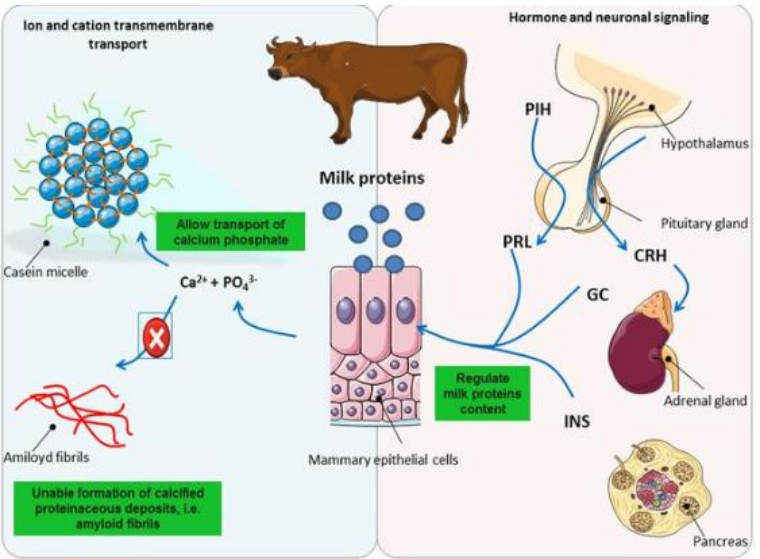

Figure 1: Regulation of Milk Protein Synthesis in the Bovine Mammary Gland

(Anonymous, n.d.)

Milk protein, mineral substances and vitamins give this feature to milk. Milk protein can buffer acids and bases as a result of its amphoteric property, and can bind toxic heavy metals and other toxic substances. For this reason, milk and yogurt are given as antidotes to protect workers in the chemical and heavy industry industry and in coal mines and boiler rooms against poisoning. Milk is a polydisperse liquid. In other words, milk fat is in emulsion, protein is in colloidal dispersion, lactose and mineral substances are in real solution, and this feature gives milk a very different digestive dynamic (Taşkın, 2011; Metin, 2012; Preira, 2014). Milk is used in newborn nutrition, as a basic food for adults in normal nutrition, in the production of dairy products, in the production of casein and lactose, and as an additive in the production of dairy products and dairy foods and many other food products. Today, milk is offered for

use in different processed forms, in addition to its natural state. The natural state of milk and some commonly used forms created as a result of industrial processes are presented in Table 1 (Yılmaz, 2010).

Table 1: Concepts defining different milk types and forms

Quality milk	Milk obtained from businesses that have regular animal care, disease control, veterinary checks, and appropriate milking, storage and transportation conditions; very low bacterial load, pathogen-free, and free from drug and chemical residues.
Openly sold raw milk	Milk that is not known whether it was milked hygienically from healthy animals or whether the cold chain rules were followed until it reached the consumer. Street milk that complies with the above hygiene and cold chain rules is of high quality and can be used.
Raw milk	Milk that has been cooled after leaving the udder, has not had any components removed or any substances added, and has not been heat-treated.
Pasteurized milk	Milk treated at 60 degrees for 30 minutes or 72 degrees for 15 minutes or temperature-time combinations equivalent to this temperature-time effect
UHT milk	Milk that has been heat treated at 135 degrees for 2-5 seconds or has been heat treated at a temperature time period that provides an effect equivalent to this temperature time effect.
Milk powder	It is the milk solids that remain after the water is removed from excess raw milk for long shelf life and market regulation purposes, and is not a different product from milk.
Diet (light) milk	The product obtained by removing at least 30% of the milk fat, which is around 3.5% on average, from milk.
Whole milk	It contains an average of 3.25% natural milk fat in its composition. No external milk fat is added to the milk to create this ratio.
Semi-skimmed milk	It is also defined as low-fat milk. Milk in which the milk fat ratio of approximately 3.5% is reduced to 1%.
Skim milk	The amount of milk fat is 0.5% or less. In these milks, milk fats have been removed as much as possible while preserving the naturalness of the milk.

Lactose-free milk	Milk in which the lactose in it is broken down by adding natural lactase, thus converting the lactose into glucose and galactose that can be more easily digested.
Enriched milk	Milk enriched with functional food additives such as probiotics, prebiotics/fibers, polyphenols, peptides, sterols/stanols, minerals, vitamins and fish oil.
Additive milk	Milk to which natural or chemical additives such as fruit flavors and cocoa have been added. Milks containing flavors, sweeteners and colorings, even if they are identical to natural, are not recommended.
Breast milk (human)	Does not contain ß-lactoglobulin, an allergenic protein. Contains all the nutrients needed for the baby's nutrition, defense, growth and tissue development.
Colostrum	Milk secreted around the 4th-5th day after birth, yellowish in color, with a salty taste, thick consistency, a composition very different from normal milk, rich in immunoglobulins.
Albumin milk	Milks that contain albumin and globulin in a ratio close to casein. Milks such as human milk, horse milk, donkey milk, dog milk, pig milk.
Casein milk	Milks that have a significant portion of their protein content in their composition consisting of casein. Cow milk, sheep milk, goat milk.
Follow-on milk	Milk supplemented with vitamins and minerals such as calcium, iron, magnesium, potassium, zinc, B12, B6, folic acid, vitamin E, Vitamin D, Vitamin A, Biotin.
Milk serum	It is the liquid part of curdled milk, technically known as "whey". It contains proteins and nutrients that have therapeutic effects of milk.
Whey	The liquid separated from milk during cheese making. It is rich in proteins. This by-product is powdered and defined as whey powder (PAST).

Components of Milk

Milk consists of approximately 87% water, 4% - 5% lactose, 3% protein, 3% to 4% fat, 0.8% minerals and 0.1% vitamins. The biological value of milk protein, which is a good source to meet protein requirements, is 0.9 out of 1.0, which is quite high. Proteins consist of essential amino acids (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, partially

histidine and arginine) and non-essential amino acids (alanine, aspartic acid, cystine, glutamic acid, glycine, proline, serine, tyrosine) and are found in a balanced form of 20% whey and 80% casein protein. In addition to protein, it is also a good source of vitamins C and A, B vitamins B12, riboflavin, iron, calcium, magnesium and phosphorus minerals, sodium and potassium electrolytes (Yılmaz, 2010).

The organic and inorganic substances in the composition of milk can be determined in more detail and more clearly thanks to current analysis methods. Current data indicate that there are approximately 200 nutrients and milk components in milk, including trace amounts. Depending on the animal species, the dry matter in milk can vary between 11-38%, fat between 1.8-22.0%, protein between 2.5-15.5%, lactose between 1.3-7.0%, and ash between 0.5-2.6% (Table 3). The amount of dry matter in milk is important because it consists of basic nutrients. Milk dry matter mass is classified as fat and non-fat dry matter. Non-fat dry matter includes milk sugar (lactose), nitrogenous substances, minerals, and other substances, which are the main nutritional components of milk other than fat (Metin, 2012; Preira, 2014).

Table 2. The effect of milk fat level on the vitamin content and antioxidant quality of milk

100 g	Full fat	Low fat	Non fat
Energy (kcal)	62	47	34
Water (g)	88.1	89.1	90.5
Protein (g)	3	3.4	3.3
Fat (g)	3.5	1.6	0.2
Carbohydrate (g)	4.7	4.9	4.9
Cholesterol (mg)	13	8	1
Vitamin A (mg)	59	22	0
Vitamin D (mg)	0.05	0.05	0
Vitamin B1 (mg)	0.04	0.04	0.05
Vitamin B2 (mg)	0.14	0.11	0.05
Na (mg)	43	41	41
Ca (mg)	109	112	114
Mg (mg)	9	9	10

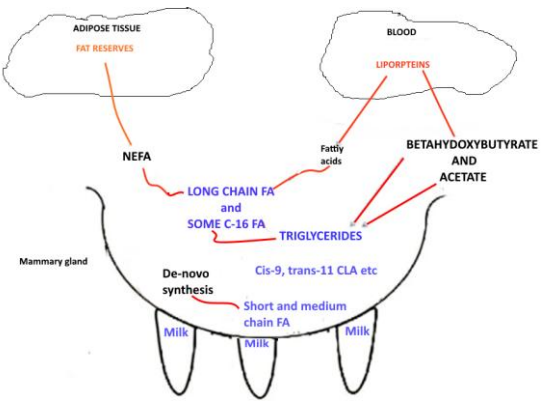

Figure 2: Milk producting mechanism in mamary glands

(Kuldeep et. al., 2022)

Table 3. Comparison of components in milks (gram/100 grams)

Milk	Total dry matter	Total protein	Fat	Lactose	Minerals
Human	13.1	1.3	4.2	7.0	0.6
Cow	12.6	3.7	3.4	4.7	0.7
Buffalo	20.5	7.5	7.3	4.8	0.8
Sheep	18.8	7.5	5.6	4.6	1.0
Goat	13.2	4.5	3.6	4.3	0.8
Mare	11.2	1.9	2.5	6.2	0.5
Donkey	10.8	1.5	2.0	6.7	0.5

Milk as a Natural Antioxidant

Oxidative stress, which occurs due to the unwanted increase in free radicals, which are normally a product of metabolism, causes many damages in cells and tissues and plays a role in the etiology of acute and chronic diseases (Dündar, 1999b; Aslan, 1999). Since this has been recognized, safe, natural and economical antioxidant food supplements are used to strengthen the antioxidant capacity and activity of the organism. The content that makes milk a protective antioxidant against free radical damage and oxidative stress is its antioxidant proteins consisting of lactoglobulin, lactoalbumin, albumin and immunoglobulins, vitamins and minerals that support antioxidant activity. Milk is rich in β-carotene, lutein, lycopene, β-cryptoxanthin and zeaxanthin, which are effective and powerful antioxidants (Yılmaz 2010). The antioxidant effects of vitamins in particular have been known for a long time. For example, it is known that vitamin D protects mothers against gestational diabetes, vitamin E provides protection against many diseases as a powerful antioxidant, and vitamin A is effective in vision and the formation of a strong immune system (Dündar, 1999a, 1999c). Milk contains both water- and fat-soluble antioxidant vitamins. The amount of fat-soluble vitamins, and therefore their effectiveness, depends on the

amount of fat in the milk. Since vitamins A, D and E are reduced in low-fat and fat-free milk, these milks lose their antioxidant effectiveness to a great extent (Lindmark-Mannson, 2000; Pihlanto, 2006; Gök, 2006). Antioxidant vitamins, which give milk its antioxidant properties and are found in high concentrations in milk, try to maintain the oxidant-antioxidant balance of the organism by at least one of the five basic antioxidant defense mechanisms when taken into the body: Collecting and cleaning radicals, stopping chemical reactions that produce radicals, suppressing the reaction rate, repairing damage to lipid, protein and DNA molecules, preventing cellular kinase losses, and increasing the synthesis of endogenous antioxidant enzymes such as superoxide dismutase (SOD) and non-enzymatic antioxidants are the basic antioxidant effect mechanisms (Packer, 1991; Jialal, 1993; Van Der Meulen, 1997).

Biotin, vitamin A, vitamin B12, vitamin D, vitamin K and riboflavin in milk are effective in maintaining the oxidant-antioxidant balance (Evelson, 1997).

Milk, being an animal product, contains the antioxidant enzymes SOD, catalase (KAT), and glutathione peroxidase (GSH-Px) of animal tissue. These enzymes continue their antioxidant activities in the organism they are taken from, thus the reactive oxygen and nitrogen species formed are reduced by these antioxidant enzymes. For example, the dismutation process converts superoxide into hydrogen peroxide and oxygen under the catalyzing of SOD. Hydrogen peroxide is reduced by the same reactions under the catalyzing of GSH-Px and KAT. Antioxidant enzymes such as superoxide and hydrogen peroxide in milk can prevent high

concentrations of radicals from posing a risk (Dündar, 1999b). Minerals such as sodium, potassium, magnesium, zinc, and calcium in the composition of milk have roles that support antioxidant activity. For example, SOD activity is supported by zinc and manganese, and GSH-Px activity is supported by selenium. In order for these enzymes to remove toxic reduction products from the environment, their enzymes must not be damaged during milk processing. The antioxidant effects of milk proteins have also been reported in many studies. A significant portion of these studies suggest that milk proteins have an antioxidant effect by increasing the level of glutathione (GSH) in the body (Flagg, 1994; Ramos, 2001; Ramos, 2003). It is thought that the effect of milk proteins, which increases the level of GSH in cells and prevents lipid peroxidation, is due to the thiol groups in their proteins. In a study conducted for this purpose, it was reported that the antioxidant effect of milk, which prevents lipid peroxidation, was eliminated in the presence of N-ethylenemaleimide in the environment by utilizing the ability of N-ethylenemaleimide to block -SH groups. (Yalçın, 2010; Velioğlu & Öğünç, 2011). It is emphasized that milk proteins are effective antioxidants in protecting tissues against free radical damage and have therapeutic potential, therefore milk should be included in our daily nutrition routine as an important antioxidant (Fernández, 2014; Stone, 2004; Dündar, 1999a; Aslan, Şekeroğlu & Tarakçıoğlu, 1996).

Milk For Physical Activity And Sports Physiology

200 ml (one glass) of whole milk contains an average of 8 grams of protein, 13 grams of carbohydrates and 8 grams of fat, 290 mg of calcium and 107 grams of sodium. With this content, it can be

said that milk is a safe energy drink and food in providing the energy needed by muscle metabolism, maintaining muscle health and developing muscles (Karakaya, 2016). Milk contains 80% casein and casein is a slowly digested nutrient. For this reason, casein keeps athletes and sedentary individuals full for longer. In addition, casein helps muscle building. Milk serum, also known as whey or whey, is also rich in protein. This protein is digested quickly and is present in milk at a rate of approximately 20%. This protein is found in protein drinks, so it helps muscle building and tissue repair.

Milk also contains a protein chain containing the amino acids leucine, isoleucine and valine. One of the infrastructures that an athlete needs the most is energy stores that will support him during long-term intense (maximal) exercises. Lactose, the carbohydrate in milk, is a sugar that the body uses to fill the empty energy stores. However, although some individuals cannot digest lactose, there is a lactose-free milk option against lactose intolerance. Calcium is used intensively during physical activity, training and sports activities. The fact that milk is rich in calcium is important at this point. Calcium accelerates fat burning and strengthens bones, and also buffers the calcium deficit that occurs after exercise. Calcium intake, and therefore milk, is also important against the high risk of osteoporosis in women. A lot of water and minerals are lost during exercise and during the day due to sweating. Milk, which consists of 87% water, is a safe drink in buffering this lost fluid. In sports and training processes, milk is a good process accelerator in replacing fluid loss in muscles and tissues and repairing muscle damage caused by physical activity. One of the rapid and effective results of milk intake in sports, physical activity, training and competition conditions is the reduction of fatigue. Another supporting feature of

milk for physical activity is its high content of electrolytes such as sodium and potassium. Milk is an important and sympathetic assistant in providing fluid-electrolyte balance disrupted during exercise and in regaining water and inorganic salts lost by muscles. During exercise, the amount of free radical metabolites increases due to accelerated metabolic activity. In these conditions, antioxidant vitamins such as biotin, vitamin A, vitamin B12, vitamin D, vitamin K, riboflavin, which are nutrients that will maintain the oxidant-antioxidant balance, are present in the natural antioxidant content of milk. This plays an important role in eliminating oxidative products that may occur during physical activity, sports and training.

Milk Amount In The Diet In Terms f Body Biochemistry

It is recommended that healthy adult individuals consume at least 400 ml of natural milk per day for a fit and sustainable quality physiological life. It is recommended that children, adolescents, pregnant and breastfeeding individuals and athletes drink 600-800 ml of milk per day. Since it is an important source of tocopherol, nutritional physiologists report that the daily need for 4 mg tocopherol and 8 mg tocotrienol can be provided from the tocopherols and tocotrienols in milk fat. Milk tocopherols are rapidly absorbed from the upper parts of the intestines and are delivered to the liver via the lymph. Milk, due to the antioxidant vitamins it contains, supports this cycle and plays an active role in maintaining a fit and high-performance life. Milk should therefore be included in the daily diet regardless of the individual's age, job, gender and seasonal conditions (Yılmaz, 2010).

A Physiological Problem: Lactose Intolerance

Lactose is the milk sugar found in mammalian milk. Intolerance to milk sugar lactose is a condition encountered in adolescence and later ages and psychologically affects milk consumption. Today's industrial development makes lactose-free milk possible, as well as antioxidant dairy products such as yogurt and kefir, where bacteria can break down lactose. The enzyme that breaks down milk sugar lactose into glucose and galactose in the small intestines is lactase. If lactase is not present in the organism or is not produced in sufficient amounts, lactose cannot be broken down, digested and absorbed. In this case, gas, bloating, abdominal pain, nausea, diarrhea and even headaches can be observed after consuming milk. Lactose intolerance is of two types: primary and secondary. In primary lactose intolerance, the enzyme is either absent or very low at birth. In secondary intolerance, enzyme deficiency has developed later due to a reason. The most well-known examples of this are diseases such as celiac, PEM, and IBD, which occur as a result of intestinal mucosal damage. Lactose-free milk is recommended in these conditions. Since lactase is added to these milks, the lactose in the milk is broken down into glucose and galactose. Glucose and galactose are natural sugars, which sweeten the milk. Therefore, lactose-free milks are sweeter than other milks without added sugar and are also more yellow in color. However, except for the lactose content, they are no different from normal milks (Metin, 2012). Cow's milk allergy is another nutritional physiology problem that can be encountered. Cow's milk allergy, in which the immune system reacts to the proteins in milk, is mostly seen in babies and children under six months of age, when they consume cow's milk, or are exposed to cow's milk protein. They may

experience symptoms such as vomiting, rash, and fever shortly after consuming the milk. In this case, the first thing to do is to remove milk and dairy products from the diet (Metin, 2012; Thorning, 2016).

Milk and dairy products, in particular, support us in growth and development, as well as in protection against diseases with their antioxidant effects, and in appetite control by keeping us full for a long time due to casein, a slowly digested nutrient. For this reason, milk consumption and including milk and its products in the diet should be encouraged at every stage of life. For example, the school milk application should be rewarded by the media and opinion makers, and methods should be researched to continue and develop this application under more attractive and encouraging conditions. Public service announcements encouraging milk should be put into action.

It is recommended that healthy adults consume approximately 400 ml/day for a fit and sustainable physiological life, and children, adolescents, pregnant and breastfeeding women and athletes consume 700 ml/day of natural milk. It may be appropriate for those with intolerance to milk sugar to prefer lactose-free milk and turn to dairy products such as yogurt, ayran and kefir. In order to prevent reactions to milk, those with lactose intolerance should be identified in advance and educated.

It should be emphasized that milk is a safe, attractive, and economical energy drink and sports nutrition with its protein, lipid, and carbohydrate components in providing the energy required by muscle metabolism, protecting muscle health, and developing muscles. Milk contains 80% casein, a slowly digested nutrient. Casein also keeps athletes full for longer. Casein is also important in

physical activity and training processes because it helps build muscle. It should not be overlooked that whey or whey, also known as whey, helps build and repair muscle.

It can be said that individuals who consume enough milk in their daily diet will not have to allocate a budget for additional food supplements and nutritional additives under the names of antioxidant support, protein support, and energy support.

As a result, milk, which has important nutrients that support the oxidant-antioxidant balance, should be recognized and evaluated as an economical food in addition to its risk-free, natural, and powerful ntioxidant content.

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CHAPTER III

A Functional Food Supplement: Royal Jelly

Recep ASLAN[1]

Introduction

The honeybee (Apis mellifera L.) is a social insect known for its high adaptability and reproductive instincts. Humans, who first discovered the bee and later began to breed it like a domesticated insect, have started to benefit from bee products (Aslan & Aksoy, 2015). Complementary medicine, which significantly uses plant and animal foods, plant extracts, and biologically active compounds, has become quite popular in recent years. However, scientific studies and proven data regarding the physiological and biochemical effects of the materials and methods used are insufficient (Aslan, 2016). In alternative and complementary therapies, methods such as plants, animals, animal products, waters, foods, oxygen-ozone, radiation, magnetic fields, temperature and heat, soil, music, massage, colors, sounds, electrical stimuli, movement, suggestion, and hypnosis can be used (Stanway, 1999; Kevin, 2004; Çevik et al., 2011). In this

[1] Prof. Dr, Afyon Kocatepe University, Faculty of Veterinary Medicine, Physiology Department

context, it is important to address royal jelly in light of current data, introduce it into alternative and complementary medical practices, present it as a functional food to researchers, and raise awareness about its qualities in daily nutrition for maintaining a healthy, effective, and energetic body.

Emphasized as the "food of royalty," royal jelly is known in Turkish as "arı sütü." It is secreted by the mandibular and hypopharyngeal glands of worker bees aged 5 to 15 days or 6 to 12 days. This creamy white secretion has a gel-like, flowing consistency, a sour taste, and a sharp phenolic odor. With a density of 1.1 g/cm³, it is partially water-soluble. Due to its content of proteins, vitamins, sugars, essential fatty acids, minerals, trace elements, antioxidant chemicals, and approximately 3.5% of unidentified substances, royal jelly is a highly valued product with significant nutritional value and biological activity. These unidentified substances are believed to regulate metabolism and play a role in immunity and cell regeneration (Ramadan, 2012; Aslan & Aksoy, 2015).

Royal jelly is the sole food for the initial development of larvae. Additionally, it is used to nourish young larvae in the hive and the queen bee. Although there is no genetic difference between worker bees and queen bees, some larvae develop into worker bees while others become queen bees. All larvae are fed with royal jelly for the first three days. The larvae that are subsequently fed with honey and pollen become worker bees, while those that continue to be fed with royal jelly become queen bees. Since the formation, life, and functions of the queen bee are associated with royal jelly, its use in human nutrition has consciously increased in recent years. The

10-hydroxy-decenoic acid in royal jelly is known to act as a natural antibiotic, effective against many bacteria, viruses, and fungi. This is why, despite the presence of diseases among worker bees, the queen bee, which is fed exclusively with royal jelly, is thought to remain disease-free and live longer (Sabatini et al., 2009; Ramadan, 2012).

Only queen bees are fed royal jelly throughout their lives and complete the larval stage in 16 days, reaching maturity. In contrast, worker bees that are fed honey and pollen from the third day complete their development in 21 days. The queen bee, fed royal jelly throughout its life, can live up to 3 years, while worker bees, fed with honey and pollen, live for 5-6 weeks. Additionally, queen bees are larger and more resilient than worker bees. Furthermore, while the reproductive organs of queen bees are highly developed, worker bees lack developed reproductive organs. The structural and functional differences between queen bees and worker bees are thought to be due to the special diet of royal jelly (Sabatini et al., 2009).

Larvae that emerge from fertilized eggs of the same genotype become anatomically and physiologically different individuals depending on the quality and quantity of the royal jelly they receive. This unique feeding results in the queen bee gaining resistance to diseases, producing eggs up to twice its weight per day, and living for years. The significant differentiation between two larvae highlights the importance of royal jelly (Ramadan, 2012; Aslan & Aksoy, 2015).

Royal jelly has a highly complex composition. More than half of it consists of water, and it also contains protein, fat, sugar,

microelements, enzymes, hormones, vitamins, fatty acids, 10-HDA, and about 3% of as-yet unidentified substances. These unknown but effective substances play a crucial role in the properties of royal jelly (Sabatini et al., 2009).

Morphological Effects, Physical and Chemical Properties

It was recorded in the literature in 1623 that royal jelly, the richest bee product in terms of nutritional value, is produced exclusively for the queen bee. Royal jelly, secreted from the hypopharynx in the head of worker bees, was first described by Huber in 1972 as "Gelee Royale" (Aslan & Aksoy, 2015). In English, it was initially called "Gelatine Reale," meaning "royal jelly," and later "Royal Jelly," which is used as a common term in scientific studies (Lercker et al., 1981; Ramadan, 2012,). Royal jelly is secreted by the hypopharyngeal glands (also known as the pharyngeal glands) and mandibular glands (lower jaw glands) of worker honeybees aged 5-15 days, who are fed on honey and pollen. Continuously produced and secreted in the hive, royal jelly is immediately used by larvae and the queen bee and is not stored due to its rapidly changing structure (Lercker et al., 1981; Brouwers et al., 1987). While all larvae are fed with royal jelly for the first three days without distinction, after the third day, only those larvae that will develop into the queen continue to be fed with royal jelly. The queen bee is fed exclusively with royal jelly during both its larval and adult stages, making it a critical factor in the queen's development and function. This feeding method accelerates the development of queen larvae and creates certain differences from worker bees, who are fed with honey and pollen after the third day

(Lercker et al., 1981). The queen bee differentiates from worker bees based on several criteria outlined below.

Morphologically, the queen bee is approximately 42% larger and has 60% more body weight compared to a worker bee. While reproductive organs develop in the queen bee, organs related to their tasks such as pollen baskets, strong jaws, wax glands, and brood food glands develop in worker bees. Developmentally, the queen bee matures in an average of 15.5 days, whereas this period takes 21 days for worker bees. The lifespans of the two types of bees also differ. The queen bee's lifespan is about 40 times longer than that of a worker bee. The average lifespan of a queen bee is 4-5 years, while worker bees live for only 2-6 months (Lercker et al., 1981; Brouwers et al., 1987).

Figure 1. Larvae Within Royal Jelly in a Honeycomb

(Aslan & Aksoy, 2015)

Worker bees that are fed on honey and pollen rarely lay eggs, whereas a queen bee fed with royal jelly can lay several thousand eggs in a single day. The weight of these eggs is 0.5-2 times the body weight of the queen bee. Some researchers suggest that the class

difference between the queen bee and worker bees is due to a hormone called farnesol, derived from the juvenile larval stage, while a significant portion attributes the morphological and functional differences to royal jelly. Therefore, there are many aspects of this subject that still require research (Lercker et al., 1981; Ramadan, 2012; Aslan & Aksoy, 2015).

In terms of organoleptic properties, royal jelly is a soft, white-yellow substance with a jelly/cream consistency, a slightly sharp odor, and a somewhat bitter taste. It has an acidic pH value ranging between 3.4 and 4.5. Although it is a homogeneous substance, remnants of larval skin or beeswax may be found within it, which result from mistakes made during the collection of royal jelly. The color of royal jelly, which is white to yellow, darkens and turns yellow during the storage process. Over time, small particles form in stored royal jelly due to the precipitation of its components. If not stored under proper conditions, it can develop a spoiled, sour taste. Therefore, organoleptic properties such as odor, taste, and appearance are essential quality criteria for royal jelly (Krell, 1996). Its viscosity is 1.1 g/cm³, and a large portion dissolves easily in water. This viscosity can vary depending on water content, ambient temperature, storage conditions, and freshness. Royal jelly gradually becomes more viscous when stored at room temperature or under refrigeration at 4-5 ˚C. Some studies link the increased viscosity to the reduction in water-soluble nitrogen and amino acids and the increase in water-insoluble nitrogenous compounds, while others attribute it to ongoing enzymatic activities and interactions between lipids and proteins (Sabatini et al., 2009).

Proteins, Enzymes and Hormones in Royal Jelly

The primary components of royal jelly are water, proteins, carbohydrates, fats, and mineral salts. Although the content of royal jelly varies across different colonies, bee breeds, seasons, and geographical and climatic conditions, the main components remain consistent. Two-thirds of fresh royal jelly is water, while most of the dry weight consists of proteins. Royal jelly contains both water-soluble and water-insoluble proteins. Approximately 46-89% of the protein dry weight is water-soluble. On average, 73-74% of the nitrogenous compounds in royal jelly are proteins. Four of the six major proteins in royal jelly are glycoproteins. Of the remaining nitrogenous compounds, 2.3% are amino acids, and 0.16% are peptides. Royal jelly contains all essential amino acids required by humans. High percentages of proline, lysine, glutamic acid, β-alanine, phenylalanine, aspartate, and serine are found in the amino acid content (Krell, 1996). Guo et al. identified 29 antioxidant peptides in royal jelly and noted that short-chain peptides with 2-4 amino acids have higher antioxidant effects, and that peptides in royal jelly have protective effects against radical-induced lipid peroxidation in both in vivo and in vitro conditions (Guo et al., 2007; Guo et al., 2009).

Studies have identified an antibacterial protein called royalisin and a protein known as Apis, which stimulates the proliferation of human monocytes, in royal jelly. Various enzymatic activities have also been observed in chemical content studies, including ascorbic acid oxidase, amylase, invertase, and catalase. Additionally, enzymes such as glucose oxidase, phosphatase, and cholinesterase, as well as insulin-like structures, have been

discovered. It has been shown that royal jelly possesses insulin and gonadotropin activities, as well as corticosteroid, estrogenic, and androgenic effects. Moreover, royal jelly is the only known natural source of acetylcholine, an important transmitter substance (Lercker et al., 1981; Krell, 1996).

Lipids, Carbohydrates, Vitamins and Minerals

The lipid content of royal jelly is very important in terms of its characteristic properties. 80-90% of the lipid fraction consists of unique or uncommon free fatty acids. Unlike the long-chain fatty acids with 14-20 carbon atoms commonly found in animals and plants, these fatty acids are short-chain hydroxy fatty acids or dicarboxylic acids with 8-10 carbon atoms and are responsible for many of the biological properties of royal jelly. The most unique and chemically interesting fatty acid found in royal jelly is trans-10-hydroxy-2-decanoic acid (10-HDA) (Lercker et al., 1981). This fatty acid also determines the distinctive properties of royal jelly. The amount of 10-HDA in pure royal jelly varies between 1.58-3.39%, depending on the source. Since 10-HDA is not found in other bee products, its amount serves as a quality control indicator for royal jelly. If other bee products have been added to the royal jelly, the concentration of 10-HDA will be low. The purity of royal jelly and the presence of other bee products can be determined by measuring the 10-HDA content. This method is used in many countries to set standards for royal jelly (Krell, 1996).

Due to the nutrients it contains, royal jelly is susceptible to microbial activity. However, the 10-HDA it contains has antimicrobial effects, so microorganisms cannot survive in royal jelly. Studies have shown that royal jelly inhibits typhoid and E. coli

bacteria. The second most prevalent fatty acid in royal jelly after 10-HDA is 10-hydroxydecanoic acid (HDA), the saturated form of this fatty acid. In addition to free fatty acids, some neutral lipids, cholesterol and other sterols, and the unsaponifiable parts of hydrocarbons resembling beeswax extract are also found in the lipid content of royal jelly (Lercker et al., 1981).

As in honey, the majority of the carbohydrate portion in royal jelly consists of glucose and fructose. Fructose is quite common, and together with glucose, it makes up 90% of the total sugar content. The sucrose content can show significant variation. Other sugars found in trace amounts in royal jelly have been identified as maltose, trehalose, melibiose, ribose, and erlose (Lercker et al., 1981).

When examined in terms of vitamins, royal jelly is seen to contain all B-complex vitamins as well as vitamins C, D, and E. The amount of pantothenic acid (vitamin B5) in royal jelly is particularly high, and this acid is known for its stress-reducing effect. Following pantothenic acid, thiamine (B1), niacin (B3), and riboflavin (B2) are present in royal jelly. Although the mineral content of royal jelly is not abundant, it contains many different minerals. These minerals, listed in order of abundance, include potassium, calcium, sulfur, phosphorus, and iron. Magnesium, zinc, and sodium are also present in trace amounts (Karaali et al., 1988).

Physiological Effects of Royal Jelly

Despite numerous studies on royal jelly, its exact medical properties, the effects of its unique components in specific situations, and the conditions in which it can be used are not yet fully understood. However, studies still support the idea that royal jelly has high healing potential and the ability to regulate metabolic

functions, frequently emphasizing its antioxidant, anti-inflammatory, antibacterial, antitumoral, and antiallergic properties. Some antioxidant peptides in royal jelly proteins have been found to exhibit antioxidant activity against in vitro lipid peroxidation, and in human cell cultures, these peptides have shown protective effects against apoptosis caused by oxidative stress (Guo et al., 2009). It has been suggested that royal jelly modulates oxidative stress and apoptosis caused by cisplatin, an important chemotherapy agent, in the kidneys and liver of rats, and that the antioxidant proteins in royal jelly act as agents that suppress biological aging processes. It has also been proposed for use in the treatment of diseases caused by oxidative stress related to atherosclerosis, hypertension, infertility, asthma, depression, diabetes, and cancer. In vitro studies have indicated that 10-HDA in royal jelly has antibacterial properties and inhibits Salmonella spp, Proteus, Escherichia coli, Bacillus subtilis, and Staphylococcus aureus. The peptides royalisin and jellein found in royal jelly have been reported to be effective against gram-positive and gram-negative bacteria, fungi, and yeasts. Studies investigating the relationship between royal jelly and fertility have indicated that steroid substances in royal jelly bind to and activate estrogen receptors. It has been reported that the use of royal jelly changes spermatological characteristics, increases spermatozoa density and motility, reduces the rate of abnormal spermatozoa, and positively affects sperm quality. Research highlights its neurotropic, antibiotic, antiallergic, and anti-inflammatory effects (Karaali et al., 1988; Krell, 1996; Aslan & Aksoy, 2015).

Royal jelly is considered an excellent nutritional supplement that helps maintain homeostatic balance and body chemistry, strengthens the immune system, neutralizes the effects of flu

infections, supports the continuity of kidney and liver functions, helps maintain LDL and HDL cholesterol levels, and meets the energy needs of the body. Due to all these properties, royal jelly is increasingly being used to prevent a wide range of diseases—from cardiovascular issues to cancer—or to strengthen the body and stimulate the immune system in such cases. Its use is recommended for patients undergoing radiotherapy and chemotherapy, where antibiotics are heavily used, to prevent liver and kidney damage and maintain their functions. The food industry's interest in functional foods that help protect human health has increased. Foods have the potential to directly affect cellular and organismal homeostasis. Today, royal jelly is considered among functional foods. The results of studies on the effects of royal jelly on physiological mechanisms have also increased the demand for these products. With its unique composition, royal jelly serves as a raw material not only in health research and the food sector but also in the pharmaceutical and cosmetic industries and other fields. Nevertheless, it is believed that there is still a lack of sufficient awareness for its effective and conscious use, and that the standards of products on the market often present trust issues. Moreover, new medical research is needed for royal jelly to become an established traditional medical product.

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CHAPTER IV

Medicinal And Aromatic Plants As Antioxidants And Functional Foods

Recep ASLAN[1]

Introduction

In medical culture, the role of plants in human and animal health has been both important and sustainable. For thousands of years, plants have been our solution partners in relieving many symptoms such as pain, pain, and alleviating or eliminating mood-related problems. Although synthetic organic products, which have become widespread with industrialization, are still very functional, there is an increasing tendency towards the natural. This has greatly increased the use of medicinal aromatic plants in daily life and made them the primary interest of the pharmaceutical industry. Plants, herbal products and phytochemicals with cell-protective, hemostatic, immunostimulant, anti-inflammatory, analgesic and anti-inflammatory properties have an important place in conventional medicine as well as traditional and complementary

[1] Prof. Dr, Afyon Kocatepe University, Faculty of Veterinary Medicine, Physiology Department

medical practices. Today, plants and phytochemicals are a very attractive area of R&D to develop more effective and less risky treatment modalities. The World Health Organization has declared that a healthy diet should consist predominantly of plants, which is another important factor that has increased interest in medicinal and medicinal plants. This review approaches medicinal and herbal plants in terms of their history, classification and common uses.

Among the diversity of more than eleven thousand plants, medicinal and aromatic plants constitute an important part of the functional food wealth, and their use in sectors such as chemistry, cosmetics, pharmaceuticals and spices is increasing.

The therapeutic, protective and fitness-supporting properties of the bioactive chemical substances in medicinal and aromatic plants that make them functional have been felt by humans and animals, and both humans and animals have tended to treat themselves with plants when they get sick. This tendency, which we can also call phytotherapy, is both a very old and successful way (Dündar, 2001). Since the early ages, the use of plants as a protective and therapeutic stakeholder in life has continued until today. Utilization of plants against diseases and disease agents has been a field of search since the first human being (Evcimen & Aslan, 2015; Aslan, 2016). This situation started with instincts, and then factors such as plants, animals, animal tissues and products, heat, water and mud started to be used as objects utilized in treatments. The widespread acceptance of the healing effects of plants, herbal extracts and extracts, glycosides and essential oils dates back to ancient times.

In the food sector, medicinal aromatic plants are used to preserve beverages, create color and aroma, and are also consumed directly as medicinal food. In the health sector, they are used in products that protect human, animal and plant health, while the number of products used and the way they are used are increasing day by day. In the cosmetics sector, product variety and usage areas are increasing in line with consumer demand for natural and organic products (Baytop, 1999; Aslan, 2016).

Historical Process in The Utilization of Plants

It is thought that humans and animals turned to medicinal aromatic plants based on instinct and inspiration, and that this process of utilization developed later with acquired learning and experience. Inscriptions and documents belonging to historical ages show that medicinal aromatic plants were used in civilizations such as Assyria, Babylon, Ancient Egypt and Ancient Greece for the treatment of diseases, nutrition for performance and fitness purposes, benefiting from the pleasant odors emitted by pheromones and embalming the dead (İli, 2003; Faydalıoğlu & Sürücüoğlu, 2013). In papyri dating back to the 2000s BC, it is seen that about 450 diseases were recorded, herbal medicine preparations were found, and treatment methods for injuries, fractures and sprains were described. In his book “History of Natural Sciences”, Aristotle discusses the use of medicinal plants in that period, Theophrastos discusses botany, and Pliny's “Natural History” deals with medical success stories until his time. In Byzantium, it is thought that the practice of medicine and the orientation towards pharmaceutical formulas lost its relative importance due to false beliefs. Nevertheless, questioning and research continued and new herbal formulas and antidotes were

discovered. Galen, for example, devised new formulas of herbal origin that are still used today. In China, as early as 3000 BC, many medicines composed of plants, animals, minerals and metals were used. The book “Ben Sao” (2600 BC) records the names of about 900 plant species. Li Shic Jen, a 16th century Chinese physician, mentions around 1900 medicinal plants in his notes. As in all civilizations, treatment practices with medicinal plants were widely used in India and Tibet, and some of them have even survived to the present day. “Susruta” (2000 BC), one of the classics of Indian medicine, lists more than 700 medicinal plants. We learn from the notes in this book that leprosy could be treated at that time (Abacıoğlu et al., 1998; Baytop, 1999).

The view of medicine changed with Islam. This evolution of perspective is not only about medical techniques and herbal preparations used for therapeutic purposes. The view of things and life was updated and brought back in line with universal general truths. For this reason, Islamic physicians carried out serious studies on medicine, medicinal and herbal medicine, preventive medicine and treatment practices. It is recorded that some researchers conducted animal experiments to determine whether a plant was toxic or not in the conditions of the day. Islamic medical research resulted in important findings due to two important institutionalized steps.

1) The Medical School was established in the second century and the Academy of Sciences in the third century.

2) According to the sources, for the first time, treatment was seen as a separate field of research from medicine and the Pharmacopoeia was created. In this context, the

3) “El Kanun fit Tıb”, one of Ibn Sina's hundred or so works, contains descriptions and information on around 900 medicinal and herbal plants, animal and inorganic drugs. It is seen that Muslim physicians and pharmacists in the Middle Ages knew and benefited from nearly two thousand medicinal plants, and that they paid attention to and studied the knowledge of other civilizations. Sharing their knowledge and experience with the world, Islamic physicians and pharmacists bequeathed the classics of medicine and pharmacy to the world. The most remarkable among these are Dineweri's “Kitâb en Nabât” and “Kitâb el Bâh”, Birûni's “Kitab el Saydala fîl Tıb” and Ibn Sina's “Shifa” and “Kânûn fit Tıb”. The Seljuks attached great importance to medicine and public health, hospitals and healing centers were established, essential oils, herbs and aromatic waters were used for healing purposes, and different pastes and pomades were used for treatment. The Ottomans developed this heritage they inherited. For example, Şemseddin Muhammed bin Hamza (Akşemseddin), as a physician, produced research findings on the causes of disease that surpassed the knowledge of his time. He defined the microbe nearly 400 years before Louis Pasteur, distinguished between genetic diseases and microbial diseases, and paid close attention to medicinal plants in treatment. Thanks to his deep knowledge of pharmacy, it was noted that he knew which plant was good for which disease, and when he saw a plant, he could immediately predict which disease it could cure. It is known that he treated Mehmet the Conqueror's daughter Gevher Sultan with herbal medicines. Among his extant works, “Mücerrebat” and Madde'tül Hayat” are two medical classics that contain important information about diseases and medicines (TDV İA, 1989).

With the discovery of the American continent, plants such as cocoa tree, quinine tree, coca, milkweed were added to this list of plants in ancient cultures. In the following years, the chemical contents of plants (phytochemicals) started to be examined, the pharmaceutical industry was established in the 19th century, and preparative drugs started to replace majistral drugs. Thanks to the rapidly developing discipline of pharmacy, the field of Pharmacognosy (Medicinal Plants) and the discipline of phytochemistry were born. In 1806, it was realized that the anesthetic effect of morphine could be used in medicine by obtaining pure morphine alkaloid from the opium/poppy (Papaver somniferum) plant. This development directed scientists to the active substances of plants, and quinine, strychnine and veratrine alkaloids were soon isolated. In the following years, active plant substances such as glycosides, saponins and resins were identified. In the early 20th century, a new page was opened in medicine with the discovery of vitamins, and subsequently antibiotics were produced from fungi and organisms with the "bactericidal molecules theory" (Baytop, 1999; İli, 2003; Faydalıoğlu & Sürücüoğlu, 2013).

Inventory of Medical and Aromatic Plants

Systematists estimate that there are about one million plant species living in the world. In the scope of plant systematics (taxonomy), some 500,000 plants have been described. Approximately 2000 new plant species are added to this number every year. According to 19th century sources, the number of plants for medicinal purposes was around 13,000 at that time. Today's possibilities have increased the number of medicinal and agricultural plants, and with the addition of 3,000 agricultural plants for food

purposes as well as 10,000 wild plants, the number of medicinal plant species has reached nearly 50,000 (Baytop, 1999; Dündar, 2001).

Research on plants whose therapeutic properties are realized as a result of inspiration, coincidence or interest and curiosity reveals different therapeutic properties of those plants and new medical plants and herbal compositions that can be used in medical applications are identified (Ibis et al., 2008; Evcimen & Aslan, 2015; Aslan, 2016). The relationship between aroma, color, smell and appetizing properties of plants and psychology, obesity and metabolism is on the agenda. All these have increased the tendency towards herbal products for therapeutic purposes and drugs with natural active ingredients have started to be preferred (Bodeker, 2002; Bodeker et al., 2005; Aslan, 2016). While the use of drugs of natural origin is 60% in developed countries, this rate is around 4% in developing countries (İli, 2003).

R&D and product-oriented studies on active substances in medicinal and aromatic plants aim to utilize plants directly and to reach faster and easier, cheaper and low-risk treatment methods. The side effects of active molecules and compounds obtained from synthetic chemicals make these researches compulsory. Some plant-based pharmaceutical raw materials are cheaper and easier to obtain than synthetic ones. When the relatively risk-free nature of herbal products is added to this picture, the attraction increases even more (Baytop, 1999; İli, 2003). Today, it is thought that around one hundred thousand plants are used for therapeutic purposes in modern medicine, traditional and complementary medical practices (Abacıoğlu et al., 1998; İli, 2003).

Medicinal and Aromatic Plant Production and Industry

Together with the species and varieties collected from nature, the number of medicinal and herbal plants subject to trade is around 350. About 100 of these are traded and exported industrially. 20 medicinal and aromatic plant varieties are cultivated and harvested on approximately 1.3 million decares of land, with black tea, red pepper, poppy, cumin, mint, oregano, oil rose and anise being the most important ones. These plants are followed by laurel, echinacea, basil, buckwheat, quinoa, sonderwort, fennel, orange blossom, saffron, St. John's wort, gum, salep orchid, stevia, sugarweed, and sweet gourd. The cultivation and processing of medicinal and aromatic plants are mostly in the Aegean, Mediterranean, Marmara, Black Sea and Central Anatolia regions. Turkey is one of the advantageous countries with its rich flora in terms of medical plants. Turkey is located at the intersection of three bio-geographical areas, hosts two gene centers and has a great richness with 11,707 plant varieties registered in the inventory. 3649 of these plants are sub-endemic species and varieties that grow in local climate and soil conditions, which makes our country stand out in terms of medicinal and aromatic plant ecosystem. There are dozens of medicinal and aromatic plants that are traded. Although some of these are classified as industrial plants, they are also considered medicinal and aromatic plants. Exports of medicinal and aromatic plants amounted to approximately $303.6 million. Thyme, poppy, laurel, tea, aniseed, cumin, sage, black cumin, lavender, mahlep, red pepper and herbal teas are among the top exports. Turkey is the world's leading exporter of thyme, laurel and poppy seeds. Half of thyme production is realized in the Aegean Free Zone. Entrepreneurs, universities and public authorities should join hands to grow medicinal and herbal

plants such as coffee, tea, flax, black pepper, carob, cumin, black cumin, black cumin seeds and hops in Turkey. Support policies are in place to increase the production of medicinal and aromatic plants in quality and sustainability in line with international demand. Within the scope of good agricultural practices, farmers who grow medicinal and aromatic plants in 2018 receive 50-100 TL support per decare, 14 TL diesel and fertilizer support, and those who practice organic agriculture receive support ranging from 10-100 TL according to product categories. Within the scope of the National Agriculture and Basin-Based Support Model, medicinal aromatic plants are supported on a planned basis (Anonymous 1).

Medicinal aromatic plants are either collected from nature or cultivated and produced. Parts such as fruits, stems, leaves and flowers of plants that grow spontaneously in places such as forests, pastures, idle agricultural lands, vineyards and gardens, and weeds in agricultural areas can be medicinal plants. A significant portion of medicinal aromatic plants traded all over the world are collected from nature. The number of medicinal aromatic plants cultivated for commercial purposes in the world is about 900. It is believed that about 1000 of the medicinal plant species in our country are utilized and 400 of them are traded. In our country, a significant portion of the medicinal plants traded are collected from nature, and there are also medicinal and aromatic plants cultivated. Capsule poppy, cumin, thyme, oregano, aniseed, black cumin, fennel, coriander, broom grass, hops, sage, oil rose, clove, lavender, fenugreek, purslane, dill, red pepper, parsley, arugula, cress are medicinal and aromatic plants that are widely produced in our country. When the production figures of the medicinal and aromatic plants cultivated are analyzed, red pepper, poppy, cumin, thyme, oil rose and aniseed,

which have a significant potential in cultivated exports, are in the first place. Especially thyme cultivation and production is increasing every year. Turkey ranks first in thyme and poppy production and Turkey and India are recognized as traditional poppy producing countries by the United Nations (Acıbuca & Bostan Budak, 2018).

Classification of Medicinal Plants

Medicinal and aromatic plants are discussed in terms of the type of plant, active ingredients and areas of use. Because of the large number of plants, it is not possible to group medicinal plants according to their families. This is also the case for grouping them according to their active ingredients and effects, since there are many different active ingredients and modes of action. Furthermore, the active ingredients can be found in every organ of the plant, and sometimes in very specific organs. For these reasons, there is no international and scientifically standardized grouping. The classifications are relative and local, depending on the researchers, sectors or institutions. In this context, let us make some groupings.

According to Plant Families: It is not practically possible to group medicinal and aromatic plants according to their families since many plants belonging to many families are used for this purpose. If such a grouping were to be made, thousands of medicinal aromatic plants in many families would be subjected to a complex classification.

According to Pharmacological Effects: They are classified as plants that affect the cardiovascular system, respiratory system, bronchi and lungs, nervous system and neurotransmission, gastrointestinal system functions, genital system and sexual functions.

According to Active Ingredients: Phytochemical content in medicinal and aromatic plants constitutes their active ingredients. Accordingly, a list can be made as follows:

Those containing bitter substances (Gensiyan, Vermut), those containing alkaloids (Atropa, Nicotiana, Papaver somniferum), those containing flavonoids (Silybum, Verbasum), those containing glycosides (Sage, Digitalis), those containing saponins (Saponaria off.., Hedere helia, Yucca Shidegera), tannins (Hamamelis, Quercus), essential oil plants (Anise, Sage, Thyme, Parsley, Mint).

According to Consumption and Uses: Spice plants (Rosemary, Mustard, Thyme), dye plants (Alkana tinctorium, Bixa orellana), pharmaceutical plants (Atropa, Digitalis), insecticidal plants (Anabasis aphylla chrysanthemum), stimulant plants (Tea, Coffee, Tobacco), wax plants (Jojoba, Myrica cerifera), perfume and cosmetic plants (Rose, Lavender), resin plants (Ferula, Liquidambar), tannin plants (Astronium balansae), gum and mucilage plants (Acacia, Astragalus, Plantago).

According to the Plant Organ Utilized: Those utilized from flowers, those utilized from herb, those utilized from leaves, those utilized from chitre and gum, those utilized from rhizomes and roots, those utilized from wood and bark, those utilized from milky liquids, those utilized from seeds and fruits, those utilized from feathers and nozzles, those utilized from tubers, those utilized from extracts (İli, 2003).

The Use of Plants as Functional Food

The use of medicinal and aromatic plants for therapeutic purposes varies according to the level of development of countries. In developing countries, 80% of the population utilizes herbal products for therapeutic purposes, and this rate increases up to 95% in Asian, African and Middle Eastern countries. Although this rate is 40-50% in Germany, 42% in the USA, 48% in Australia, 49% in France, it is noteworthy that the commercial organizations where medicinal and aromatic plants are produced industrially are in Germany, the USA, Japan and the UK. However, another emerging approach is to work on herbal medicine formulas from traditional medicine to obtain local patented medicines. Studies produced with new formulas such as Ankaferd, for which drug phase trials have been completed and are ongoing, are increasing day by day (Aslan, 2016). While the therapeutic effect of a drug varies depending on its dose, the physical structure of the person and the body resistance/response to the drug used, its side effects can be very diverse. The negative and realistic perception of side effects leads to a high expectation of efficacy and a sense of safety from drugs prepared from herbal active ingredients. The common belief about the therapeutic effects of medicinal plants is that herbs have a slow but longer lasting effect than drugs. For this reason, the use of herbs should be continued for a long time for the expected benefit. The most common method of using herbs for this purpose is brewing, also called infusion. Herbal medicines bearing flowers and fine leaves are prepared by infusion method and the infusions are prepared fresh each time. The table shows the uses of some medicinal plants in folkloric medicine (İli, 2003; Anonymous 2).

Table 1: Common uses of some medicinal plants in folk medicine

For mouth sores	Sage, Mulberry Sage, St. John's Wort, Chitre, Chamomile
As a painkiller	Mustard Seed, Oregano Oil (or Thyme Oil, depending on the type of thyme or oregano used), Mint, Chamomile
As an antiseptic	Bitter Apple Oil, Sage, Juniper Berry, Bay Leaf, Oleaster Flower, Spike Lavender Oil, Clove, Thyme, Nutmeg, Peppermint Oil, Lemon Balm, Eucalyptus Oil
Treatment of stye	Licorice Root, Chamomile, Nerve Herb , Garlic
In anemias	Cinchona
Antipyretic	Bitter Chips, Blackthorn Root, Oleaster Flower , Chamomile, Wormwood, Olive Leaf, Vinegar Water
In tonsillitis	Blackberry, Indian Oud
Expectorant	Wild Fennel Root, Okra Flower, Sweet Clover, Mountain Sage, Sea Cabbage, Poppy Flower, Hibiscus Flower, Jujube, Linden**,** Wild Cherry Seed, Myrtle Leaf, Licorice Root
Hemorrhoids	Bitter Chips, Comfrey (for external use), Yarrow (for external use), Milk Thistle Seed, Cocoa Butter, Myrrh (resin), Chamomile (for external use), Cypress Cone (for external use), Rue Seed
In headache	Harpagophytum, Rosemary, Linden (also known as Lime Blossom, Thyme, Celery Seed, Mint
Against skin dryness	Almond Oil, Poppy Seed Oil, Cocoa Butter

In boils	Okra flower, Bitter melon, Aloe vera
Arteriosclerosis	Yarrow, Olive leaf
Vasodilator	Rosemary, Mistletoe, Flaxseed
In diabetes	Lupin, Sage, Blackberry, Mastic gum, Jujube, Thyme, Rosehip, Mahaleb cherry, Lettuce seed, Myrtle oil, Salep, Cypress cone, Sesame oil, Wild thyme, Olive leaf
In eczema	Soapwort root, Bitter melon (balsam pear)
As a carminative	Bitter apple oil, Anise, Yarrow, Mountain tea, Calamus root, Basil, Carrot seed, Cardamom, Clove oil, Cumin, Coriander, Fennel, Ginger, Turmeric
Diuretic	Bitter apple oil, Hawthorn, Juniper seed, Horsetail, Rosemary, Blackberry, Yarrow, Wild oat, Black seed (Nigella), Basil, Heather, Linden (Lime blossom), Celery seed, Cherry stalk, Corn silk, Chamomile, Fumitory
Diarrhea suppressant	Hawthorn, Blackberry, Wild oat, Heather, Frankincense, Black myrobalan, Cornelian cherry, Gallnut, St. John's wort, Cypress cone
Appetizing	Bitter chip, Amber, Yarrow, Black cumin, Mountain ash, Nettle, Cardamom, St. John's wort, Celery seed, Wormwood, Hops, Tarragon, Cinnamon oil
Constipation reliever	Okra flower, Walnut oil, Tamarind oil, Castor oil, Jujube, Flaxseed, Salep, Yellow sage, Cassia, Sesame oil, Sweet almond oil
Heart palpitations	Linden, Mint

Strengthening circulation	Hawthorn, Amber, Ginseng, Mistletoe, Rosemary
Against cancer	Oleander (1 flower per day), Nettle seeds
Digestive problems	Ajamma oil, Juniper seeds, Mountain tea, Bay leaf, Basil, Basil, Carrot seeds, Cardamom, Cloves, Thyme, Cinnamon, Cinnamon oil, Turmeric, Pomegranate, Peppermint, Mint, Capsicum, Cinnamon oil, Turmeric
Breath opener	Okra flower, Sea buckthorn, Camphor, Lavender, Mahlep, Mint
Cough suppressant	Ajyonga, Juniper root, Darilfulful, Milk thistle, Bay seed, Mustard seed, Jujube, Flax seed, Licorice root, Salep, Cress seed, Udulkahir, Ginger
Against parasites	Bitter chip, Safflower root, Safflower, Besbase, Oregano oil, Peppermint, Wormwood, Sweetgum oil, Oil of oregano
In rheumatism	Trout oil, Juniper seed, Safflower, Rosemary oil, Laurel oil, Bay oil, Rue root, Mustard seed, Nettle, Clove oil, Thyme oil, Lavender, Corn silk, Rosemary oil, Sandalos, Turpentine
Hair care	Yarrow, Black cumin oil, Black cumin root, Laurel oil, Basil, Nettle, Thyme, Lavender, Violet oil, Turpentine
Bile expectorant	Vetiver root, Rosemary, Walnut oil, Thistle seed, Thyme oil, Lavender, Peppermint, Chamomile, Turmeric, Olive oil
Milk Booster	Anise, Black cumin, Dill seed, Cumin, Fennel
Blood pressure lowering	Anise, cecheem, hawthorn, olive leaf, lemon

Stone reducer	Blackberry, Celery seed, Rosehip, Corn stigmas, Hops
Calming, relaxing	Sage, Anise, Rosemary, Yarrow, Clove, Thyme, Cumin, Coriander, Lemon oil, Marjoram, Mint, Fennel, Saffron, Cinnamon, Vanilla, Ginger
Against scabies	Thyme, Mint
For burns	Almond oil, Poppy oil, Linseed oil
For wounds	Bitter palm oil, Almond oil, Rosemary, Yarrow, Halile, Hawthorn, Pomegranate, Sweetgum oil

It is stated that approximately 72,000 of the known plant species are considered as medicinal and aromatic plants with bioactive content, the number of popular medicinal and aromatic plants is 6,000 and the number of traded species is around 3,000. The highest number of aromatic plant species are found in China, the USA and India, respectively. The total number of species and subspecies taxa in Turkey is 11,707, the number of endemic taxa is 3,649, and the endemism rate is reported as 31.82%. The richest regions in terms of endemic species are the Mediterranean, Eastern Anatolia and Central Anatolia regions (Acıbuca & Bostan Budak, 2018).

Nowadays, medicinal and aromatic plants have become important in our country, where returning to nature has become a lifestyle. Gene centers have been established for many plants and some endemic species have been adapted to different geographical regions. Throughout history, humans have tried to find remedies for many microbial, metabolic and psychological health problems with

plants. The methods of treating some diseases with herbs are therefore based on deep experience and have very successful results, which is why the use of herbal products in treatment continues to this day. These natural remedies, whose medicinal effects are recognized based on inspiration, curiosity or experience, are widely known in folk medicine, and new and different plants are added to this pool of knowledge over the years. Another interesting feature is the use of medicinal and herbal plants in nutritional physiology. As the flavor, odor, taste and appetizing properties that make up their aromas are understood, the use of new plants in nutrition is increasing due to their therapeutic and feel-good effects. However, due to increased interest and unconscious approaches, medicinal and aromatic plants are under pressure as a result of over-collection from natural flora. Cultivation and gene conservation projects for the medicinal and aromatic plants of the flora of our country, which are under pressure, should be implemented for each aromatic plant. The economic ones should be first breeded and then adapted to each geographical region and cultivated industrially. Families and institutions that will cultivate these plants should be informed, raised awareness and encouraged with incentives and exemptions. The cultivation of medicinal plants such as thyme, sage, lavender and rosemary, which are resistant to cold/hot climatic conditions, should be expanded to all regions, and a state purchase guarantee should be introduced for medicinal and aromatic plants. For the diversity and sustainability of products collected from nature, villagers should be made aware of the characteristics of these plants and the timing of their collection. Increasing the number of registered seeds and synthetic varieties of medicinal and aromatic plants in our country, which is extremely limited compared to many developed countries,

should be an important target, and R&D projects should be supported to provide growers with medicinal aromatic plant varieties with high yields and high quality essential oil ratios for their cultivation, industrial production and transformation into high value-added products in sectors such as pharmaceuticals, chemicals, food and cosmetics.

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We pleased to present an overview of the book "On Some Traditional Functional Foods: Milk, Royal Jelly, Medicinal and Aromatic Plants." This work explores the nutritional, therapeutic, and cultural significance of various functional foods, including milk, royal jelly, and selected medicinal and aromatic plants. These substances have been integral to human diets for centuries and are increasingly recognized for their potential health benefits. The book provides a comprehensive review of their traditional uses, scientific basis, and modern-day applications.