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REVIEW ARTICLE

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The Bulgarian ethnic tradition of manufacturing rakia: a cultural heritage and a potential functional food resource

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Abstract

Ethnic foods and beverages are cultural heritage. This review summarizes the available data about the manufacturing, flavouring, and colouring of the homemade Bulgarian ethnic alcoholic beverage *rakia*, including information from scientific and grey literature, published surveys, traditional old recipe books, and field observations and interviews with local producers of homemade rakia. Taking into consideration the scarce scientific evidence available on the subject, this study aims to contribute to the preservation of a valuable Bulgarian tradition and cultural heritage for future generations. A detailed description of the process of manufacturing homemade rakia is presented, and the role of this ancient technology in the extraction of bioactive compounds is discussed. Different aspects of the consumption of alcoholic beverages and their dual metabolic effects on human health are elucidated. The centuries-old knowledge about the preparation of the homemade beverage rakia, flavoured and coloured using arboreal species, is discussed as a basis for the development of low-alcohol or non-alcoholic functional beverages with high content of bioactive compounds with beneficial health effects.

Keywords Bulgaria, Ethnic beverages, Homemade rakia, Local manufacturing, Cultural heritage

Introduction

The empirical knowledge accumulated over the centuries about the nutritional value and the healing power of plants is the basis for a significant amount of research. The traditional Bulgarian diet includes the ubiquitous and everyday use of plants and plant products in various forms, preparations, and in a variety of culinary formulations. One application of fruits, for example, is in the manufacturing of high-grade alcoholic beverages [1]. Wood material from several arboreal species (stems, heartwood, chips) is used in the ageing process of the spirits [2]. Due to the geographical location (Fig. 1A), the diverse landscapes of Bulgaria (mountains, plains, and aquatic landscapes), and the favourable climate, the Bulgarian flora is rich and diverse, and the microflora is region-specific [3]. The wisdom of our ancestors about the application of edible plants, herbs, wood, and spices in the preparation of alcoholic beverages has been passed down through the generations. Some of this knowledge is still applied nowadays in rural areas, and another part of the information is available from published sources [1, 2, 4–8]. A 6-year survey (2014–2020) presented data on the usage and preparation of plant-based foods and traditional beverages among the population of the Bulgarian North-Eastern Black Sea region [9]. Unfortunately, globalization and the entry of new production technologies, as well as urbanization through its unfavourable impact on the ecosystems, have caused the partial loss of this

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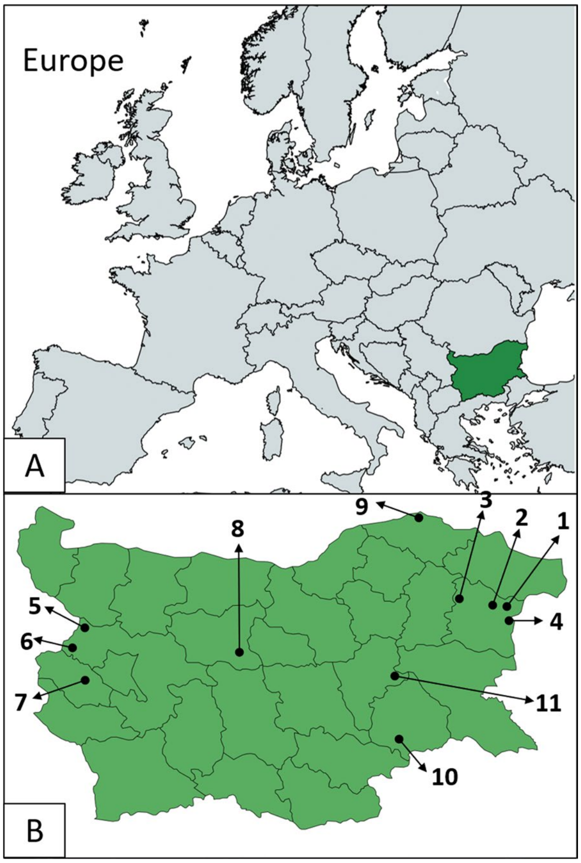

Fig. 1 **A** The geographical location of Bulgaria: Bulgaria is part of the Balkan Peninsula, located in South-Eastern Europe, with geographic coordinates 42.733883° N and 25.48583° E.; **B** A detailed map showing the 28 administrative provinces; the arrows indicate the eleven rural areas where field observations were carried out: 1—Oreshak (43.30141° N, 27.91352° E), 2—Kalimantsi (43.278° N, 27.72235° E), 3—Belogradets (43.35156° N, 27.33323° E), 4—Vinitsa (43.24573° N, 27.98047° E), 5—Godech (43.0667° N, 23.0667° E), 6—Tsatsarovtsi (42.86492° N, 22.86398° E), 7—Batanovtsi (42.60065° N, 22.95526° E), 8—Apriltsi (42.84079° N, 24.9134° E), 9—Silistra (44.1183° N, 27.26° E), 10—Elhovo (2.1724° N, 26.5676° E), and 11—Padarevo (42.72903° N, 26.66968° E) (Source: created with MapChart.net, accessed 27 December 2023 and 29 February 2024, https://www.mapchart.net/index.html)

traditional knowledge. Furthermore, the number of new studies exploring Bulgarian ethnic foods and beverages is very low. An even less explored area of research is the usage of the wooden parts of various arboreal plant species for the ageing of alcoholic beverages. Extracting bioactive substances from the wood during the ageing of the spirits enhances their taste, flavour, and metabolic activity [10].

With a critical look at the harm of alcohol abuse, in this review, we have focused on the available data about this underexplored area—manufacturing, flavouring, and colouring of the ethnic alcoholic beverage *rakia*, an indelible part of the Bulgarian tradition. Furthermore, we have discussed the bioactive compounds extracted in the process of rakia manufacturing with regard to their metabolic effects and their potential use as a source for the development of functional foods.

Methods

This review is based on the accumulated traditional knowledge about homemade Bulgarian rakia, a brandy-like alcoholic beverage, and its cultural and societal significance. We provide an overview of the available literature on the topic, including scientific and grey literature, published surveys, and traditional old recipe books, encompassing the production of the traditional rakia, which is part of the Bulgarian national cultural heritage, a summary of the phytochemical composition and biological effects of extracts from the types of plants most frequently used for ageing and colouring rakia, scientific evidence on the metabolic effects of alcohol contained in alcoholic beverages, and an exploration of the underlying mechanisms of action. In addition, ethnographic data were collected by field observations and interviews with local homemade rakia producers in eleven rural areas in different parts of the country. The face-to-face interviews investigated the manufacturing process of homemade rakia, the methods of flavouring and colouring, ageing, storage, and usage. Interviews were conducted in the period 2015–2023 in the villages of Oreshak, Kalimantsi, Belogradets, and Vinitsa (Varna region), Godech and Tsatsarovtsi (Sofia region), Batanovtsi (Pernik region), Apriltsi (Gabrovo region), Silistra (Rousse region), Elhovo (Yambol region), and Padarevo (Sliven region) after informed consent was received from the respondents. Information on the geographical location of the interview points across Bulgaria is presented in Fig. 1B. This study expands the knowledge acquired during the *Study of the Therapeutic Potential of Black Mulberry Wood as a Resource for the Pharmaceutical Industry* project (2015–2016), Contract No. 14013/18.12.2014, Annex No. 1/18.12.2015, under the Medical Science Fund of the Medical University of Varna.

Traditional Bulgarian brandy "rakia" Bulgaria's national identity and cultural heritage

Alcohol beverages and human health

When it comes to alcohol, there are always two things in the foreground—the abuse of alcohol and the resulting societal and health consequences on the one hand, and, on the other hand—the millennia-old cultural traditions in rural communities according to which the consumption of alcoholic beverages is associated with rituals and customs; it is part of religious, nutritional, and healing habits. While efforts are towards the development of new therapies for alcoholism and addiction to drinking, the truth is that the multiplex pattern of molecular modifications induced by ethanol is poorly explored. Among the lifestyle factors, alcohol, along with smoking, has received the most attention, and its role in poor health, particularly the high cardiovascular disease (CVD) mortality rates, is supported by scientific evidence [11, 12]. Alarming data from recent years revealed that alcohol consumption is dramatically increasing and becoming a global health problem [13, 14]. Even though only half of the world's population consumes alcohol, it is the third leading cause of health issues and premature death in the world, after smoking and high blood pressure [15]. According to WHO data, of the 2 billion people in the world who consume alcoholic beverages, 76.3 million have been diagnosed with alcohol-related disorders [16].

Over the past 50 years, the problem of risky alcohol intake has deepened and is therefore the focus of attention of European countries and societies, including Bulgaria [17]. We will not say anything new if we admit that Bulgarians also consume alcoholic beverages, including rakia, as part of the traditional diet. Rakia consumption per capita, as reported for the main planning regions of Bulgaria [18], is presented in Fig. 2. Detailed information on the consumption of alcohol in different populations points out that the total consumption of alcohol per capita (*litres* of pure alcohol) among adults (15 years and older) in Bulgaria within a calendar year is 12.5 *L*, while for the European region, the consumption per capita has decreased from 12 *L* in 2000 to 9.5 *L* in 2019 [19].

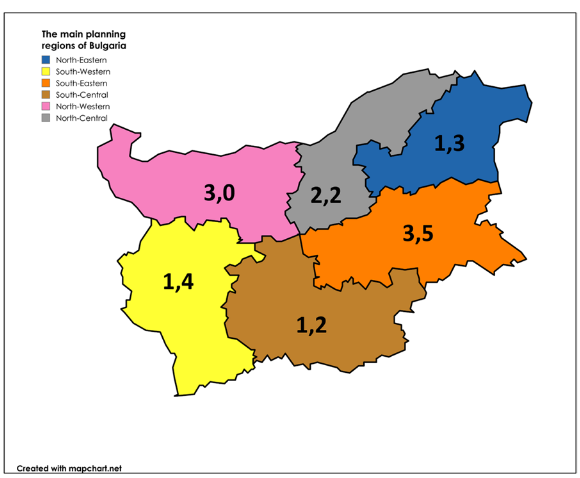

Fig. 2 A map of Bulgaria showing the consumption of rakia as reported about each of the six main planning regions (data are presented as average litres per person from the household) according to Veselinova N [18]; (Source: created with MapChart.net, accessed 21 February 2024, https://www.mapchart.net/index.html)

At the same time, cardiologists recommend drinking a 50-g dose of distilled alcohol daily, e.g. liquors such as whiskey, gin, vodka, rum, brandy, or others, which should not be exceeded, with this amount being enough to reduce cholesterol, normalize blood pressure, and strengthen the walls of blood vessels [20, 21].

Distilled spirits are produced by fermentation of grain mash, fruits, or other ingredients, heated afterwards until the alcohol and flavourings vaporize and can be drawn off, cooled, and condensed back into a liquid [22]. Distilled beverages range in alcoholic content, usually from 40 to 50 per cent, although higher or lower concentrations are found. In addition to being used in their pure form, they are often used as the basis for the preparation of many medicinal herbal tinctures and elixirs. The elixirs containing brandy have powerful antiseptic, antibacterial, and antiviral properties. They are often used to treat throat problems (e.g. sore throat), relieve inflammation of the tonsils, bronchitis, cough, runny nose, reduce fever, relieve toothache, joint pain, and numerous other ailments [5]. These effects of alcoholic beverages should not solely be attributed to the ethanol content but also to other plant-extracted ingredients and the secondary metabolites released during fermentation processes. Natural fermentation of the fruit material for the preparation of alcoholic beverages is facilitated by the presence of region-specific spontaneously formed microbial ecosystems. Fruits host diverse microorganisms whose communities significantly vary depending on the landscape and climate conditions, and they may also contribute to the organoleptic characteristics of the beverages [23]. The microflora composition defines the uniqueness of Bulgaria's ethnic foods and beverages, including homemade rakia.

Rakia as a cultural heritage

For a Bulgarian, there is no "medicine" more commonly used than rakia (also spelled "rakija" or "rakiya"), a potent fruit-based homemade double-distilled brandy with alcohol content between 40 and 50 per cent, a traditional drink that is ubiquitous in the Balkans. Rakia is different from *raki*, the Turkish spirit made from grapes or raisins, or *ouzo* in Greece with its anise flavour profile. Rakia is also not Italian grappa, which is made from leftover grapes from the production of wine, or Japanese sake, made from fermented rice.

Often just as an excuse to drink, it is promoted as a panacea for all diseases and a real national treasure, and here we must specify that this refers to the real homemade brandy rakia and not the store-bought variety. The Bulgarian people have preserved proverbs and legends about the good and bad sides of human consumption of alcohol and, to this day, continue to produce wine and rakia domestically. Furthermore, there are several festivals dedicated to the tradition of producing, tasting, and drinking rakia, e.g. the annually held Festival of Bacon and Mulled Rakia in the town of Apriltsi (Fig. 3), the Balkan Rakia Fest, The Festival of Homemade Rakia "Rakia—magic", etc.

Historically, drinking rakia has become a part of the lifestyle, traditions, customs, and culture of the Bulgarian people. People think that all diseases could be prevented by drinking 50 mL of rakia at dinner (Fig. 4).

Unrecorded rakia production

In a comprehensive report issued by the World Health Organization summarizing the global status of alcohol consumption and health, homemade traditional beverages are formulated as "unrecorded alcohol". Summarized data in the report pointed out that approximately 25% of alcohol consumption worldwide is in the form of unrecorded alcohol [13].

Cauldrons (Fig. 5) for the production of rakia distillate from fermented fruit pulp, wine materials, fermented pomace, piquette, and other alcohol-containing raw materials are manufactured and sold by some small companies. Suitable for placement in a small estate for

Fig. 4 Homemade rakia has been a part of the Bulgarian traditional diet for centuries, together with traditional home foods such as gherkins. A toast with rakia is a tradition at every Bulgarian table during various celebrations and holidays (*Source*: author's photo)

Fig. 3 The Festival of Bacon and Mulled Rakia is held each year in the town of Apriltsi, located in the Balkan Mountains. This festival is one of the most colourful and delicious Bulgarian festivals bringing together thousands of people from all over the country. Mulled rakia is very popular in the winter season and most people associate it with the Christmas and New Year's holidays. It has a mild taste and a warming effect (Source: the authors' own photo, February 2024)

Fig. 5 Local legal facility for rakia distillation from the village of Belogradets, Varna county, Bulgaria. The stainless-steel cauldron has a fine copper net incorporated in it for neutralizing toxic by-products and bacterial contamination (*Source* authors' own photo)

personal use or for providing services in populated areas, the cauldrons are made of copper sheets in a variety of useful volumes—80 L, 100 L, 120 L, 150 L, or larger. Copper has the property of binding and neutralizing poisonous sulphur compounds, especially important for the final degree of purification of the distillate. In addition, copper has another very important chemical property—it reduces the likelihood of bacterial contamination and prevents the production of methylcarbamate, a poisonous substance formed from cyanide [24]. Another advantage is the higher thermal conductivity, which helps not only to warm, but also to cool the vapours. However, this can lead to easier burning. Professional stainless-steel cauldrons have a special copper section with a fine copper net in it to compensate for the absence of copper.

Grape, plum, and apricot rakias are considered to be with the highest healing qualities. Rakia can also be made from quince, pear, apples, figs, peaches, raspberries, and cherries, among other fruits. For centuries, rakia has been an ubiquitous drink in the Balkans, and in recent years, unrecorded homemade rakia has been distributed in the form of smuggled goods. A detailed description of the process of manufacturing homemade rakia is presented in Fig. 6.

The alcoholic fermentation converting sugars into ethanol is usually carried out by yeasts, mainly *Saccharomyces cerevisiae*, which can be grown directly, using fruit sugars [25]. Literature data also report on the involvement of wild (especially non-*Saccharomyces*) yeasts in producing alcoholic beverages. These contribute to a high production of fruity and floral aroma compounds and low ethanol production. Besides *S. cerevisiae* and non-*Saccharomyces* yeasts, in spontaneous fermentation, alcoholic beverages may contain other microorganisms, mostly lactic acid bacteria. They interact and compete with yeast in the process of fermentation, producing secondary metabolites that may impair the taste and flavour [26]. The climate changes nowadays affect the natural microflora ecosystems and thus—the spontaneous fermentation. This imposes the requirement to support the fermentation process by adding commercially available selected yeast strains.

Being a product of the fermentation of plant material, many components pass into the beverage during fermentation and distillation, among them volatile oils that contribute to the flavour and taste. Further, ageing the spirit in wooden barrels for five, ten, or even twenty years adds depth and flavour to the beverage, similar to the process of aged whisky or reminiscent of good cognac, more colourful, sophisticated, and smooth. Many high-quality rakia brands are sold nowadays in Europe, America, and Asia. Rakia may also be blended with sour cherries, walnuts, honey, and herbs before bottling. Traditionally in Bulgaria, alcoholic beverages are stored in barrels made of pedunculate oak (*Quercus robur* L.) or black locust tree (*Robinia pseudoacacia* L.) [27]. Sometimes, in order to give rakia a colour (Fig. 7), wooden chips or young branches from several arboreal species, such as white or black mulberry tree (*Morus alba* L. and *Morus nigra* L.), black locust tree (*R. pseudoacacia*), and less often (mainly in North-Eastern Bulgaria)—smoke tree (*Cotinus coggygria* Scop.), are used. According to ethnobotanical studies, wood-coloured rakia consumed in small quantities could benefit health [9, 28].

How healthy is rakia?

Metabolic effects of alcohol contained in alcoholic beverages

Alcoholic beverages affect human health via the direct metabolic effects of alcohol. Alcohol may be metabolized via an oxidative pathway (alcohol dehydrogenase, ADH, is an activity used as a measure of the pathway; cytochrome P4502E1, CYP2E1, and catalase) and non-oxidative pathways (fatty acid ethyl ester, FAEE, synthase activity involved). CYP2E1-mediated alcohol metabolism generates reactive oxygen species (ROS), which can oxidize lipids and nucleic acids and dysregulate fatty acid synthesis and oxidation [29]. The highly oxidative effect of the reactive aldehyde, acetaldehyde, contributes to the formation of protein adducts. Acetaldehyde, subsequently oxidized to acetate by aldehyde dehydrogenase (ALDH), is converted to CO_2 and H_2O. Thus, alcohol consumption results not only in elevated ROS but also in elevated NADH/NAD ratio featuring ethanol as being responsible for more than 50% of each individual's energy metabolism and ethanol oxidation being the largest carbon source for energy metabolism at the time of its

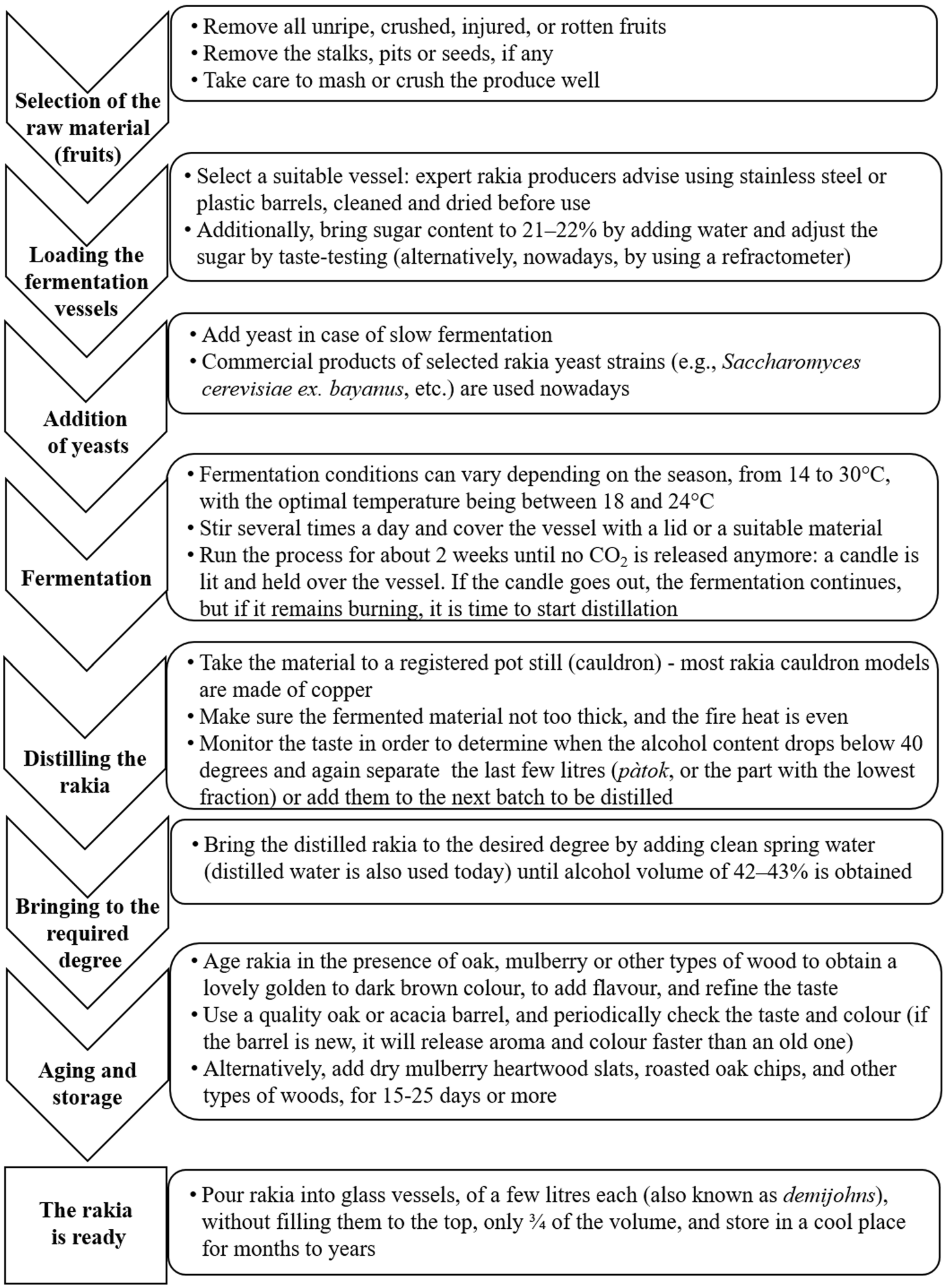

Fig. 6 A flowchart illustrating the process of manufacturing homemade rakia

Fig. 7 Traditional Bulgarian brandy, rakia, made from different fruits and coloured with black mulberry chips. The most popular fruits for rakia preparation are grape, plum, and apricot, but other fruits, such as quince, pear, apples, figs, peaches, raspberries, and cherries, could also be used. Ageing with mulberry chips makes the beverage more colourful, sophisticated, and smooth (*Source* authors' photo)

elimination [30]. Shifting the cellular energy state in the brain explains the positive responses to ethanol ingestion.

The changes in the central nervous system due to alcohol intake affect the brain neurotransmitters and signal peptides involved in the reward and stress signal pathways [31, 32]. Ethanol intake generates a sense of well-being by exaggerating dopaminergic neural activity while suppressing glutamatergic neural activity, signalling anxiety and unease [33]. Still, although there is general agreement that ethanol induces substantial changes in the neural function, its relative contribution to metabolism and cognitive function remains under discussion.

Elevated levels of ROS and the NADH/NAD ratio resulting from heavy alcohol consumption are also associated with epigenetic changes in DNA and histone modification—upregulation and high expression of various genes in alcoholics are the main established effects [34]. It was shown that FAEEs can activate nuclear factor kappa-light-chain-enhancer of activated B cells (NF-kappa B) and activator protein 1 (AP-1), while acetaldehyde inhibited NF-kappa B activation. Thus, oxidative and non-oxidative ethanol metabolites regulate transcription factors differently, at least as proven in pancreatic acinar cells [35].

The effect of ethanol treatment of 3T3-L1 cultured preadipocyte cell line demonstrated an increase in the inflammatory potential of adipose tissue by upregulation of the expression of the proinflammatory cytokines—interleukin 6 (IL-6) and tumour necrosis factor alpha (TNF-alpha), and the inflammatory enzymes—inducible NO synthase (iNOS) and cyclooxygenase -2 (COX-2), at transcriptional level [36]. Increased IL-6 and TNF-alpha levels in the adipose tissue of rats were earlier established by Kang et al. [37], while in men—increased adipose tissue IL-6 and TNF-alpha levels correlated with alcohol-induced liver injury [38]. Low-grade chronic inflammation in obesity and metabolic impairment in insulin resistance, type 2 diabetes mellitus, atherosclerosis, and in CVD is associated with elevated IL-6 and TNF-alpha levels [39].

To make it even worse, unrecorded alcohol has been linked to illness above and beyond that caused by ethanol alone because of the possible presence of toxic contaminants. Although unrecorded spirits rarely contain metals at levels that can cause acute toxicity, chronic exposure presents a health risk since many metals, including cadmium (Cd) and lead (Pb), have been linked to kidney diseases, neurological disorders, and cancers of the skin, lung, bladder, pancreas, colon, and liver [40].

Another set of experimental data, in vitro and in vivo, demonstrates that ethanol can act as an anti-inflammatory agent. Thus, the fact that alcohol-containing preparations are applied by traditional medicine practices for amelioration of certain inflammatory conditions may be attributed to their ability to interfere with molecular mechanisms underlying inflammatory response. The anti-inflammatory potential of ethanol is demonstrated by its capacity to diminish the ability of pro-inflammatory stimuli, such as bacterial lipopolysaccharides, to upregulate the expression of the inflammatory cytokines IL-6 and TNF-alpha [41] and iNOS [42].

Moderate alcohol consumption may improve human health, especially in regard to CVDs [43]. Increased levels of high-density lipoprotein (HDL) cholesterol due to the increased transport rate of apolipoprotein A-I were reported [44]. In addition, the reduced CVD risk in low-to-moderate drinkers could be attributed to the potential of low doses of alcohol to attenuate inflammation by modulating markers such as adiponectin, intercellular adhesion molecule-1 (ICAM-1), and interleukin 10 [45].

Debates about the benefits and harms of alcohol consumption have always been contradictory. Conclusions about the relationship between alcohol consumption and health outcomes depend on various factors: alcohol dosing and frequency of consumption, age, sex, and last but not least, the type of alcohol. Traditionally prepared beverages have been shown to have a rich polyphenolic composition and a large proportion of the reported beneficial effects are likely due to this non-alcoholic portion of the beverages.

What else but alcohol is there in rakia?

It is logical to expect that the fruits or seeds from which traditional alcoholic beverages are prepared would have a significant contribution to the polyphenolic composition of the beverage. The organoleptic characteristics of the fruit spirits may be a combined contribution from the raw material and by-products released during alcohol fermentation, distillation, and ageing. The specific taste and aroma are influenced by the type and concentration of the higher alcohols, esters, carbonyl compounds, volatile phenols, and other aroma-active compounds in the beverages [46, 47]. In addition, the microflora strains, temperature, and pH complete the list of the crucial factors needed to obtain a beverage with the desired quality. The impact of aroma compounds on the sensory profile of the spirits has recently been comprehensively revised by Stanzer et al. (2023) [48]. The process of industrial rakia manufacturing involves partial rectification of the distillates, which increases their ethanol content, concentrates the aroma substances, and removes the difficult-to-ferment unwanted final impurities [46].

The ageing in wooden barrels is an important stage in preparing alcoholic beverages. Wood has a complex structure consisting of several main types of biopolymers: cellulose, hemicellulose, lignins, and only up to 10% of other volatile and non-volatile bioactive molecules, which determine the specificity of the phytochemical composition [10, 49]. During the contact between the wood of the respective plant species and the alcohol, a small amount of biologically active compounds is extracted, contributing to the specific colour, taste, and aroma of the drink [50, 51].

Most studies related to the production of traditional spirits indicate oak as the most preferred wood for alcoholic beverage ageing, although species such as walnut, cherry, and chestnut are also indicated as alternatives [10, 50].

It is interesting to know the influence of the wood used in the ageing process on the change of the phytochemical composition of alcoholic beverages. A detailed study on the subject showed that adding wood chips to apple brandy, a traditional drink in Romania, dramatically changed the composition of the polyphenols extracted into the drink compared to freshly distilled non-wood-exposed brandy [50]. In addition to a significant enrichment of the qualitative polyphenol composition, it was found that contact with the wood led to a significant increase in the amount of polyphenols initially found in the control sample. For example, the amount of chlorogenic acid increased by approximately 80% after ageing with mulberry wood [50]. The contribution of several types of wood to the enrichment with various polyphenols and phenolic acids in a specific composition and ratio depending on the plant species was also demonstrated in the study. Based on our knowledge of the potential of polyphenol-rich extracts to modulate various biological processes, it can be assumed that the specific phytochemical composition contributes to the biological effects of traditional beverages. Some examples are summarized in Table 1.

Several studies in recent years have been dedicated to revealing the possible positive effects of traditional Bulgarian rakia on the human health. A comparative study of ethanol extracts from woods of popular species used for ageing and colouring of high-alcohol beverages in Bulgaria reported a high correlation between total polyphenol content and antioxidant activity after forty days of extraction period. The extract from *M. nigra* showed higher polyphenol content and in vitro antioxidant activity compared to extracts from *Q. robur*, *R. pseudoacacia*, and *C. coggygria* [54]. The reported optimal extraction time of 40 days is in accordance with the traditions of the Bulgarian population when colouring homemade rakia. After this period no significant changes in the phytochemical composition and antioxidant activity of the alcohol extracts were established [54, 75]

Further, the biological effects of mulberry heartwood ethanol extracts were studied in cell culture models of oxidative stress and inflammation [56]. It was suggested that the extracts had the potential to conserve cellular glutathione by influencing the expression of the enzymes involved in glutathione metabolism. Under conditions of induced oxidative stress in a preadipocyte cell culture, the extract increased the expression of glutamatecysteine ligase (GCL)—the enzyme responsible for the synthesis of glutathione, and at the same time did not change the levels of glutathione peroxidase (GPx)—the enzyme that utilizes glutathione [56], and the effect on glutathione levels was attributed to the antioxidant activity of the polyphenols and tannins contained in the extract.

In addition, a modulatory effect on the genes involved in the inflammatory response was also reported about the mulberry extract. The expression of NF-kB and the proinflammatory cytokine TNF-alpha was inhibited in a concentration-dependent manner in preadipocytes treated with mulberry heartwood extract, while IL-6 gene expression was stimulated. This immunomodulatory effect may explain the anti-inflammatory prophylactic and therapeutic potential of the investigated extract [57].

Furthermore, a beneficial effect of mulberry heartwood extract on lipid metabolism was suggested based on its effects on genes directly involved in adipocyte differentiation and lipid accumulation [58].

The smoke tree is among the 15 most used medicinal plants in Bulgaria [76] and is known for its

Table 1 Phytochemical composition and biological effects of extracts from plants mostly used for ageing and colouring rakia

Source (plant species, wood)	Phenolic compounds in alcohol extracts	Biological Effects of Extracts	References
Black mulberry (*M. nigra*)	Chlorogenic, p-hydroxybenzoic, and dicaffeoylquinic acids, vanillin, catechin, coniferaldehyde, syringaldehyde, trimethoxyphenol, yringaldehyde, 2-aryl benzofuran	In vitro: Antioxidant *Cell cultures*: cytoprotective, cytoproliferative, antioxidant anti-inflammatory, beneficial effect on lipogenesis	[50, 52–58]
Smoke tree (*C. coggygria*)	Sulfuretin, fustin, gallic acid, methylgallate, catechins, quercetin, dihydroquercetagetin	In vitro: Antioxidant *Cell cultures*: cytoprotective, cytoproliferative *Experimental animals*: antiulcer effect, improving serum redox status, improving serum lipid profile	[54, 55, 59–62]
Black locust (*R. pseudoacacia*)	Syringaldehyde, hydroxybenzaldehyde, vanillin, anisaldehyde, dihydrorobinetin, furfural, 5-methylfurfural, guaiacol, kaempferol, rutin, fustin, butin, catechin, quercetin, myricetin; gallic, ellagic, caffeic, and p-Coumaric acids	In vitro: Antioxidant Combined antibacterial and antifungal, antibacterial against periodontal pathogens, combined antioxidant and antifungal effect	[52, 54, 63–69]
Pedunculate oak (*Q. robur*)	Furfural, vanillin, syringaldehyde, sinapaldehyde, eugenols, a-terpineol, catechin, quercetin, myricetin, phenolic acids [gallic, ellagic, protocathetic, vanillic, cinnamic, p-Coumaric], ruburiins (A–E),	In vitro: Antioxidant *Antibacterial*: antiulcer against *Helicobacter pylori* *Experimental animals:* antiulcer, anti-inflammatory, antioxidant, antitumor, antihypertensive, antimicrobial, gastric mucosa protection	[10, 54, 64, 65, 70–74]

anti-inflammatory, antiseptic, anti-haemorrhagic, and astringent properties. According to folk recipes, the aqueous infusions from leaves are applied externally to treat wounds, to alleviate toothache by gargling, and it is consumed in small quantities for the treatment of gastric and duodenal ulcers [5]. In some regions, mainly in North-East Bulgaria, the heartwood of the plant is used for colouring homemade rakia. Several studies on the biological effects of ethanol extracts from smoke tree heartwood were inspired by this tradition. Its antioxidant potential and cytoprotective effects were demonstrated in vitro using ABTS radical scavenging assay and in cell cultures [54, 55]. In in vivo experiments, the gastroprotective effect of the extract was demonstrated in indomethacin-induced gastric ulcers in Wister rats [61]. Furthermore, 30 days of treatment with the extract, using stomach gavage, showed a lack of liver, renal, and brain toxicity in the experimental animals. Even more, some beneficial effects of the ethanol extract were estimated, manifested by improved serum redox status and lowered serum triglycerides [62]. The detailed phytochemical analysis revealed that the main flavonoids in the heartwood ethanol extract were fustin and sulfuretin, whereas gallotannins and gallic acid were the ones found in highest concentrations in the aqueous leaf extract featured in popular folk medicine recipes [59]. Recently, the gastroprotective effect of fustin, extracted from smock tree, has been demonstrated by its potential to prevent ethanol-activated [33] and indomethacin-induced [77] ulceration in experimental rats. Thus, the reported biological effects of the wood extracts could be attributed to the content of the above-mentioned specific bioactive compounds extracted during rakia ageing.

Folk medicine empirical data reports indicate that infusions from flowers and leaves of black locust have a powerful action against gingivitis and gastrointestinal disorders and are also recommended as expectorant, spasmolytic and diuretic remedies [3]. Scientific studies have established the antioxidant, antifungal, and antimicrobial effects of black locust leaf and branch extracts [68, 69]. The beneficial properties of the ethanol extracts from different parts of black locust were analysed with regard to their antimicrobial and antifungal synergistic effect [66]. The bactericide potential of the plant was demonstrated also by the effectiveness of the extract from branches to inhibit the growth of pathogens responsible for dental plaque formation, thus alleviating periodontal inflammatory diseases [67].

Since ancient times oak has been utilized worldwide by traditional medicine practices. The most commonly used part of the plant is the bark and rarely seeds and fruits. A decoction of the dried oak bark is used as an anti-inflammatory and antiseptic remedy and is considered effective in the treatment of dysentery, intermittent fever, and haemorrhages [78]. According to Bulgarian folk medicine recommendations, a decoction of oak bark is effective against diarrhoea, cough, bronchitis, bladder inflammation, and stomach pain [5]. Extracts of *Quercus* spp. are rich in bioactive molecules and are proven to have a wide range of beneficial biological effects, such as antioxidant, antitumour, anti-inflammatory, antihypertensive, antimicrobial, etc. [73]. Tannins and phenolic acids extracted from oak bark and heartwood have the potential to protect the gastric mucosa and can prevent gastrointestinal inflammation [74]. Scientific data indicate that oak ethanol extract has the ability to reduce the expression of protooncogenes related to gastric ulcer development and to improve the redox status and proinflammatory marker levels in experimental models of gastric ulcer [71]. In addition, active components extracted from the heartwood of pedunculate oak are shown to be potential antiulcer agents in terms of their ability to inhibit the growth of *Helicobacter pylori* [72].

Along with the phenolic compounds, the extractants may contain many more active chemical compounds, most highly concentrated in heartwood, such as terpenes, stilbenes, and resin acids. These secondary metabolites are mainly produced to protect the plant from various pathogens, herbivores, and hostile environmental conditions [79, 80]. It should be taken into consideration that, in addition to the health benefits, some of the extracted molecules, e.g. tannins, may have adverse effects in humans or animals when consumed. Tannins bind nutrients and may reduce their bioavailability; other negative health consequences of their intake include mutagenicity and carcinogenicity, and hepatic and kidney toxicity [81].

The above data support that, during the process of manufacturing and ageing, rakia is enriched with biologically active compounds that contribute to the overall effect of the drink on the human body.

Conclusion

Rakia preparation technology originates from ancient times. Transferring this knowledge from one generation to another preserves Bulgarian cultural identity. No research to date has attempted to summarize the information about the tradition of rakia manufacturing and consumption. Concerning the contribution of this cultural heritage, different aspects of the consumption of alcohol, including the biological effects of alcohol and alcohol extracts produced during colouring, flavouring, and maturation of homemade rakia in Bulgaria, were elucidated.

Adhering to the warnings of moderate consumption in small quantities, we can speculate that traditional homemade rakia could provide a basis for the development of low-alcohol or non-alcoholic functional beverages with beneficial health potential. By adopting the approach of natural extraction of bioactive compounds, the contemporary food industry could apply the instrumentation for dealcoholization of wines and beers to beverages like rakia and other elixirs for the development of a variety of new drinks with high content of such compounds for the benefit of human health.

We believe that the information covering various aspects of homemade rakia as an ethnic beverage underlines the overall socioeconomic value of this unique tradition in Bulgaria. Its popularization may stimulate tourism, small-scale producers and other craftsmanship, and attract investments to the rural areas where the traditions are best kept by the local population, mostly affected by the globalization processes.

Study limitations

The strength of this study lies in the overview of ethnographic evidence supplemented by the available literature on the cultural, societal, and scientific aspects of traditional production and usage of rakia. Despite the illustrated value of rakia as a traditional Bulgarian alcoholic beverage, the study has some limitations. The overall amount of scientific evidence currently available on the subject is low. Stigmatizing alcohol consumption in society limits scientific investigations in the field. There is a lack of interventional studies addressing the metabolic effects of rakia, and this restricts the understanding of its complete effect on human health. Furthermore, the production of rakia from different fruit sources and the modifications in the manufacturing techniques contribute to an even greater variety of rakia types, which does not allow us to claim comprehensiveness in this context.

Abbreviations

ADH	Alcohol dehydrogenase
ALDH	Aldehyde dehydrogenase
AP-1	Activator protein 1
COX-2	Cyclooxygenase-2
CVD	Cardiovascular disease
CYP2E1	Cytochrome P_{450}2E1
FAEE	Fatty acid ethyl ester
GCL	Glutamatecysteine ligase
GPx	Glutathione peroxidase
HDL	High-density lipoprotein
ICAM-1	Intercellular adhesion molecule-1
IL-6	Interleukin 6
iNOS	Inducible NO synthase
NF-kB	Activate nuclear factor kappa-light-chain-enhancer of activated B cells
ROS	Reactive oxygen species
TNF-alpha	Tumour necrosis factor alpha
WHO	World Health Organization

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Author contributions
MN and DI contributed to the conceptualization. MN was responsible for writing the original draft. MN and DI contributed to writing and editing the review. DI contributed to funding acquisition. All authors have read and approved the final version of the manuscript.

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Availability of data and materials
All data used for this study are included in the manuscript.

Declarations

Ethics approval and consent to participate
All respondents gave their informed consent before the interviews.

Consent for publication
All authors agree for this publication.

Competing interests
The authors declare that they have no competing interests.

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