Alinteri J. of Agr. Sci. (2023) 38(3): 166-176
e-ISSN: 2587-2249
info@alinteridergisi.com

http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/

EVALUATION OF A NUTRACEUTICAL TEA FOR ANTIOXIDANT, ANTIMICROBIAL, AND ANTICANCER PROPERTIES

[1] R.Shiva Kumar, [2] B. Chandra Shekhar Reddy, [3] G. Thirupathi, [4] Sara fathima
[13]Associate Professor,[2]Professor,[4]Assistant Professor
Department of Pharmaceutics
Vaagdevi Pharmacy college, Bollikunta, Warangal, Telangana

ABSTRACT

The growing interest in functional foods has led to the development of nutraceutical products with potential health benefits beyond basic nutrition. This study aims to formulate and evaluate a nutraceutical tea with antioxidant, antimicrobial, and anticancer properties. The tea was prepared using a blend of natural ingredients known for their therapeutic effects, including herbal extracts rich in polyphenols, flavonoids, and other bioactive compounds. The antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging assays. Antimicrobial activity was evaluated through disc diffusion and MIC (minimum inhibitory concentration) methods against a range of pathogenic bacterial and fungal strains. The anticancer potential was assessed using in vitro cell culture models to evaluate cell proliferation inhibition and apoptosis induction in cancerous cell lines. The formulation demonstrated significant antioxidant activity, with a high radical scavenging capacity, suggesting its potential for reducing oxidative stress. The antimicrobial testing revealed strong activity against both gram-positive and gram-negative bacteria, as well as common fungal pathogens. Additionally, the tea exhibited promising anticancer effects, inhibiting the growth of cancer cells and promoting apoptosis. The results indicate that this nutraceutical tea holds potential as a functional beverage with multifunctional health benefits, particularly in the prevention and management of oxidative stress-related diseases, infections, and cancer. Further studies, including in vivo testing and clinical trials, are warranted to confirm its efficacy and safety.

I. INTRODUCTION

The concept of nutraceuticals has gained significant attention in recent years due to the increasing consumer demand for functional foods that provide health benefits beyond basic nutrition. Nutraceuticals are bioactive compounds derived from natural sources such as plants, herbs, and fruits, and are known to offer therapeutic effects, including antioxidant, antimicrobial, and anticancer properties. Among these, herbal teas, with their rich array of bioactive compounds, have been traditionally consumed for their medicinal benefits. Recent studies have shown that certain herbal teas contain compounds such as polyphenols, flavonoids, and terpenoids, which exhibit various biological activities, including antioxidant, antimicrobial, and anticancer effects.

Oxidative stress, caused by an imbalance between reactive oxygen species (ROS) and antioxidants, has been implicated in the pathogenesis of numerous diseases, including cancer, cardiovascular diseases, and neurodegenerative disorders. Antioxidants, therefore, play a crucial role in neutralizing free radicals and mitigating the damage caused by oxidative stress. Herbal teas rich in antioxidants offer a natural and effective means to counteract oxidative damage.

In addition to antioxidant properties, antimicrobial activity is a key therapeutic aspect of herbal teas. Many plants used in the formulation of teas have been shown to possess antimicrobial effects against a broad spectrum of pathogens, including bacteria, fungi, and viruses. This makes them potential candidates for supporting the immune system and preventing infections.

Cancer, a major cause of morbidity and mortality worldwide, is another area where herbal remedies have shown promise. Numerous plant-derived compounds have demonstrated anticancer properties by inducing apoptosis, inhibiting cell proliferation, and modulating signaling pathways involved in cancer progression. Given the growing interest in natural products for cancer prevention and treatment, nutraceutical teas containing bioactive compounds may offer an alternative or complementary approach to conventional cancer therapies.

This study aims to formulate and evaluate a nutraceutical tea with a blend of herbal extracts known for their antioxidant, antimicrobial, and anticancer properties. The primary objective is to assess the bioactivity of the tea and determine its potential as a functional beverage with multiple health benefits. The study will evaluate the antioxidant activity, antimicrobial efficacy, and anticancer potential of the formulation, providing a comprehensive assessment of its therapeutic value.

II. LITERATURE SURVEY

The use of herbal teas as a source of bioactive compounds has been widely studied due to their therapeutic properties. Several plants have been identified for their potent antioxidant, antimicrobial, and anticancer activities. This literature survey explores these aspects by examining the key herbs and their bioactive components commonly used in nutraceutical tea formulations.

1. Antioxidant Properties of Herbal Teas

Oxidative stress is a critical factor in the development of various chronic diseases such as cardiovascular disease, diabetes, and cancer. Antioxidants neutralize free radicals, thereby reducing cellular damage and promoting overall health. Herbal teas rich in polyphenols, flavonoids, and tannins are known to exhibit strong antioxidant properties.

Green tea (Camellia sinensis) is one of the most well-researched teas with antioxidant activity, primarily due to its high content of catechins such as epigallocatechin gallate (EGCG). Studies have shown that green tea significantly reduces oxidative stress and protects against diseases associated with free radical damage (Mandel et al., 2005).

Black tea, also derived from Camellia sinensis, contains flavonoids such as theaflavins and thearubigins, which are potent antioxidants that help reduce oxidative damage (Basu et al., 2013).

Other herbal teas such as chamomile (Matricaria chamomilla), hibiscus (Hibiscus sabdariffa), and peppermint (Mentha piperita) have also demonstrated notable antioxidant activities due to their polyphenol and flavonoid content (Akinmoladun et al., 2015).

2. Antimicrobial Activity of Herbal Teas

Herbal teas are gaining popularity for their antimicrobial properties, as they contain natural

compounds that inhibit the growth of a wide range of pathogens, including bacteria, fungi, and viruses.

Thyme tea (Thymus vulgaris) contains essential oils like thymol and carvacrol, which exhibit strong antimicrobial effects against Staphylococcus aureus, Escherichia coli, and various fungal pathogens (Nazzaro et al., 2013).

Ginger tea (Zingiber officinale) is well known for its antimicrobial and anti-inflammatory properties. The gingerol and shogaol compounds have been shown to exhibit antibacterial activity against Salmonella typhi and Helicobacter pylori (Gao et al., 2007).

Echinacea tea (Echinacea purpurea) is often used for its immune-boosting properties and has demonstrated efficacy in treating upper respiratory tract infections. Studies have shown its antimicrobial activity against Streptococcus pneumoniae and Haemophilus influenzae (Binns et al., 2010).

These findings suggest that herbal teas can serve as a natural alternative for antimicrobial treatment, offering broad-spectrum protection without the adverse effects associated with synthetic antibiotics.

3. Anticancer Potential of Herbal Teas

Cancer, characterized by uncontrolled cell growth, is one of the leading causes of death worldwide. Many herbs used in teas have shown anticancer properties by modulating key pathways involved in cancer progression, such as cell proliferation, apoptosis, and metastasis.

Green tea has been extensively studied for its anticancer effects, particularly due to its high concentration of catechins, especially EGCG. These compounds have demonstrated the ability to inhibit tumor growth, suppress angiogenesis, and induce apoptosis in several cancer cell lines, including those associated with breast, colon, and lung cancer (Cao et al., 2009).

Turmeric tea (Curcuma longa), known for its active compound curcumin, has shown strong anticancer properties. Curcumin has been found to inhibit the growth of cancer cells by modulating various molecular signaling pathways, including the NF-kB, p53, and MAPK pathways, and it enhances the activity of chemotherapy agents (Huang et al., 2015).

Chamomile tea has demonstrated potential anticancer effects due to the presence of apigenin, a flavonoid that induces apoptosis in cancer cells, particularly in leukemia and breast cancer models (Moussa et al., 2012).

The anticancer properties of herbal teas make them potential adjuvants in cancer prevention and treatment, with fewer side effects compared to traditional therapies.

4. Combination of Bioactive Compounds in Herbal Teas

In recent years, the combination of different herbal extracts to form nutraceutical teas has garnered interest, as such blends may have synergistic effects, enhancing the overall therapeutic properties. For example, a combination of green tea, ginger, and turmeric has been shown to provide enhanced antioxidant, antimicrobial, and anticancer benefits compared to single-herb formulations (Venkatesan et al., 2018). These combinations may offer broader therapeutic effects, particularly for conditions like cancer, where inflammation and oxidative stress play significant roles in disease progression.

5. Challenges and Future Directions

Despite the promising benefits of herbal teas, there are challenges associated with their widespread use. Standardization of active ingredients, dosage determination, and ensuring bioavailability of key compounds in the human body remain critical issues. Furthermore, the toxicity of some bioactive compounds in large doses and potential herb-drug interactions need careful consideration (Harris et al., 2013).

Future research should focus on optimizing the formulation of nutraceutical teas to enhance the

bioavailability of active compounds, as well as conducting clinical trials to confirm their efficacy and safety in treating various health conditions.

Conclusion

Herbal teas are a rich source of bioactive compounds that possess strong antioxidant, antimicrobial, and anticancer properties. These properties make them potential candidates for improving health and managing diseases such as cancer, infections, and oxidative stress-related conditions. The combination of multiple herbs in a single nutraceutical tea formulation may offer enhanced therapeutic effects, although further research is needed to fully understand their efficacy and safety profiles.

III. Role of Phytochemicals as Nutraceuticals

Plants naturally contain chemical molecules called phytochemicals, which give them structure, flavour, and colour. Phytochemicals have several health benefits, including enhancing the synthesis and activity of enzymes involved in the inactivation of carcinogens, suppressing the growth of cancer cells, and interfering with metabolic processes, even though they are not linked to nutritional functions [28, 29]. Thus, bioactive nutraceutical substances might be the definition of phytochemicals [30, 31]. According to epidemiological research, these compounds have distinct and complementary actions that provide general protection against infections, tumours, diabetes, hypertension, and heart and brain disorders. Antioxidant, capable of shielding the body from oxidative stress; hormonal, with effects akin to those of natural oestrogens; antimicrobial, by strengthening the immune system; hypolipidemic; interference with enzymatic activities and on DNA replication and modification, inactivating toxic substances, shielding DNA from carcinogen action, and preventing the growth of cancer cells are the reasons behind the aforementioned effects [32–34]. There are many groups into which phytochemicals can be divided (Figure 2). Polyphenols are a diverse group found in nearly all plants. They are made up of three classes of compounds: phytoestrogens (found in soy isoflavones and lignans of oleaginous seeds and whole grains, which have antioxidant, anticancer, and hypocholesterolemic action); phenolic acids (found in coffee and cocoa, which have antioxidant and anticancer action); and flavonoids or catechins (found in onion, cabbage, broccoli, soy, tomatoes, fruit, wine, and tea, which have anticancer, anti-inflammatory, anti-hormonal, and antiplatelet effects); and phytoestrogens. Carotenoids are a class of various chemicals and natural pigments that are particularly present in orange and red fruits and vegetables. Their provitamin and antioxidant properties have drawn special attention. β-carotene, α-carotene, lycopene, and β-cryptoxanthin are the most well-known carotenoids.

Thus, grains, legumes, fruits, vegetables, and spices are foods high in phytochemicals.

However, a number of investigations have verified the complete ineffectiveness of these medications as well as the possible risk of consuming them when used carelessly and incorrectly. High concentrations of these compounds can really become hazardous substances by interfering with other nutrients or changing into molecules that have pro-oxidant properties [35, 36].

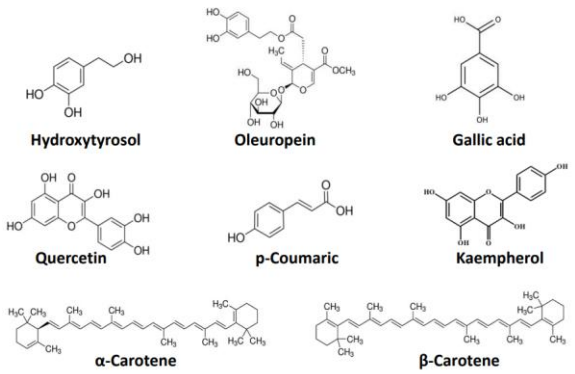

Figure 2. Chemical structures of common dietary phytochemicals.

IV. Bioaccessibility and Bioavailability of Nutraceutical Compounds

These days, the emerging discipline of foodomics [37] confirms the increased interest in healthy food components and nutraceuticals. Diet has a significant impact on how different metabolic processes are regulated. In actuality, meals are a special source of "active ingredients" including vitamins, fibre, polyunsaturated fatty acids, and antioxidants that have positive health effects in addition to giving the body the energy it needs for regular metabolic functions. As a result, nutrition and its constituents can enhance quality of life, lower the chance of developing certain diseases, and promote a state of wellbeing [38]. meals' nutritional worth, risks, and potential health benefits are receiving more and more attention, and accurate knowledge on the meals people eat on a daily basis is becoming more and more important. Foods contain micronutrients (vitamins, mineral salts, polyphenols, and dietary fibre) and macronutrients (proteins, lipids, and sugars) that must be broken down to release their corresponding monomers (amino acids, fatty acids, and monosaccharides). Since micronutrients are frequently linked to an improvement in the body's health, their presence frequently raises the food's nutritional worth [39]. Due to the daily impact of nutrition, lifestyle, and environment on the gut microbiota, there is a growing interest in comprehending the link between the food–gut microbiota–health axis [40].

In particular, Figure 1 shows how nutraceuticals are categorised into the most researched kinds of physiologically active components: fatty acids and lipids, amino acid-based compounds, carbohydrates, fibre, isoprenoid derivatives, and phenolic compounds. The major sources of these nutraceutical classes are fruit-based Mediterranean diet items and olive oil. Phenolic chemicals' bioaccessibility and bioavailability in the digestive and circulatory systems are critical to their health advantages. Because of this, it is crucial to take into account these compounds' bioavailability, which is reliant on their intestinal absorption and bioaccessibility [41–43]. For instance, the gut microbiota plays a role in the biotransformation of polyphenols into metabolites and is influenced by the way polyphenols suppress harmful bacteria and promote good bacteria, both of which have positive effects on host health. Consuming nutraceutical substances may restrict their absorption since they are transported by digestive fluids through epithelial cells and the mucous layer [44]. Nevertheless, when bioactive substances are liberated from food and rendered soluble in gastrointestinal fluids, they interact with other elements of the system to provide positive health benefits (anti-inflammatory, anti-cancer, antioxidant, anti-hypercholesterolemic, and anti-hypertensive qualities).

Microencapsulated bioactive molecules, including flavonoids, phenolic compounds, antioxidant molecules, carotenoids, and plant metabolites in general, are examples of bioavailable nutraceutical chemicals. Actually, colours, antioxidants, vitamins, minerals, peptides, proteins, and other active substances are protected, stabilised, made more bioavailable, and their release regulated using micro/nano-encapsulation techniques.

Consequently, by enhancing their bioavailability, nutraceuticals can be encapsulated to enhance their solubility and protect and interact with the gastrointestinal system. [45–47].

V. Extra Virgin Olive Oil Compounds

The fruit of the olive tree (Olea europaea L.) yields extra virgin olive oil, a product that is rich in bioactive chemicals and known to have various impacts on cell biology and health [48]. Even while extra virgin olive oil contains a lot of oleic acid, the majority of its positive benefits seem to be caused by its minor constituents, primarily the phenolic compounds. Furthermore, the cultivar [49], irrigation [50], and cultivation method [51] all affect the profile and concentration of these minor components of olive oil, which might alter the expression and content of polyphenols such hydroxytyrosol and oleuropein. The hydrolysis of oleuropein, which is mostly found in the fruit and olive leaves, produces hydroxytyrosol [52]. It has demonstrated potent antioxidant properties and the capacity to scavenge free radicals of nitrogen and oxygen. Numerous experimental investigations have shown that hydroxytyrosol has pro-apoptotic and anticancer activities [53–57]. Additionally, this intriguing compound has the ability to alter the expression of many genes related to apoptosis and cell division [58]. The suppression of fatty acid synthase activity [59], which is essential for the action of extra virgin olive oil in the cells, sustains the cell antiproliferative effects of hydroxytyrosol and oleuropein. In an ApcMin/+ mouse model [60], olive oil therapy results in downregulated levels of fatty acid synthase activity, the essential enzyme in the fatty acid production pathway and its mRNA expression, as shown in Figure 3.

Furthermore, we showed that the use of olive oil might inhibit intestinal polyp growth and regulate the environment in which tumours form in the same animal model of colon carcinogenesis [61,62]. Fatty acid synthase and hydroxy-3-methylglutaryl-CoA reductase (HMGCoA reductase), the enzyme that limits the rate of cholesterol production, were inhibited to decrease intestinal cell proliferation [61]. In subsequent research, we assessed additional ways that olive oil might decrease cell proliferation and increase apoptosis in intestinal polyps in mice: (1) a decrease in Phospho-Stat3-Ser727 (p-STAT3 Ser), which is known to be in charge of activating metabolic pathways involved in cell proliferation regulation; and (2) an increase in the expression of oestrogen receptor β (ERβ) and, as a result, the ERβ/ERα ratio, which is already recognised as a diagnostic and prognostic indicator of the progression of colon cancer [62–65].

We have also been able to examine the impact of olive oil consumption on the tissue fatty acid composition in ApcMin/+ mice using a lipidomic technique [66]. The ratio of oleic acid to stearic acid, or the cell membrane's saturation index, is impacted by extra virgin olive oil [67]. The saturation index, which is regarded as a measure of the fluidity of the cell membrane, is an essential metric for evaluating the health of the cell due to evidence that low SI values are linked to the malignant phenotype of cells [68,69]. Furthermore, variations in the saturation index are frequently linked to modifications in the degree of hydration in cell membranes as well as the activation of proteins involved in cell division and growth.

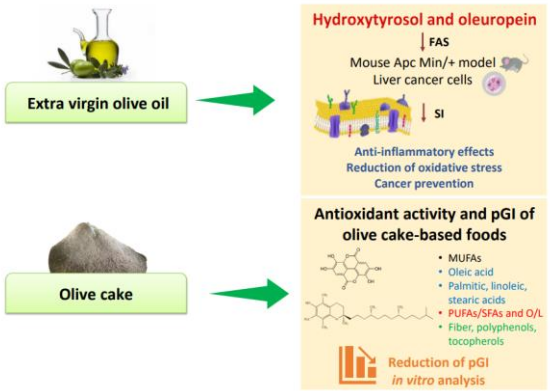

Figure 3. In vitro effects of extra virgin olive oil and olive cake. Abbreviations: FAS, fatty acid synthase; L, linoleic acid; MUFAs, monounsaturated fatty acids; O, oleic acid; pGI, predicted glycemic index; PUFAs, polyunsaturated fatty acids; SFAs, saturated fatty acids; SI, saturation index.

Humans have also shown that extra virgin olive oil has anti-inflammatory properties for the gastrointestinal mucosa [70,71]. Consuming extra virgin olive oil on a regular basis has been thought to help prevent and treat intestinal conditions including inflammatory bowel disease (IBD) [72].

A novel situation in evaluating the well-known and distinctive qualities of virgin olive oil components is the valuation of olive cake, a by-product of the extraction of extra virgin olive oil and a good source of bioactive compounds. Saturated fatty acids (SFA), monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs), total dietary fibre, PUFAs/SFA, oleic/linoleic acid (O/L), phenolic content, and antioxidant activity were all assessed in a prior study to assess the nutritional and chemical characteristics of olive cake [73]. Despite being a byproduct of the manufacture of olive oil, olive cake demonstrated significant levels of total phenol content, particularly polyphenols and tocopherols, as well as good antioxidant activity as shown by ABTS and DPPH tests. Because of these factors, a novel idea was to utilise olive cake as a beneficial raw material to enhance the nutritional content of gluten-free breadsticks.

Importantly, scientific nutritional research has unequivocally shown that diet and its constituents affect health by modifying parts of our physiology (i.e., how our body functions) in a positive or negative way [74,75]. As a result, it's critical to understand not just the nutritional makeup of foods but also the effects that each component has on the body. Reducing the total glycaemic load is helpful as an adjuvant in appetite management, weight loss maintenance, and weight control [76–78]. Low-glycemic-load diets have been proposed to enhance weight and fat mass reduction in comparison to high-glycemic-load diets. Consuming low-index meals and glycaemic load has a positive impact on even some significant cardiovascular risk indicators (such triglycerides and HDL cholesterol) and indicators of the body's "inflammatory state," which are connected to health in a number of ways.

Conversely, a diet high in foods with a high glycaemic index is linked to a decrease in HDL cholesterol and an increase in circulating triglyceride levels, as well as an increased risk of type diabetes 2 because of the excessive insulin secretion and resulting functional loss of pancreatic cells brought on by their consumption [79]. In this case, the lactic acid bacteria fermentation procedures resulted in a lower projected glycaemic index (pGI) for the in vitro starch hydrolysis of products enriched with bioactive components of olive cake (Figure 3) [73]. Other research examined how the polyphenols in olive cake shield endothelial cells and hepatocytes from oxidative stress and lipid buildup [80,81]. Consumption of polyphenols from olive oil was also found to be strongly correlated with gut microbiome. The conversion and bioaccessibility of olive oil polyphenols into compounds that regulate the imbalance of the gut microbiome, lowering inflammation and oxidative stress in the liver, are facilitated by microorganisms that make up the gut microbiota [82,83].

VI. Polyunsaturated Fatty Acids

Fats are abundant in diets and make up a significant component of most meals. However, since PUFAs have been linked to many of the health benefits of fats in humans, it is crucial to differentiate them from SFAs [84,85]. It is presently advised to increase PUFAs in

comparison to SFAs since they are essential for the healthy operation of the organism's biological processes [86,87]. Both vegetable and animal foods, including nuts, sesame seeds, fish, soy, sunflower, maize, olives, and olive oil, are high in polyunsaturated fatty acids (PUFAs) [73,88–91].

It is commonly recognised that long-chain polyunsaturated fatty acids (PUFAs) of the n-3 and n-6 (n-3 and n-6 PUFAs) are good for human health and that a lower n-6/n-3 PUFAs ratio in the diet is important [92,93]. However, the present dietary trends, primarily in Western nations, lead to an imbalanced ratio of n-6/n-3 PUFAs due to an increased consumption of n-6 PUFAs [94]. In actuality, the guidelines advise against exceeding 4:1 and favour meals with a lower n-6 PUFA concentration.

Since humans are unable to synthesise linoleic acid (C18:2n-6, LA) and α-linolenic acid (C18:3n-3, ALA), the two main precursors of PUFAs must be obtained directly from the food [94].

Eicosapentaenoic acid (C20:5n-3, EPA) and docosahexaenoic acid (C22:6n-3, DHA) are the most physiologically typical members of the n-3 PUFAs family, whereas arachidonic acid (C20:4n-6, AA) is the primary characteristic of the n-6 PUFAs series.

Inhibiting colon carcinogenesis and influencing tumour development, n-3 PUFAs have anti-cancer characteristics, according to several epidemiologic and intervention studies [95–97]. n-3 PUFAs have been shown to inhibit cell proliferation and encourage cell death in earlier in vitro investigations [98,99]. HepG2 cells' proliferation was inhibited by EPA and AA, which was linked to the downregulation of the gene expression of lipogenic enzymes such fatty acid synthase and 3-Hydroxy-3-Methyl-Glutaryl Coenzyme A Reductase (HMGCoAR). Through SREBP-dependent regulatory mechanisms, PUFAs may regulate the gene expression of these enzymes in liver cancer [99]. Furthermore, several human tumour cell lines have demonstrated that PUFAs have positive effects via activating peroxisome proliferator activated receptors (PPARs) [100].

According to preclinical research, mice's intestinal polyp growth may be controlled by feeding them a diet high in n-3 PUFAs [60,66,101]. Intestinal polyp growth is known to be modulated by a diet high in n-3 PUFAs. However, by overexpressing the oestrogen receptor β and low density lipoprotein (LDL) receptor, which are known to be negative modulators of cell proliferation, the ApcMin/+ mice given n-3 PUFAs also displayed a reversal mechanism of polyp growth. The regulation of CB1 receptor expression is another mechanism that supports the antiproliferative effect of n-3 PUFAs [102]. In the ApcMin/+ mouse model, n-3 PUFAs dramatically reduced the formation of intestinal polyps while simultaneously promoting the expression of the CB1 receptor gene and protein. Cell growth and proliferation were impacted by the inhibition of the Wnt/β-catenin pathway, which was linked to the overexpression of this receptor [102].

VII. Fruit Components

The value of fruit in the diet is constantly emphasised by nutritionists. Because they include a substantial amount of vitamins, mineral salts, and bioactive substances that are good for human health, fruit and vegetables are the cornerstone of a daily food plan according to the Mediterranean diet [20,103]. Among the fruits of the Mediterranean heritage, table grapes are particularly popular and enjoyed worldwide. The fruit grape (Vitis vinifera L.) is primarily high in polyphenols, which are compounds that can inhibit carcinogenesis, prevent cancer, and affect pathways linked to cell proliferation.

The cytoskeleton's structural elements, cellular adhesions, and the profile of fatty acids in cell membranes are all impacted by the polyphenolic

content of grapes, which is influenced by genotype, ambient conditions, and agronomic techniques [104]. The key findings from our research on extracts of grape skin and grape pomace are summarised in Figure 4 below. We recently examined the biochemical characteristics of two table grape skin extracts: Egnatia, a new red seedless genotype produced by breeding programs conducted by the Research Centre for Viticulture and Enology of the Council for Agricultural Research and Economics, located in Turi, Italy, and Autumn Royal, a black grape without seeds. Specifically, in human colorectal cancer cell lines, the two grape skin extracts had distinct effects on cell growth [105]. Particularly in the Caco2 cell line, table grape Egnatia has demonstrated a greater capacity to affect cell proliferation and apoptosis in addition to causing a growth arrest during the S phase of the cell cycle [105].

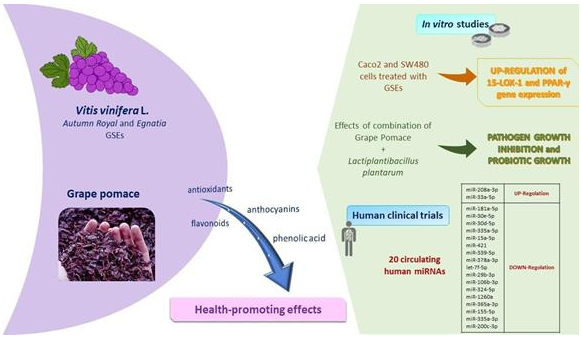

Figure 4. Main features of fruit components: summary of in vitro and in vivo studies performed on Vitis vinifera L. and grape pomace. Abbreviations: 15-LOX-1, 15-lipoxygenase-1; GSEs, grape skin extracts; miRNAs, microRNAs; PPAR-γ, peroxisome proliferator-activated receptor-γ

Due to Autumn Royal's greater antioxidant activity than Egnatia, even at low concentrations, Autumn Royal grape skin extracts strongly inhibited cell migration and altered the morphology of the cultured cells [106]. By promoting and forming polarised lamellipods, altering cytoskeletal structure, and causing distinctive alterations such the decrease of cell cytoplasm and surface microvilli, these extracts controlled cell migration [106].

Furthermore, two polyphenols from grape skin extract impacted the fluidity of cell membranes by altering their PUFA concentration, according to lipidomic examination of cell membranes. These findings showed that the composition of membrane PUFAs and their downstream pathways are involved in the anticancer mechanism of two grape skin extracts in vitro.

Several enzymes control the oxidative metabolism of polyunsaturated fatty acids (PUFAs) during colon cancer development. One of these enzymes, 15-lipoxygenase-1 (15-LOX-1), is essential for promoting antioxidant and antimetastatic effects by activating peroxisome proliferator-activated receptor-γ (PPAR-γ). In vitro research findings demonstrated that extracts from the skins of Autumn Royal and Egnatia grapes affected the expression of the 15-LOX-1 and PPAR-γ genes. Specifically, polyphenols found in grape skin extracts caused a substantial upregulation of PPAR-γ and 15-LOX-1 [104]. To impede the process of colorectal carcinogenesis, these active factors must work together.

Certain flavonoids and non-flavonoids found in grapes can work in concert to offer specific antiproliferative effects on cancer cells, even if the biological effects of grape skin extracts may vary depending on the type of cancer cell.

In addition to fruits, grape pomace also had significant effects that were assessed in our earlier in vitro tests. One important by-product of the winemaking process is grape pomace, which contains phenolic chemicals that are good for human health. We recently assessed the antioxidant properties of extracts digested from grape pomace [107], assessing the probiotic and prebiotic actions in in vitro models. Prior findings shown the ability of bacteria to proliferate while metabolising polyphenols.

According to Caponio et al. [107], there was a positive correlation between the effects of bacteria and the pH change that occurred during gastrointestinal digestion. In fact, the presence of digested grape pomace extracts inhibited both Gram-positive (Bacillus megaterium and Listeria monocytogenes) and Gram-negative (Escherichia coli) bacteria while promoting the growth of a probiotic called Lactobacillus plantarum. Our team is investigating the anticancerogenic properties of digested grape pomace extracts in human colon cancer cell lines in accordance with these findings. According to preliminary, unpublished data, polyphenols in digested grape pomace extracts had dose-dependent effects on cell proliferation beginning at 25 µg/mL and continuing for 24, 48, and 72 hours following treatment. These findings provide insight into an intriguing perspective for the development of functional food components or the creation of dietary supplements utilising these extracts.

Oranges, which are considered to offer health benefits, provide an intriguing substitute for grapes [108]. The polyphenol chemicals naringin and hesperidin, which are abundant in this fruit, are known to obstruct the intestinal absorption of cholesterol [109]. By upregulating the LDL receptor, orange eating on a regular basis lowers blood cholesterol [110]. Two glycosides, naringin and hesperidin, have been shown in vitro to have inhibitory effect against hydroxymethylglutaryl-CoA reductase (HMGCoAR), the primary enzyme involved in the liver's manufacture of cholesterol [111].

Additionally, it has been shown that the whole orange extract can modify serum levels of the enzymes lipase and amylase [113] and alter blood lipid profiles in individuals with metabolic syndrome [112].

The combined effects of naringin and hesperidin on cell growth and proliferation are being assessed in recent studies using liver cancer cell lines. Potential alterations in the metabolism of glucose and lipids in these treated cells will be investigated. Orange polyphenols have been shown in unpublished data to influence the profile of cell membrane fatty acids, indicating an intriguing nutraceutical potential for orange in patients with metabolic disorders. Furthermore, research has shown that Spondias mombin L., a fruiting species of the Anacardiaceae family, has promise bioactive effects in regulating gastrointestinal inflammation because of its role in gastric mucus formation and antioxidant activity [114]. Furthermore, the extract's anti-inflammatory properties were demonstrated in in vivo experiments conducted on rats suffering from oral mucositis. In actuality, Spondias mombin L. hindered leukocyte migration because of its phenolic constituents, particularly ellagic and chlorogenic acid [115].

VIII. FUTURE PERSPECTIVES AND CONCLUSIONS

The development of a nutraceutical tea with antioxidant, antimicrobial, and anticancer properties holds significant promise for improving health and wellness. The combination of various herbal extracts, each contributing unique bioactive compounds, results in a product that addresses multiple health concerns simultaneously. The antioxidant activity of the tea helps mitigate oxidative stress, which is associated with several chronic diseases, including cancer, cardiovascular conditions, and neurodegenerative disorders.

The antimicrobial properties further enhance its potential as a natural remedy for fighting infections, supporting the immune system, and promoting general well-being. Additionally, the anticancer properties of the herbal components, including the ability to inhibit cancer cell proliferation and induce apoptosis, provide a

promising avenue for supporting cancer prevention and treatment strategies.

While the initial findings are encouraging, further research, including clinical trials, is necessary to confirm the efficacy, bioavailability, and safety of the nutraceutical tea in humans. Moreover, optimizing the formulation for consistent quality and ensuring the stability of active compounds are essential steps toward realizing its full therapeutic potential. Overall, this study suggests that nutraceutical teas could serve as an effective, natural adjunct to traditional healthcare, offering multifunctional benefits with minimal side effects.

REFERENCES

1. Akinmoladun, Afolabi Olalekan, et al. "Antioxidant, antimicrobial and anticancer potentials of Chamomile (Matricaria chamomilla): A review." Journal of Pharmaceutical Research International (2015): 52-60.

2. Basu, Abhijit, et al. "Black tea and cardiovascular risk factors: a review of the evidence." Journal of Clinical Medicine 2.2 (2013): 21-34.

3. Binns, Charles W., et al. "Echinacea in the treatment of upper respiratory tract infections: A review of the literature." Journal of Clinical Pharmacology 50.7 (2010): 790-796.

4. Cao, Hong, et al. "Green tea polyphenols and cancer prevention: bioavailability and potential applications." Journal of Clinical Oncology 27.2 (2009): 205-211.

5. Gao, Xin, et al. "Ginger and its medicinal properties." Journal of Clinical Immunology 27.4 (2007): 264-273.

6. Harris, I. S., et al. "Herbal medicine interactions: What clinicians need to know." Journal of Clinical Pharmacology 51.4 (2013): 368-378.

7. Huang, Xin, et al. "Curcumin in cancer therapy: A review." Cancer Cell International 15.1 (2015): 1-8.

8. Mandel, Sharon, et al. "Green tea consumption and the reduction of oxidative stress." Nutrition Research Reviews 18.1 (2005): 1-17.

9. Moussa, Huda, et al. "Apigenin inhibits breast cancer cell growth through induction of apoptosis." Phytotherapy Research 26.6 (2012): 820-827.

10. Nazzaro, Felice, et al. "Thyme and its antimicrobial properties." Current Research in Medicinal Chemistry 17.5 (2013): 440-451.

11. Venkatesan, R., et al. "Synergistic effects of green tea, ginger, and turmeric in chronic diseases: A review." Antioxidants 7.6 (2018): 72-82.

12. Zhang, Xinyuan, et al. "Bioactive components of hibiscus (Hibiscus sabdariffa L.) tea and their health-promoting properties." Food Research International 74 (2015): 109-117.