Recent Advances Regarding the Phytochemical and Therapeutic Uses of Ribes Nigrum Leaves

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Oana Coman[1#], Cristina Ana-Maria Cobzariu Dan[1#], Mihaela Boţa[2*], Lavinia Vlaia[2], Diana- Simona Tchiakpe-Antal[3,4,5], Ioana Ioniţă[6,7], Iasmina Predescu[3,5], Andreea Smeu[3,5]

[1]*Doctoral School, "Victor Babeş" Unsiversity of Medicine and Pharmacy, 30041 Timişoara, Romania,*
[2]*Department II-Pharmaceutical Technology, Faculty of Pharmacy, "Victor Babeş" University of Medicine and Pharmacy, 2nd Eftimie Murgu Square, RO-300041 Timisoara, Romania,*
[3]*Faculty of Pharmacy, "Victor Babes," University of Medicine and Pharmacy, 2nd Eftimie Murgu Square, 300041, Timisoara, Romania,*
[4]*Department of Pharmaceutical Botany, Faculty of Pharmacy, "Victor Babes" University of Medicine and Pharmacy Timisoara, 2nd Eftimie Murgu Square, 300041 Timisoara, Romania,*
[5]*Research Center for Pharmacotoxicologic Evaluations (FARMTOX), "Victor Babes" University of Medicine and Pharmacy Timisoara, 2nd Eftimie Murgu Square, 300041 Timisoara, Romania,*
[6]*First Department of Internal Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania,*
[7]*Department of Hematology, Emergency Municipal Hospital Timisoara, 300041 Timisoara, Romania.*
[#]*Authors with equal contribution*

Correspondence to:
Name: Mihaela Bota
E-mail address: mihaela.rif18@gmail.com

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Abstract

1.Background/Objectives: This review examines the phytochemical composition and therapeutic effects of Ribes nigrum (blackcurrant). Rich in anthocyanins, flavonoids, polyphenols, and essential fatty acids, it exhibits antioxidant, anti-inflammatory, antimicrobial, and cardioprotective properties, highlighting its medical potential. 2. Methods: A systematic analysis of recent in vitro, in vivo, and clinical studies was conducted to evaluate its pharmacological effects. The review focuses on its role in inflammation reduction, oxidative stress prevention, metabolic regulation, anticancer activity, and antimicrobial defense. Extraction methods and key bioactive compounds were also assessed. 3. Results: Ribes nigrum demonstrates strong anti-inflammatory effects by inhibiting pro-inflammatory cytokines and enzymes. Its antioxidant properties help reduces oxidative stress. Metabolic benefits include cholesterol regulation, improved glucose metabolism, and cardiovascular protection. Studies suggest its potential anticancer effects through apoptosis induction in cancer cells. Additionally, its antimicrobial and antiviral properties support its use in treating infections and maintaining oral health. 4. Conclusion: The findings confirm Ribes nigrum's therapeutic value, supporting its traditional medicinal applications and future pharmaceutical development. Further research is needed to explore its long-term clinical benefits, optimize extraction methods, and develop standardized medicinal formulations.

Keywords: Ribes nigrum, natural compound, blackcurrant, antioxidant, therapeutic effects

INTRODUCTION

Blackcurrant (Ribes nigrum L., Grossulariaceae) is native to Central Europe and North Asia and is found worldwide, including the United States. Recently, researchers have demonstrated various significant pharmacological effects for global health, including anti-inflammatory, antioxidant, and antimicrobial effects. The medical and pharmaceutical properties of blackcurrant are conferred by its constituents, especially delphinidin-3-O-glucoside, delphinidin-3-O-rutinoside, cyanidin-3-O-glucoside, and cyanidin-3-O-rutinoside, as well as flavonols and phenolic acids. Many studies in the specialized literature have been the subject of research on the impact of this natural compound in the medical field [1].

Berries are compounds with nutritional advantages due to their high content of vitamins, minerals, and compounds with antioxidant action. Among them, blackcurrants (Ribes nigrum L.) are appreciated not only for their fruits but also for their leaves. Several publications have reported on blackcurrant leaves, which, due to their rich polyphenol content, are more effective than berries in reducing inflammation and exhibiting antioxidant effects. Other mentions have brought to light the antimicrobial and antiviral effects, equally important for human health [2, 3]. R. nigrum is considered a "super-plant" due to its numerous therapeutic benefits, which are attributed to the phytocompounds it contains. Recent research has demonstrated their ability to treat chronic diseases associated with oxidative stress. The main classes of bioactive compounds in R. nigrum are: phenolic acids, flavonoids, and proanthocyanidins [3]. A group of researchers applied the thin-layer chromatographic method for the quantitative determination of bioactive compounds, including the presence of proanthocyanidins and prodelphinidins [4,5]. Blackcurrant juice and extract, rich in anthocyanins and polyphenolic compounds with anti-inflammatory, antioxidant, and cardioprotective effects, have been demonstrated to exhibit immunostimulatory effects in recent clinical research [6].

Given the multiple phytotherapeutic uses of Ribes nigrum leaves, this review provides an updated perspective on the active compounds and their pharmacological mechanisms, highlighting potential therapeutic applications and future research directions. Figure 1 was created for an overview of the biological properties observed in research on Ribes nigrum L. extracts.

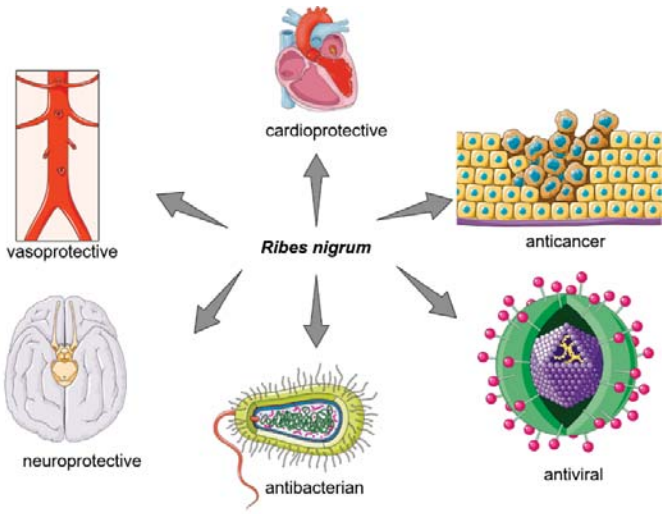

Figure 1. General presentation of the biological properties observed in specialized studies for Ribes nigrum L. The figure was made using SMART-SERVIER

GENERAL ASPECTS OF THE PHYTOCHEMICAL COMPOSITION OF RIBES NIGRUM L.

R. nigrum has been used since ancient times as a traditional botanical medicine in various cardiovascular pathologies, hypertension, and hepatitis due to its high content of anthocyanidins, flavonoids (which give the fruit its intense black color), and polysaccharides [1]. The fruits of the plant have a vitaminizing, remineralizing action, being recommended in cases of overwork, convalescence, anemic states, and iron deficiency, having positive effects on sports performance by reducing free radicals that cause fatigue [2, 3]. Equally important are studies demonstrating improved cognitive performance [4]. In the composition of the R. nigrum species, a large amount of vitamin C was also identified, 3-4 times higher concentration than in oranges, which contributes to support the immune system, maintains the health of bones, teeth, cartilage, blood vessel walls and plays a role in protecting cells from oxidative stress, fatty acids have also been identified, including linoleic acid (omega 6), a polyunsaturated acid with a role in maintaining optimal cell function, gamma-linolenic acid (GLA), a derivative of linoleic acid, with anti-inflammatory role and α-linoleic acid (omega 3), a well-known cardiovascular and neuroprotective [5].

Volatile compounds with anti-inflammatory, antimicrobial, antifungal, and respiratory tract decongestant properties have been detected in R. nigrum leaves. The most important aromatic compounds identified were α-pinene (a monoterpene responsible for the pine odor, with anti-inflammatory and antioxidant properties), linalool, β-pinene (with an anti-inflammatory effect), and limonene (responsible for the citrus odor, with an antimicrobial effect [11]. A 2015 study by Sasaki, based on a phytochemical analysis of R. nigrum leaves, identified lignoid compounds. Out of the 8 lignoids isolated, 6 exhibited antioxidant activity [6]. Another group of researchers identified phenolic acids (p-coumaric acid, caffeic acid, ferulic acid, gallic acid, ellagic acid, p-coumaric acid, caffeic acid, ferulic acid, gallic acid, ellagic acid) by methanolic acetic acid extraction using the HPLC technique [7]. Because evaluation of extracts and active compounds has been and is a topical subject, another paper regarding the chemical composition of plant products identifies the main flavonoids and phenolic acids in R. nigrum leaves: quercetin (the main compound), isoquercetin, campherol, myricetin, myricetin, isoramnetin, quercetol, with multiple therapeutic properties, among which we mention the antioxidant, anti-free radicals, reacting with superoxide anions [8].

Aim of the study

This study aims to discuss the phytochemical composition and biological effects of Ribes nigrum leaves, highlighting their potential therapeutic applications.

MATERIAL AND METHODS

This review was conducted through a systematic analysis of scientific literature on Ribes nigrum, focusing on its phytochemical composition and pharmacological properties. Relevant studies, including in vitro, in vivo, and clinical research, were collected from reputable scientific databases such as PubMed, Scopus, ScienceDirect, and Google Scholar. The selection criteria prioritized peer-reviewed articles that explored the anti-inflammatory, antioxidant, metabolic, anticancer, antimicrobial, and dermatological effects of R. nigrum. The searching was carried out using the following terms or combinations: Ribes nigrum, natural compound, blackcurrant, antioxidant, therapeutic effects.

RESULTS

Anti-inflammatory effect

Anti-inflammatory properties have been demonstrated in numerous studies by the inhibition of enzymes and molecules involved in inflammatory processes, such as cyclooxygenase (COX) and pro-inflammatory cytokines (TNF-α, IL-1, and IL-6). In this sense, a study showed reduced levels of these genes in ovariectomized (OVX) rats fed a regular diet or a diet supplemented with 3% blackcurrant extract (CaNZac-35), compared to the group fed a regular diet for three months [9]. Another study by Garbacki, N. studied the anti-inflammatory effects of proanthocyanidins from Ribes nigrum L. were evaluated using carrageenan-induced paw edema and carrageenan-induced pleurisy in laboratory rats, and the results indicated that pretreatment with proanthocyanidins reduced carrageenan-induced paw edema in a dose- and time-dependent manner and also proanthocyanidins inhibited carrageenan-induced pleurisy in a concentration-dependent manner [10]. Due to the rich content of fatty acids, with a role in reducing inflammation and relieving muscle and joint pain, it was concluded that the anti-inflammatory activity is similar to that of indomethacin/niflumic acid [11]. It has been shown that an extract of R. nigrum, under the trade name of "Currantex 30" reduces inflammation of stimulated human pulmonary epithelial cells and suppresses secretion of CCL11, a chemokine responsible for triggering allergic asthma [12]. Another paper indicates the beneficial effects for the inflammated respiratory tract, the study being carried out using 4 concentrated macerates, extracted with alcohol-glycerol-water solution in equal parts, from different plants, including R. nigrum, of which 5-15 drops/day were administered [13].

Anti-oxidant effect

Numerous studies have been performed that have highlighted the antioxidant potential of R. nigrum [14,15]. Free radicals, caused by radiation, environmental pollution, smoking, and chemicals, can damage cells and accelerate the aging process, as well as contribute to the development of chronic diseases. In a in vivo study, R. nigrum extract was shown to reduce inflammation and improve the activity of antioxidant enzymes such as superoxide dismutase (SOD) and catalase [16]. Above all, the compounds in blackcurrant fruits and leaves are recognized for their preventive and therapeutic properties, with HPLC analyses demonstrating that they comprise various polyphenols and anthocyanins that serve antioxidant activity. [16]

Metabolic activity

In addition to its anti-inflammatory and antioxidant properties, blackcurrant may help improve the immune system, protect cardiovascular health, and improve eye health [5,9,17]. In vivo metabolic activity in laboratory animals showed a decrease in body mass, a hypotensive and cardiodepressant effect on blood pressure, and a hypoglycemic effect by lowering postprandial glycemia [18]. A recent study evaluates the effects on cellular CaCo-2 gene proteins and shows increased cholesterol transport through enterocytes, with a hypocholesterolemic role [18,19].

Blackcurrant extract has been shown to have a vasculoprotective effect on blood vessels on laboratory animals included in a study [17]. Investigations indicated that Ribes nigrum may improve endothelial function and reduce the risk of cardiovascular disease. Anthocyanins and other bioactive substances in R. nigrum have been associated with lower blood pressure and improved blood circulation [20]. Another group of researchers has shown an in vitro hypoglycemic effect. In this regard, it has been mentioned that berries have beneficial effects on postprandial glucose metabolism that have been linked to the presence of polyphenolic compounds derived from berries [21].

Anti-cancer effects

Bishayee et al. studied the induction of apoptosis and/or inhibition of proliferation in different types of cancer, demonstrating the antitumor effect of R. nigrum extract on hepatocellular carcinoma cells [22]. Also, numerous studies on R. nigrum extracts have demonstrated significant antitumor activity, suggesting their future use as adjuvants in the treatment of cancers for increased efficacy and reduced side effects [23]. Using a 45% (v/v) ethanolic solution on mice, another work showed that after administration of black currant extract, the development of Ehlich carcinoma was delayed by 45% [22,23]. Valuable information was also evidenced on gastric cancer, where black currant extract demonstrated anticancer potential by the potential to induce apoptosis, programmed cell death [23].

Activities on the skin and mucous membranes

The components of the terpene family, including terpinen-4-ol, terpinolenol, spatulenol, and caryophyllene oxide, are primarily found in blackcurrant extracts. These volatile compounds are responsible for the anti-inflammatory effect on the mucous membranes of the respiratory tract and have beneficial effects in conditions such as rhinitis, rhinopharyngitis, colds, sinusitis, and bronchitis [24].

The anti-inflammatory effects of these compounds could also be relevant in inflammation induced by external factors such as UV radiation, which causes inflammation of the epidermis and stimulates the production of inflammatory cytokines. In one study, CAPS administration (0.2% and 1% R. nigrum powder, respectively) reduced UV-induced skin dehydration and prevented atopic dermatitis in NC/Nga mice [25]. Kendir Gon et al. used male albino mice and rats as experimental models, and they focused on investigating the effect of administering 1% R. nigrum extract added to Fitocream ointment for 15 days, demonstrating a beneficial effect on wound healing [26]. In vitro, due to its high content of vitamin A, β-carotene, and zeaxanthin, R. nigrum maintains the health and integrity of mucous membranes and is successfully used in ophthalmologic disorders [27]. It also increases levels of collagen, elastin, and hyaluronic acid in the skin, having an anti-aging effect [28]. A recent in vitro study on fibroblasts (BJ cells) and normal human keratinocytes (HaCaT) demonstrates the beneficial role of R. nigrum extract on the skin by inhibiting collagen degradation. It also has a beneficial effect on the respiratory tract mucosa and has been successfully used in the treatment of viral and bacterial infections of the upper respiratory tract. A recent in vitro study on fibroblasts (BJ cells) and normal human keratinocytes (HaCaT) demonstrates the beneficial role of R. nigrum extract on the skin by inhibiting collagen degradation [29].

Antimicrobial and antiviral activity

Extracts of R. nigrum have demonstrated antimicrobial effects against pathogenic bacteria such as Staphylococcus aureus and Escherichia coli, thus suggesting its potential use in treatments for mild infections or as an adjunct in oral hygiene. As a major result, the bactericidal effect of blackcurrant juice against bacteria responsible for the development of caries, periodontosis, and endodontic infections was discovered, thus demonstrating its efficacy also for the dental sphere [30].

Concerning antiviral functions, a group of researchers have studied antiviral activity using mice as an experimental model, administered an aqueous extract 10 mg/ml (LADANIA 067), and observed dose-dependent reduction in virus titers (anti-influenza virus) [26]. In vitro results of a studie highlighted antibacterial and antiviral activity against a broad spectrum of common germs. Antiviral activity has also been demonstrated in herpes virus infectious diseases by inhibition of herpes virus replication in cells due to inhibition of protein synthesis [31, 32]. In complementary, 9 out of 10 extracts of blackcurrant studied had an antibacterial effect against the bacterium Listeria monocytogenes [31, 32].

CONCLUSIONS

In conclusion to this comprehensive overview of Ribes nigrum leaves, these botanical compounds demonstrate a wide range of biological effects, including cardioprotective, antioxidant, anti-inflammatory, antidiabetic, and antibacterial properties, which lead to further advanced studies on the mechanisms underlying these actions. As future research directions, in vitro studies on various cancer cell lines could also provide discoveries in the oncological field.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Sun Q, Wang N, Xu W, Zhou H. Genus Ribes Linn. (Grossulariaceae): A comprehensive review of traditional uses, phytochemistry, pharmacology and clinical applications. J Ethnopharmacol. 2021;276:114166.

[2] Schrage B, Stevenson D, Wells RW, Lyall K, Holmes S, Deng D, et al. Evaluating the health benefits of fruits for physical fitness: A research platform. J Berry Res. 2010;1:35–44.

[3] Braakhuis AJ, Hopkins WG, Lowe TE. Effects of dietary antioxidants on training and performance in female runners. Eur J Sport Sci. 2014;14:160–8.

[4] Watson AW, Haskell-Ramsay CF, Kennedy DO, Cooney JM, Trower T, Scheepens A. Acute supplementation with blackcurrant extracts modulates cognitive functioning and inhibits monoamine oxidase-B in healthy young adults. J Funct Foods. 2015;17:524–39.

[5] Ejaz A, Waliat S, Afzaal M, Saeed F, Ahmad A, Din A, et al. Biological activities, therapeutic potential, and pharmacological aspects of blackcurrants (Ribes nigrum L): A comprehensive review. Food Sci Nutr. 2023;11:5799–817.

[6] Enkhtuya E, Kashiwagi T, Shimamura T, Ukeda H, Tseye-Oidov O. Screening Study on Antioxidant Activity of Plants Grown Wildly in Mongolia. Food Sci Technol Res. 2014;20:891–7.

[7] Mattila P, Hellström J, Törrönen R. Phenolic Acids in Berries, Fruits, and Beverages. J Agric Food Chem. 2006;54:7193–9.

[8] Törrönen R, Häkkinen S, Kärenlampi S, Mykkänen H. Flavonoids and phenolic acids in selected berries. Cancer Lett. 1997;114:191–2.

[9] Nanashima N, Horie K, Yamanouchi K, Tomisawa T, Kitajima M, Oey I, et al. Blackcurrant (Ribes nigrum) Extract Prevents Dyslipidemia and Hepatic Steatosis in Ovariectomized Rats. Nutrients. 2020;12:1541.

[10] Garbacki N, Tits M, Angenot L, Damas J. Inhibitory effects of proanthocyanidins from Ribes nigrum leaves on carrageenin acute inflammatory reactions induced in rats. BMC Pharmacol. 2004;4:25.

[11] Declume C. Anti-inflammatory evaluation op a hydroalcoholic extract op black currant leaves (Ribes nigrum). J Ethnopharmacol. 1989;27:91–8.

[12] Shaw OM, Nyanhanda T, McGhie TK, Harper JL, Hurst RD. Blackcurrant anthocyanins modulate CCL11 secretion and suppress allergic airway inflammation. Mol Nutr Food Res. 2017;61:1600868.

[13] Di Vito M, Gentile M, Mattarelli P, Barbanti L, Micheli L, Mazzuca C, et al. Phytocomplex Influences Antimicrobial and Health Properties of Concentrated Glycerine Macerates. Antibiotics. 2020;9:858.

[14] Xu Y, Niu X, Liu N, Gao Y, Wang L, Xu G, et al. Characterization, antioxidant and hypoglycemic activities of degraded polysaccharides from blackcurrant (Ribes nigrum L.) fruits. Food Chem. 2018;243:26–35.

[15] Raudsepp P, Koskar J, Anton D, Meremäe K, Kapp K, Laurson P, et al. Antibacterial and antioxidative properties of different parts of garden rhubarb, blackcurrant, chokeberry and blue honeysuckle. J Sci Food Agric. 2019;99:2311–20.

[16] Bonarska-Kujawa D, Cyboran S, Żyłka R, Oszmiański J, Kleszczyńska H. Biological Activity of Blackcurrant Extracts (Ribes nigrum L.) in Relation to Erythrocyte Membranes. Biomed Res Int. 2014;2014:1–13.
[17] Horie K, Maeda H, Nanashima N, Oey I. Potential Vasculoprotective Effects of Blackcurrant (Ribes nigrum) Extract in Diabetic KK-Ay Mice. Molecules. 2021;26:6459.
[18] Esposito D, Damsud T, Wilson M, Grace MH, Strauch R, Li X, et al. Black Currant Anthocyanins Attenuate Weight Gain and Improve Glucose Metabolism in Diet-Induced Obese Mice with Intact, but Not Disrupted, Gut Microbiome. J Agric Food Chem. 2015;63:6172–80.
[19] Kim B, Bae M, Park Y-K, Ma H, Yuan T, Seeram NP, et al. Blackcurrant anthocyanins stimulated cholesterol transport via post-transcriptional induction of LDL receptor in Caco-2 cells. Eur J Nutr. 2018;57:405–15.
[20] Miladinovic B, Brankovic S, Kostic M, Milutinovic M, Kitic N, Šavikin K, et al. Antispasmodic Effect of Blackcurrant (<i>Ribes nigrum</i> L.) Juice and Its Potential Use as Functional Food in Gastrointestinal Disorders. Medical Principles and Practice. 2018;27:179–85.
[21] Lappi J, Raninen K, Väkeväinen K, Kårlund A, Törrönen R, Kolehmainen M. Blackcurrant (Ribes nigrum) lowers sugar-induced postprandial glycaemia independently and in a product with fermented quinoa: a randomised crossover trial. Br J Nutr. 2021;126:708–17.
[22] Bishayee A, Mbimba T, Thoppil RJ, Háznagy-Radnai E, Sipos P, Darvesh AS, et al. Anthocyanin-rich black currant (Ribes nigrum L.) extract affords chemoprevention against diethylnitrosamine-induced hepatocellular carcinogenesis in rats. J Nutr Biochem. 2011;22:1035–46.
[23] Jia N, Xiong YL, Kong B, Liu Q, Xia X. Radical scavenging activity of black currant (Ribes nigrum L.) extract and its inhibitory effect on gastric cancer cell proliferation via induction of apoptosis. J Funct Foods. 2012;4:382–90.
[24] ASHIGAI H, KOMANO Y, WANG G, KAWACHI Y, SUNAGA K, YAMAMOTO R, et al. Effect of administrating polysaccharide from black currant (<i>Ribes nigrum</i> L.) on atopic dermatitis in NC/Nga mice. Biosci Microbiota Food Health. 2018;37:19–24.
[25] ASHIGAI H, KOMANO Y, WANG G, KAWACHI Y, SUNAGA K, YAMAMOTO R, et al. Effect of administrating polysaccharide from black currant (<i>Ribes nigrum</i> L.) on atopic dermatitis in NC/Nga mice. Biosci Microbiota Food Health. 2018;37:19–24.
[26] Kendir G, Süntar I, Çeribaşı AO, Köroğlu A. Activity evaluation on Ribes species, traditionally used to speed up healing of wounds: With special focus on Ribes nigrum. J Ethnopharmacol. 2019;237:141–8.
[27] Matsumoto H, Nakamura Y, Iida H, Ito K, Ohguro H. Comparative assessment of distribution of blackcurrant anthocyanins in rabbit and rat ocular tissues. Exp Eye Res. 2006;83:348–56.
[28] Nanashima N, Horie K, Maeda H, Tomisawa T, Kitajima M, Nakamura T. Blackcurrant Anthocyanins Increase the Levels of Collagen, Elastin, and Hyaluronic Acid in Human Skin Fibroblasts and Ovariectomized Rats. Nutrients. 2018;10:495.
[29] Ziemlewska A, Zagórska-Dziok M, Nizioł-Łukaszewska Z. Assessment of cytotoxicity and antioxidant properties of berry leaves as by-products with potential application in cosmetic and pharmaceutical products. Sci Rep. 2021;11:3240.
[30] Kranz S, Guellmar A, Olschowsky P, Tonndorf-Martini S, Heyder M, Pfister W, et al. Antimicrobial Effect of Natural Berry Juices on Common Oral Pathogenic Bacteria. Antibiotics. 2020;9:533.
[31] Raudsepp P, Koskar J, Anton D, Meremäe K, Kapp K, Laurson P, et al. Antibacterial and antioxidative properties of different parts of garden rhubarb, blackcurrant, chokeberry and blue honeysuckle. J Sci Food Agric. 2019;99:2311–20.
[32] Suzutani T, Ogasawara M, Yoshida I, Azuma M, Knox YM. Anti-herpesvirus activity of an extract of Ribes nigrum L. Phytotherapy Research. 2003;17:609–13.