Journal of
Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2026-228

Review Article

Open Access

Capuli and Potential Benefits: A Brief Review Focused on Characteristics and Active Properties

Gabriela López Coronado[1] and Cristian Patiño Vidal[1,2*]

[1]Faculty of Engineering, Safety and Resources, Valorization Research Group (INVAGRO), National University of Chimborazo, Riobamba, Ecuador
[2]Group for Research and Innovation in Food Packaging, Riobamba, Ecuador

***Correspondence to:**
Cristian Patiño Vidal
Faculty of Engineering, Safety and Resources,
Valorization Research Group (INVAGRO),
National University of Chimborazo,
Riobamba, Ecuador.

Group for Research and Innovation in
Food Packaging,
Riobamba, Ecuador.
E-mail: cristian.patino@unach.edu.ec

Received: May 18, 2026
Accepted: June 15, 2026
Published: June 18, 2026

Citation: Coronado GL, Vidal CP. 2026. Capuli and Potential Benefits: A Brief Review Focused on Characteristics and Active Properties. *J Food Chem Nanotechnol* 12(2): 49-55.

Copyright: © 2026 Coronado and Vidal. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY) (http://creativecommons.org/licenses/by/4.0/) which permits commercial use, including reproduction, adaptation, and distribution of the article provided the original author and source are credited.

Published by USG United Scientific Group

Abstract

Capuli (*Prunus serotina*) is a native fruit found in several provinces of Ecuador whose scientific interest has been associated with its nutraceutical potential and abundance of bioactive compounds. This article provides a brief review of capuli and its benefits, highlighting its bioactive properties and potential industrial applications. Capuli has been identified as a complex food matrix whose chemical composition exhibits remarkable antioxidant and antimicrobial properties. Active compounds have been extracted from the pulp, leaves, seeds, and peel using ethanol (EtOH), and their antioxidant properties have primarily been evaluated using 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) ($ABTS^{+\bullet}$), 2,2-diphenyl-1-picrylhydrazyl (DPPH•), and ferric reducing antioxidant power (FRAP) assays. Regarding the antimicrobial activity of capuli, only a limited number of studies have evaluated its antimicrobial activity against Gram-positive and Gram-negative bacteria. The industrial exploitation of capuli-derived active compounds such as natural pigments, dietary supplements, antimicrobial additives, and bioinsecticides has also been insufficiently investigated. The review revealed a limited number of studies employing the FRAP assay, and the antioxidant compounds of capuli have not yet been evaluated in real-world applications. However, challenges associated with extraction optimization, the stability of active compounds, and toxicological assessment continue to limit its large-scale industrial utilization and require further scientific investigation.

Keywords

Bioactive compounds, Antioxidants, Antimicrobial activity, Food applications

Introduction

The increasing global demand for functional foods, natural bioactive compounds, and sustainable sources of health-promoting ingredients has intensified scientific interest in underutilized fruits with high nutraceutical potential, such as capuli. Capuli (*P. serotina*) is a fruit belonging to the *Rosaceae* family. It is a natural resource of considerable importance in countries such as Ecuador, Peru, and Bolivia [1]. In Chimborazo Province, Ecuador, capuli represents a local resource with significant industrial potential [2]. Capuli can be transformed into raisins, jams, and juices using different processing technologies to obtain value-added food products with improved nutritional and quality attributes [2]. Traditional knowledge has supported the use of capuli in medicinal treatments for coughs, respiratory disorders, and diarrhea [2]. For instance, its bark has been used as a tonic to treat influenza, colds, and bronchopulmonary diseases, while fruit juice combined with the bark has been reported to improve respiratory conditions [2, 3].

Capuli fruit is characterized by a complex chemical composition that includes

carbohydrates, dietary fiber, organic acids, vitamins, minerals, among other constituents [1, 2]. In addition, other plant parts are rich in antioxidant and antimicrobial compounds. The main bioactive compounds include anthocyanins, phenolic compounds, and flavonoids [1, 4].

Several studies have reported high levels of flavonoids and anthocyanins in capuli, and these compounds are considered responsible for their strong antioxidant activity [1, 5]. Antioxidant activity has been evaluated using standardized methods, primarily based on the inhibition of ABTS+• and DPPH• radicals and the FRAP assay [6, 7]. On the other hand, research has demonstrated the ability of capuli extracts to inhibit the growth of both Gram-negative and Gram-positive bacteria [1]. Although only a few studies have been conducted, the antimicrobial efficacy of capuli has been attributed to the synergistic action of its bioactive compounds, which are capable of disrupting microbial cell membranes, altering enzymatic activity, and interfering with essential metabolic pathways [8].

Capuli has been scarcely utilized in the food industry for the development of functional foods. Its fruit is a potential source of antioxidant compounds that can be incorporated into beverages, nutraceutical products, natural colorants, edible coatings, and dietary supplements [9, 10]. This interest is primarily associated with the reported ability of its bioactive compounds to strengthen the immune system, reduce the risk of cardiovascular diseases, and slow the aging process [11, 12]. A recent study highlighted the potential industrial application of capuli seeds, husk, pulp, and oil as sources of antioxidant compounds for the production of functional foods, natural preservatives, and nutritional supplements [13]. Another study evaluated fruits of the *Prunus* genus as potential sources of phenolic compounds, flavonoids, and anthocyanins with antioxidants, anti-inflammatory, and antidiabetic properties. The study highlighted the use of these metabolites in the development of functional supplements, natural therapeutic products, and preventive compounds against chronic diseases associated with oxidative stress and metabolic syndrome [14]. In addition, extracts from capuli leaves and flowers have been proposed as ingredients for the cosmetic, pharmaceutical, and food industries [10]. However, limitations related to extraction technology optimization, compound stability during processing and storage, bioavailability, and toxicological evaluation still remain.

The aim of this review is to comprehensively discuss the chemical composition of capuli, with emphasis on its antioxidant and antimicrobial properties. The review analyzes the most recent research on these topics, with a focus on the methodologies applied. Additionally, the current and potential industrial applications of capuli-derived compounds in the food and pharmaceutical industries are briefly discussed.

Capuli

Characteristics, types, and production

Capuli is a tree belonging to the Rosaceae family, and its species is *P. serotina* [1]. *P. serotina* is a native species of Central and South America and is divided into five subspecies [15, 16]. Capuli is characterized by simple, lanceolate leaves attached to the branches by short petioles. The flowers are clustered in small white racemes, and the fruits are drupes that are initially green and become black or reddish upon ripening. Furthermore, the fruits contain a single seed surrounded by the endocarp and are considered a highly nutritious food source [15-17]. The capuli fruit, also known as black cherry, is characterized as a globular drupe composed of a thin peel and green pulp. The fruit diameter ranges from 12 to 20 mm, and its taste is characterized as sweet to sour [4, 18]. Capuli is a seasonal fruit that is highly available in Ecuadorian markets from December to February, and it can be consumed fresh or processed into products such as wine, jam, and canned products [18, 19].

In Ecuador, capuli is commonly incorporated into various agroforestry systems. This species has a notable presence in family gardens and rural plots. Capuli is geographically distributed across the provinces of Carchi, Imbabura, Pichincha, Cotopaxi, Tungurahua, Chimborazo, Cañar, and Azuay. Capuli grows optimally at elevations between 1,800 and 3,500 meters above sea level. At these altitudes, capuli fulfills two key functions: it serves as a locally important seasonal fruit and is used as a living boundary for agricultural land and residential properties [1, 16].

Chemical composition

Capuli contains various metabolites that can be extracted from its roots, stems, leaves, and fruits, as shown in figure 1. The main metabolites extracted from capuli are phenolic compounds and tannins, which exhibit high antioxidant activity [1, 17]. In the case of the stem, its bark has been widely used to prepare teas and syrups with antioxidant properties [1, 17]. Recent studies have reported significant concentrations of phenolic compounds and procyanidins. These metabolites are directly involved in scavenging free radicals and mitigating reactive oxygen species (ROS). Consequently, these metabolites represent valuable ingredients for the development of functional foods [1].

Capuli leaves contain bioactive compounds such as flavonoids, tannins, and polyphenols. These compounds have been quantitatively determined through spectrophotometric analyses, and their antioxidant activity has been evaluated using electrochemical and spectrophotometric assays [20]. Other identified compounds include luteolin-7-O-glucoside, caffeic acid, and chlorogenic acid [21].

On the other hand, capuli fruit is rich in antioxidant

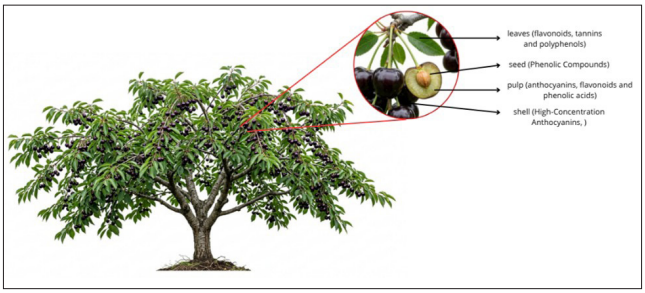


Figure 1: Schematic representation of capuli and main active compounds to be extracted.

compounds such as anthocyanins, flavonoids, and phenolic acids. These bioactive compounds have primarily been studied using spectrophotometric methods based on free-radical inhibition assays [22]. Furthermore, the fruit peel has also been analyzed, and compounds such as ferulic acid and other phenolic acids have been identified. These compounds contribute to fruit coloration, inhibition of microbial growth, and the protection of foods highly susceptible to lipid oxidation [1, 17]. A study reported the excellent antioxidant capacity of capuli peel, pulp, and seed oil, which was associated with their phenolic content. The authors suggested the use of these compounds as functional ingredients or natural food additives to slow lipid oxidation and replace synthetic antioxidants [13]. Other studies have shown that natural antioxidants extracted from fruits can be incorporated into food-packaging materials to reduce rancidity and extend the shelf life of foods such as oils, meats, and minimally processed fruits. Thus, antioxidant compounds extracted from capuli may potentially be used to develop active food-packaging materials capable of preventing oxidative deterioration and maintaining the nutritional and sensory quality of foods [23, 24].

Active properties

Bioactive compounds are generally molecules or mixtures of compounds that exhibit notable biological activity. These compounds can influence nutritional, physiological, pharmacological, and toxicological processes in living organisms [25, 26]. Bioactive compounds are generally plant-derived chemicals, including flavonoids, carotenoids, phenolic acids, and glucosinolates, among others, that are capable of triggering specific physiological responses in the human body [25, 27]. These compounds have been widely used in the development of functional foods because of their health benefits and their ability to enhance the nutritional value of food products [28].

Antioxidant properties

Antioxidants are defined as substances capable of slowing down or preventing oxidative processes, even when present at very low concentrations [29]. These molecules are mainly derived from biological sources, including plants, animals, and microorganisms [26].

According to their mechanism of action, antioxidants can be classified into two main groups. The first group comprises tocopherols, flavonoids, and other phenolic compounds. These compounds are able to act directly as free-radical scavengers through the transfer of hydrogen atoms or electrons to free radicals. This mechanism stabilizes free radicals and effectively interrupts the chain reaction involved in oxidative processes [10]. In contrast, the second group consists of compounds whose primary function is to prevent the formation of free radicals or accelerate the decomposition of reactive species [26]. This group includes enzymatic antioxidants such as superoxide dismutase, catalase, and glutathione peroxidase [30]. Their main function is to prevent the formation of free radicals by converting ROS into less harmful molecules before cellular damage occurs.

Tocopherols, flavonoids, and other phenolic compounds are among the main antioxidant compounds. Tocopherols are natural antioxidants capable of preventing lipid oxidation in food matrices such as vegetable oils and processed fatty products [31]. Flavonoids belong to a family of phenolic compounds, and their antioxidant activity is primarily associated with the neutralization of ROS through several mechanisms, including: (i) donation of electrons or hydrogen atoms, (ii) stimulation of antioxidant enzyme activity, and (iii) chelation of transition metal ions [32]. In addition, gallic, caffeic, ferulic, p-coumaric, and protocatechuic acids can also be found and contribute to antioxidant capacity [33].

Capuli exhibits high antioxidant capacity, which is mainly associated with its flavonoid content. Several studies have reported values ranging from 400 and 500 mg trolox equivalents (TE)/g of sample, which are higher than those reported for grapes, blackberries, and guava [4, 18]. These values have been determined using different free-radical inhibition and reduction assays. These methodologies are described below.

Free-radical Inhibition Methods

Table 1 summarizes studies focused on the evaluation of the antioxidant capacity of capuli. The pulp, peel, and leaves have been the most extensively studied plant parts due to their chemical composition. The methodologies employed have primarily included ABTS+• and DPPH• radical inhibition assays.

The ABTS assay measures the ability of a sample to neutralize the ABTS+• cation radical generated by the oxidation of ABTS with potassium persulfate. This oxidation reaction produces a blue-green solution with a maximum absorbance at 734 nm. Thus, the antioxidant capacity of a sample is quantified based on its ability to decolorize this solution [34]. This method is widely used because it can measure the antioxidant activity of both hydrophilic and lipophilic compounds. According to the literature, EtOH has been widely preferred as an extraction solvent for bioactive compounds [35, 36]. This preference has been mainly attributed to its ability to extract a wide range of bioactive compounds [37].

Another commonly used method for evaluating antioxidant activity is the DPPH• radical inhibition assay (Table 1). DPPH• radicals are synthetic nitrogen-containing compounds characterized by an intense purple color and a maximum absorbance at 517 nm. This assay is also based on the decolorization of the DPPH• solution in the presence of antioxidants and is commonly expressed as the IC_{50} value, representing the concentration required to inhibit 50% of DPPH• radicals. Similar to the ABTS assay, DPPH results may also be expressed as TE per unit volume or gram of sample. The DPPH assay is widely used because of its simplicity, low cost, and applicability to different types of extracts (aqueous or alcoholic). However, the assay generally exhibits better performance with organic solvents such as methanol (MeOH) or EtOH, which may result in more reliable measurements [35]. As shown in table 1, the experimental conditions generally included the preparation of a DPPH• stock solution (0.1 - 0.5 mM) in 80 - 100% (v/v) EtOH. These solutions were mixed with extract volumes ranging from 0.005 to 200

Table 1: Research based on the antioxidant evaluation of capuli.

Part of plant	Antioxidant assay	Experimental conditions	Main findings	Ref.
Pulp	DPPH	Extract volume: 0.01 mL Solvent: EtOH Resting time: 45 min	165 mg TE/100 mL	[36]
Pulp	DPPH	Extract volume: 0.02 - 200 mL Solvent: MetOH Resting time: 30 min	2.1 mg IC_{50}/mL	[12]
	FRAP	Extract: 0.1 to 0.3 mL Solvent: distilled water Resting time: 15 min Temperature: 37 °C	1.56 mM Fe^{+2}/100 g	
Peel, pulp, and seed	DPPH	Extract volume: 0.05 mL Solvent: EtOH Resting time: 30 min	Peel: 568 µM TE/g Pulp: 562 µM TE/g	[13]
	ABTS	Extract volume: 0.1 mL Solvent: EtOH Resting time: 7 min	Peel: 1528 µM TE/g Pulp: 1229 µM TE/g Seed: 18894 µM TE/g	
Pulp	DPPH	Extract volume: 0.005 mL Solvent: EtOH	197 mg TE/100 ml	[4]
Leaves	DPPH	Extract volume: 0.1 mL Solvent: EtOH Resting time: 90 min	5.43 mg TE/g	[11]
	ABTS	Extract: 0.1 mL Solvent: EtOH Resting time: 90 min	8.55 mgTE/g	
Pulp	FRAP	Extract volume: 0.02 mL Solvent: EtOH	63.7 µM TE/g	[5]

mL and incubated for up to 90 min to promote decolorization of the DPPH• solution. Additionally, some studies have emphasized the standardization of pH and incubation times, as well as the measurement of the release kinetics of bioactive compounds, to avoid underestimating the antioxidant activity of samples [38].

Table 1 summarizes studies evaluating antioxidant activity using ABTS and DPPH assays. For example, seeds exhibited a higher antioxidant activity value (18,894 µM TE/g) compared with the peel (1,528 µM TE/g) and pulp (1,229 µM TE/g) [13]. This result was attributed to the high concentration of polyphenols and tannins in the seeds. The pulp exhibited moderate antioxidant capacity. Some studies have reported values ranging from 165 to 197 mg TE/100 mL following DPPH analysis [4, 36]. Leaf extracts exhibited strong antioxidant capacity. Values ranging from 5.43 mg TE/g to 8.55 mg TE/g have been reported for *Prunus padus* and *P. serotina* leaf extracts using DPPH and ABTS assays, respectively [11].

FRAP

The FRAP assay is a colorimetric method that measures the ability of a sample to reduce the ferric 2,4,6-tris(2-pyridyl)-s-triazine (TPTZ) complex (colorless) to its ferrous form (deep blue) in an acidic medium (pH 3.6), with a maximum absorbance at 593 nm [7, 39]. This assay is widely used because of its simplicity, speed, and applicability to both hydrophilic and lipophilic samples. Unlike the DPPH and ABTS assays, the FRAP method measures the non-specific reducing power of a sample. Therefore, evaluating antioxidant activity using both FRAP and DPPH or ABTS assays is recommended to provide a more comprehensive assessment of the behavior of antioxidant compounds [40]. Despite its advantages, this method has been scarcely used to evaluate the antioxidant activity of capuli [5, 12].

Antimicrobial properties

Antimicrobial compounds are chemical substances capable of inhibiting the growth of microorganisms, including bacteria, fungi, and viruses [41]. Although antimicrobial compounds are used in various fields, microbial resistance limits their effectiveness and promotes the search for alternative antimicrobial agents [42]. Medicinal and aromatic plants contain numerous secondary metabolites, including alkaloids, flavonoids, and phenolic compounds, that are capable of inhibiting microbial growth [41].

Flavonoids and phenolic compounds have demonstrated the ability to inhibit microbial growth. The antimicrobial activity of flavonoids has been associated with several mechanisms, including: (i) disruption of cell membranes, (ii) inhibition of essential enzymatic processes, and (iii) suppression of key biochemical pathways [32]. In this context, previous studies on plant extracts containing phenolic compounds and flavonoids have demonstrated significant antimicrobial activity. A study on *Luma chequen* extracts containing phenolic compounds and flavonoids demonstrated antimicrobial activity against bacteria such as *Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa,* and *Escherichia coli* [43]. Similarly, extracts from Mediterranean agri-food by-products exhibited strong antimicrobial activity against

S. aureus, *Bacillus cereus*, *Listeria monocytogenes*, *E. coli*, *Enterococcus faecalis*, and *Salmonella enteritidis* [44]. Another study evaluated the antimicrobial activity of flavonoids and procyanidins extracted from grape seeds against intestinal bacteria. The results showed that facultative anaerobes were highly resistant, whereas strict anaerobes were 10- to 100-fold more sensitive to flavonoids [45]. The antimicrobial activity of aqueous, ethanolic, and aqueous–ethanolic extracts obtained from coffee grounds was evaluated against *S. aureus*, *L. monocytogenes*, *E. coli*, and *P. aeruginosa*. The extracts exhibited strong antimicrobial activity, which was associated with their high flavonoid content [46].

In the case of capuli, its antimicrobial activity has been scarcely investigated. Extracts from *P. padus* and *P. serotina* leaves were tested against bacterial and fungal strains. The extracts and bacterial cultures were incubated for 24 h at 37 °C, and inhibition zones were subsequently measured. Inhibition zones were recorded for *Enterococcus faecium* (24 mm), *L. monocytogenes* (23 mm), and *Klebsiella pneumoniae* (18 mm). For fungal strains, negligible antimicrobial activity was observed against *Aspergillus* spp. (5 mm) and *Fusarium* spp. (3 mm) [11]. The antimicrobial activity of pulp and peel extracts obtained from *Prunus salicifolia* has also been evaluated against *Streptococcus mutans*. Twenty microliters (20 µL) of extract were brought into contact with the bacterial culture and incubated for 48 h at 37 °C. The results showed greater antimicrobial activity for the pulp extract (12 mm) than for the peel extract (9 mm) [47].

The limited number of studies evaluating the antimicrobial activity of capuli may be attributed to the greater research focus on its phenolic composition, antioxidant capacity, and invasive behavior in European ecosystems. Therefore, further research in this area could provide innovative insights and expand the potential applications of capuli-derived compounds.

Industry Applications

Table 2 presents the potential industrial applications of antioxidant and antimicrobial compounds extracted from capuli. In the food industry, anthocyanins have played a key role as natural pigments in the development of value-added products for human consumption [39]. The antioxidant properties of polyphenols and flavonoids have been exploited to enrich food matrices for dietary supplementation purposes [26, 40].

In the non-food sector, terpenes and flavonoids have shown significant potential in the agrochemical industry as bioinsecticides for pest control in crops [13]. Tannins have demonstrated the ability to bind and precipitate proteins, making them valuable in the tannery industry [41]. In addition, the pharmaceutical sector has employed these bioactive compounds because of their diverse biological activities. Polyphenols, flavonoids, and anthocyanins have demonstrated antidiabetic effects, antibacterial properties, and the ability to reduce the risk of cardiovascular diseases and certain types of cancer [27, 41]. Likewise, phenolic compounds and terpenoids extracted from the *Prunus* genus have been reported to provide protection against metabolic syndrome, regulate lipid metabolism, and reduce visceral obesity and hypertension [25]. Furthermore, the consumption of polyphenols has been proposed as an effective preventive strategy against lifestyle-related chronic diseases [40].

Antioxidant compounds act in the human body by neutralizing ROS and free radicals through electron donation. This mechanism prevents oxidative damage to biomolecules such as lipids, proteins, and DNA. Additionally, it helps maintain cellular redox balance, supports antioxidant defense systems, and reduces inflammatory processes [48].

Conclusion

Capuli is a species rich in phenolic compounds, tannins, procyanidins, anthocyanins, and flavonoids. These bioactive compounds have demonstrated antioxidant and antimicrobial properties, and their effectiveness has been evaluated using different methodologies. ABTS and DPPH assays have been widely applied to evaluate antioxidant activity, while the disk diffusion method has been used to determine the antimicrobial properties of extracts. The bioactivity of the extracts has been strongly influenced by the experimental conditions employed. The use of EtOH has enhanced the extraction of anthocyanins and phenolic acids from capuli pulp and leaves, resulting in extracts with notable antioxidant and antimicrobial activity against both Gram-positive and Gram-negative bacteria. Additionally, these compounds have shown potential applications in the food and pharmaceutical sectors. Despite these advances, research on the antimicrobial properties of capuli and the industrial exploitation of its bioactive compounds remains limited. Therefore, further studies addressing these knowledge gaps are needed to expand the scientific understanding and potential applications of

Table 2: Potential industrial application of antioxidant and antimicrobial compounds.

Active compounds	Industry	Main applications	Ref.
Anthocyanins	Food	They can be used as natural pigments in added-value products	[9, 10]
Polyphenols	Food	They can be used as a food additive in healthy diets	[10]
Flavonoids	Food	They can be used as food supplements	[4]
Terpenes flavonoids	Agrochemistry	They can be used as bioinsecticides	[1]
Polyphenols	Pharmaceutical	They exhibit antidiabetic effects and reduce the risk of respiratory and gastrointestinal diseases	[11, 12]
Flavonoids	Pharmaceutical	They show strong antibacterial activity and reduce risks associated with heart and cancer diseases	[49]
Terpenoids	Pharmaceutical	They can avoid stress, immunological problems and anemia	[13]
Tannins	Tannery	They can precipitate alkaloids	[49]

capuli.

Acknowledgements

The author thanks the Ecuadorian Corporation for the Development of Research and Academia (CEDIA) [Project No. 42 I+D+I XVIII].

Conflict of Interest

None.

References

1. Rodrigo OGF. 2025. Preparation of a Literature Review on the Active Properties of Capulí (*Prunus serotina*) and Its Potential Application in the Agro-industry.
2. Yuquilema MAL. 2026. Production of Capulí (*Prunus salicifolia*) Raisins by Dehydration Using Hot Air Circulation.
3. Avila-Mendoza E, Lascurain-Rangel M, González-Hernández CA, de la Cruz Elizondo Y, Ortiz JFO, et al. 2025. Use, knowledge and management of the capulin ethnobotanical complex in an altitudinal gradient of central Veracruz, Mexico. *Madera Bosques* 31: 1-18. https://doi.org/10.21829/myb.2025.312744
4. Rios-Corripio G, Guerrero-Beltrán J. 2020. Physicochemical, antioxidant and sensory characteristics of black cherry (*Prunus serotina* subsp. capuli) fermented juice. *Int J Fruit Sci* 20(Suppl 1): S145-S163. https://doi.org/10.1080/15538362.2019.1709113
5. Hernández-Rodríguez G, Espinosa-Solares T, Pérez-López A, Salgado-Escobar I, Guerra-Ramírez D. 2019. Antioxidant capacity of capulin (*Prunus serotina* subsp. capuli (Cav.) McVaugh) fruit at different stages of ripening. *Ecosist Recur Agropecu* 6(16): 35-44. https://doi.org/10.19136/era.a6n16.1947
6. López de Dicastillo C, Piña C, Garrido L, Arancibia C, Galotto MJ. 2019. Enhancing thermal stability and bioaccesibility of açaí fruit polyphenols through electrohydrodynamic encapsulation into zein electrosprayed particles. *Antioxidants* 8(10): 464. https://doi.org/10.3390/antiox8100464
7. López de Dicastillo C, Bustos F, Guarda A, Galotto MJ. 2016. Cross-linked methyl cellulose films with murta fruit extract for antioxidant and antimicrobial active food packaging. *Food Hydrocoll* 60: 335-344. https://doi.org/10.1016/j.foodhyd.2016.03.020
8. Jimenez M, Castillo I, Azuara E, Beristain CI. 2011. Antioxidant and antimicrobial activity of capulin (*Prunus serotina* subsp. capuli) extracts. *Rev Mex Ing Quim* 10(1): 29-37.
9. Padilla AQ. 2021. Determination of total phenols and antioxidant capacity in the fruit of guinda (*Prunus serotina* spp.) from the province of Acobamba - Huancavelica. National University of Huancavelica. (Graduate Thesis)
10. Brozdowski J, Waliszewska B, Gacnik S, Hudina M, Veberic R, et al. 2021. Phenolic composition of leaf and flower extracts of black cherry (*Prunus serotina* Ehrh.). *Ann For Sci* 78(1): 1-16. https://doi.org/10.1007/s13595-021-01089-6
11. Telichowska A, Kobus-Cisowska J, Ligaj M, Stuper-Szablewska K, Szymanowska D, et al. 2020. Polyphenol content and antioxidant activities of *Prunus padus* L. and *Prunus serotina* L. leaves: electrochemical and spectrophotometric approach and their antimicrobial properties. *Open Chem* 18(1): 1125-1135. https://doi.org/10.1515/chem-2020-0121
12. Lopa J, Valderrama M, León N, Lazo L, Llerena JP, et al. 2021. Evaluation of the antioxidant capacity and bioactive compounds of passionfruit (*Passiflora mollissima*) and cherry (*Prunus serotina*). *Horiz Med* 21(3): 1-9. https://doi.org/10.24265/horizmed.2021.v21n3.08
13. Gallardo-Rivera CT, Lu A, Treviño-Garza MZ, García-Márquez E, Amaya-Guerra C, et al. 2021. Valorization of almond (*Prunus serotina*) by obtaining bioactive compounds. *Front Nutr* 8: 1-12. https://doi.org/10.3389/fnut.2021.663953
14. Popović BM, Blagojević B, Kucharska AZ, Agić D, Magazin N, et al. 2021. Exploring fruits from genus *Prunus* as a source of potential pharmaceutical agents - *in vitro* and *in silico* study. *Food Chem* 358: 129812. https://doi.org/10.1016/j.foodchem.2021.129812
15. Pathania S, Itle RA, Chávez CR, Lema LF, Caballero-Serrano V, et al. 2022. Fruit characterization of *Prunus serotina* subsp. capuli. *Horticulturae* 8(9): 838. https://doi.org/10.3390/horticulturae8090838
16. Carrasco-Baquero JC, Lema-Palaquibay LF, Caballero-Serrano VL, Acosta-Rivera ÁG, Chávez-Velásquez DJ, et al. 2022. Production and marketing of capuli (*Prunus Serotina* subsp. Capuli): a case study in the rural areas of the central Andes of Ecuador. *Dominio Cienc* 8(2): 886-906.
17. Ortiz CVT, Medina LEM, Dilas-Jiménez JO. 2022. Traditional uses and knowledge associated with the capulí (*Prunus serotina*) in an inter-Andean zone of Ecuador. *Rev Investig Cient Tecnol Llamkasun* 3(1): 56-65.
18. Luna-Vázquez FJ, Ibarra-Alvarado C, Rojas-Molina A, Rojas-Molina JI, Yahia EM, et al. 2013. Nutraceutical value of black cherry *Prunus serotina* Ehrh. fruits: antioxidant and antihypertensive properties. *Molecules* 18(12): 14597-14612. https://doi.org/10.3390/molecules181214597
19. Vasco C, Riihinen K, Ruales J, Kamal-Eldin A. 2009. Phenolic compounds in *Rosaceae* fruits from Ecuador. *J Agric Food Chem* 57(4): 1204-1212. https://doi.org/10.1021/jf802656r
20. Kostikova EN, Aksinenko NK, Biryukov TN, Poluyanov AM, Dorovskikh EA, et al. 2026. Pharmacognostic and phytochemical study of leaves and dry extract of *Padus serotina* (Ehrh.) Borkh. seu *Prunus serotina* Ehrh. *Res J Pharm Technol* 19(4): 1520-1526. https://doi.org/10.52711/0974-360x.2026.00218
21. Bączek P, Łyczko J, Twardowska K, Iwanowski M, Gruss I, et al. 2025. Antifeedant activity of invasive *Prunus serotina* leaves methanolic extract against *Sitophilus granarius*, a pest of stored products. *Sci Rep* 15(1): 25469. https://doi.org/10.1038/s41598-025-10326-1
22. García OC, García-Mateos MR, Gonzalez AMC, Moncada MCY, Ramos LH. 2025. Nutraceutical and nutritional characteristics of capulin segregants (*Prunus serotina*) fresh and processed. *Curr Top Agron Sci* 5: 1-10. https://doi.org/10.5154/r.ctasci.2024.05.02
23. Khan MR, Di Giuseppe FA, Torrieri E, Sadiq MB. 2021. Recent advances in biopolymeric antioxidant films and coatings for preservation of nutritional quality of minimally processed fruits and vegetables. *Food Packag Shelf Life* 30: 100752. https://doi.org/10.1016/j.fpsl.2021.100752
24. Kuai L, Liu F, Chiou BS, Avena-Bustillos RJ, McHugh TH, et al. 2021. Controlled release of antioxidants from active food packaging: a review. *Food Hydrocoll* 120: 106992. https://doi.org/10.1016/j.foodhyd.2021.106992
25. Urrialde R, Gómez-Cifuentes A, Pintos B, Gómez-Garay MA, Cifuentes B. 2022. Bioactive compounds from plants: development of new or novel food. *Nutr Hosp* 39: 8-11. https://doi.org/10.20960/nh.04302
26. Siddeeg A, AlKehayez NM, Abu-Hiamed HA, Al-Sanea EA, AL-Farga AM. 2021. Mode of action and determination of antioxidant activity in the dietary sources: an overview. *Saudi J Biol Sci* 28(3): 1633-1644. https://doi.org/10.1016/j.sjbs.2020.11.064
27. Galindo-Hernández D, Castellanos-López F, Toledo-Clemente M, Vázquez-Villegas PT, Lam-Gutiérrez A. 2025. Natural chemistry: the impact of bioactive compounds in modern diet. *Rev Latinoam Difus Cient* 7(13): 173-198. https://doi.org/10.5281/zenodo.15844236
28. Banwo K, Olojede AO, Adesulu-Dahunsi AT, Verma DK, Thakur M, et al. 2021. Functional importance of bioactive compounds of foods with potential health benefits: a review on recent trends. *Food Biosci* 43: 101320. https://doi.org/10.1016/j.fbio.2021.101320

29. Gulcin İ. 2025. Antioxidants: a comprehensive review. *Arch Toxicol* 99(6): 1893-1997. https://doi.org/10.1007/s00204-025-03997-2

30. Helberg J, Pratt DA. 2021. Autoxidation vs. antioxidants – the fight for forever. *Chem Soc Rev* 50(13): 7343-7358. https://doi.org/10.1039/d1cs00265a

31. Barouh N, Bourlieu-Lacanal C, Figueroa-Espinoza MC, Durand E, Villeneuve P. 2022. Tocopherols as antioxidants in lipid-based systems: the combination of chemical and physicochemical interactions determines their efficiency. *Compr Rev Food Sci Food Saf* 21(1): 642-688. https://doi.org/10.1111/1541-4337.12867

32. Rodríguez B, Pacheco L, Bernal I, Piña M. 2023. Mechanisms of action of flavonoids: antioxidant, antibacterial and antifungal properties. *Cienc Ambient Clima* 6(2): 33-66. https://doi.org/10.22206/cac.2023.v6i2.3021

33. Hernández-Moreno LV, Salazar JR, Pabón LC, Hernández-Rodríguez P. 2022. Antioxidant activity and quantification of phenols and flavonoids of Colombian plants used in urinary tract infections. *Rev UDCA Actual Divulg Cient* 25(1): 1-8. https://doi.org/10.31910/rudca.v25.n1.2022.1690

34. Vidal CP, Muñoz-Shugulí C, Guivier M, Puglia D, Luzi F, et al. 2024. PLA- and PHA-biopolyester-based electrospun materials: development, legislation, and food packaging applications. *Molecules* 29(22): 5452. https://doi.org/10.3390/molecules29225452

35. Vásquez-Ovando A, Mejía-Reyes JD, García-Cabrera KE, Velásquez-Ovalle G. 2022. Antioxidant capacity: concepts, quantification methods and its application in the characterization of tropical fruits and derived products. *Rev Colomb Investig Agroind* 9(1): 9-33. https://doi.org/10.23850/24220582.4023

36. Rios-Corripio G, Welti-Chanes J, Rodríguez-Martínez V, Guerrero-Beltrán JÁ. 2024. High hydrostatic pressure processing of fresh juice and a fermented beverage of black cherry (*Prunus serotina*). *J Agric Food Res* 15: 100937. https://doi.org/10.1016/j.jafr.2023.100937

37. Rojas A, Misic D, de Dicastillo CL, Zizovic I, Velásquez E, et al. 2023. A review on thymol-based bioactive materials for food packaging. *Ind Crops Prod* 202: 116977. https://doi.org/10.1016/j.indcrop.2023.116977

38. Moreno LEZ, Alvarado DTT, Carrasco DVC, Arcentales AMA, Campuzano FED, et al. 2025. Analysis of the antioxidant capacity using the DPPH method of a beverage with sweet cucumber (*Solanum muricatum* Aiton) and peach (*Prunus persica* L. Batsch). *InvestiGo Multidiscip Sci J* 6(1): 122-134. https://doi.org/10.56519/7pejyy46

39. López de Dicastillo C, Rodríguez F, Guarda A, Galotto MJ. 2016. Antioxidant films based on cross-linked methyl cellulose and native Chilean berry for food packaging applications. *Carbohydr Polym* 136: 1052-1060. https://doi.org/10.1016/j.carbpol.2015.10.013

40. Rosa AJO, Arias-Arroyo GC, López-Belchi MD, Bracamonte-Romero M, Arones-Limaymanta A. 2021. Nutritional and bioactive compounds of *Solanum quitoense* Lam. (naranjilla), native fruit of the Andes with high nutrient potential. *Tecnol Quim* 41(1): 92-108.

41. Pérez LD, Pérez YS, Ortega AR, Novelles MCT. 2021. Current status and perspectives of natural antimicrobials. *Cuba J Pharm* 54(3): 1-22.

42. European Commission. 2026. Research, Projects and Studies. Public Health. [https://health.ec.europa.eu/antimicrobial-resistance/research-projects-studies_es] [Accessed June 17, 2026]

43. Fernández-Rebaza GA, Quintana ADB, Soto-Tantaraico EC, Zeña-Chiara EN, Salazar-Salvatierra ME, et al. 2024. Characterization of flavonoids and antimicrobial activity of methanolic extract of *Luma chequen* (Molina) A. gray leaves. *An Fac Med* 85(4): 398-406. https://doi.org/10.15381/anales.v85i4.27473

44. Šimat V, Čagalj M, Mekinić IG, Možina SS, Malin V, et al. 2024. Antioxidant and antimicrobial activity of extracts from selected Mediterranean agro-food by-products, their mutual interaction and interaction with phenolic compounds. *Food Biosci* 61: 104599. https://doi.org/10.1016/j.fbio.2024.104599

45. Ares PS, Gaur G, Willing BP, Weber F, Schieber A, et al. 2023. Antibacterial and enzyme inhibitory activities of flavan-3-ol monomers and procyanidin-rich grape seed fractions. *J Funct Foods* 107: 105643. https://doi.org/10.1016/j.jff.2023.105643

46. García-Larez FL, Murillo-Hernández JL, Vargas-Sánchez RD, Torrescano-Urrutia GR, Torres-Martínez BM, et al. 2021. Effect of extraction solvent on metabolite content, antioxidant and antibacterial activity of coffee bagasse. *TIP Rev Espec Cienc Quim Biol* 24: 1-10. https://doi.org/10.22201/fesz.23958723e.2021.363

47. Reyes IY, Cruz VA, Castro MR, Santacruz SG, Villacres CE, et al. 2019. Antibacterial effect of extracts of *Prunus salicifolia* (capulli) and *Vaccinium floribundum* (mortiño) against *Streptococcus* mutans strains: an *in vitro* study. *Kiru* 16(1): 14-18.

48. Chaudhary P, Janmeda P, Docea AO, Yeskaliyeva B, Abdull Razis AF, et al. 2023. Oxidative stress, free radicals and antioxidants: potential crosstalk in the pathophysiology of human diseases. *Front Chem* 11: 1-24. https://doi.org/10.3389/fchem.2023.1158198

49. Miranda BLQ. 2024. Antioxidant activity of hydroalcoholic extract and lyophilized extract of *Prunus serotina* Ehrhart ("guinda") fruit - Ayacucho 2023. National University of San Cristóbal de Huamanga. (Graduate Thesis)