The Phytochemical Screening and Antioxidant Activity of Ethanol Extract Yacon Tubers (*Smallanthus sonchifolius*)

Raden Anita Indriyanti[1], Yuktiana Kharisma[2], Meta Maulida Damayanti[2], Lelly Yuniarti[3], Siti Annisa Devi Trusda[3], Salsabila Ayu Fatmawati[4]

[1]Department of Pharmacology, Faculty of Medicine, Universitas Islam Bandung, West Java, Indonesia.
[2]Department of Anatomy Pathology, Faculty of Medicine, Universitas Islam Bandung, West Java, Indonesia.
[3]Department of Biochemistry and Molecular, Faculty of Medicine, Universitas Islam Bandung, West Java, Indonesia.
[4]Bachelor Degree Program, Faculty of Medicine, Universitas Islam Bandung, West Java, Indonesia.

r.anitaindriyanti@gmail.com

Abstract. The tubers of Yacon (*Smallanthus sonchifolius*) are regarded as a functional food due to their biologically active components, which may confer physiological benefits beyond basic nutritional functions, potentially reducing the risk of chronic diseases. This study aimed to conduct a phytochemical screening of the ethanol extract of *S. sonchifolius* tubers sourced from the Monoko plantation field in Lembang, West Java, Indonesia, and to evaluate its antioxidant activity. This research method is to determine the qualitative presence of active compounds, a phytochemical analysis was performed, focusing on alkaloids, polyphenols, flavonoids, saponins, tannins, glycosides, and terpenoids. The antioxidant properties were evaluated using DPPH as a reagent, with the findings reported as the percentage of inhibition concentration (%IC_{50}). Results: The ethanol extract of *Smallanthus sonchifolius* from Lembang, West Java, contained polyphenols, flavonoids, tannins, glycosides, and terpenoids. In this study, these bioactive compounds were found to exhibit a very strong antioxidant effect, with an IC_{50} of 19.87 ppm. This potent antioxidant activity could be attributed to several factors, such as the sinergism effect among various bioactive compounds, the specific plant parts used, or the extraction method and solvent employed. Additionally, given the numerous promising health benefits, further development of Yacon tuber extracts could potentially offer a potential antioxidant effects that may help lower the risk of chronic diseases and enhance human health in the future.

Keywords: *Antioxidant activity, Phytochemical screening, Smallanthus sonchifolius.*

A. Introduction

The tubers of Yacon (*Smallanthus sonchifolius*) are regarded as a functional food due to their biologically active components, which may confer physiological benefits beyond basic nutritional functions. These components are associated with a reduced risk of chronic diseases, attributed to their abundant bioactive properties(1). Yacon, an underutilized crop belonging to the family Asteraceae, originates from the Andean region of South America. This perennial herb, which is relatively obscure, typically requires 6 to 12 months to reach maturity. Several bioactive compounds have been identified in both the roots and leaves of yacon, including polyphenol compounds, fructans, and phytoalexins, which exhibit antioxidant, prebiotic, and antimicrobial properties(2).

In Yacon, elevated concentrations of polyphenols are typically observed in the leaves and stems. Thin-layer chromatographic analysis has identified chlorogenic, caffeic, ferulic, and protocatechuic acids in the tuber and leaf extracts of yacon. Among these, chlorogenic and caffeic acid derivatives are the predominant polyphenols, with chlorogenic acid present in higher concentrations(2). The polyphenols in yacon leaves contribute to an acrid and astringent flavor and a distinctive odor. These polyphenols are significantly associated with superoxide radical, DPPH radical, and nitric oxide scavenging activities, suggesting that they possess antioxidant properties.

* r.anitaindriyanti@gmail.com

Consequently, they may play a crucial role in reducing the risk of cancer, cardiovascular disease (CVD), atherosclerosis, and diabetes(3). Phenolic compounds represent a predominant category of secondary metabolites in plants, characterized by hydroxy groups attached to aromatic hydrocarbon groups (benzene rings), and they encompass a spectrum from simple to highly polymeric structures(4). These compounds exhibit antioxidant properties attributable to the hydroxyl groups, which function as quenching agents for harmful free radicals. Epidemiological studies have indicated the potential health benefits of phenolic compounds in the prevention of various chronic diseases, such as diabetes, cancers, and cardiovascular diseases, likely due to their antioxidant, anti-inflammatory, and anti-carcinogenic properties(5).

Flavonoids were exclusively identified in acid-hydrolyzed yacon tubers, where they exhibited associations with lipid peroxidation, acetylcholinesterase, and butyrylcholinesterase inhibition. Simonovska et al. demonstrated the presence of the flavonoid quercetin, along with caffeic acid and ferulic acid, through thin-layer chromatography in the acid hydrolysis of yacon tubers(6). Flavonoids, as polyphenolic compounds, contribute to the sensory attributes of plant-based foods, such as taste and flavor. Moreover, they are recognized for their antioxidant properties, anticancer activities, and antidiabetic effects(7). The concentration of flavonoids is influenced by the cultivar, suggesting a potential impact of genotype on the biosynthesis of flavonoid compounds in yacon plants(8). The antioxidant efficacy of flavonoids is contingent upon the configuration of functional groups around the nuclear structure. The configuration, substitution, and total number of hydroxyl groups significantly affect various antioxidant mechanisms, such as radical scavenging and metal ion chelation. Antioxidant mechanisms may include (1) suppression of reactive oxygen species (ROS) formation through enzyme inhibition or chelation of trace elements involved in free radical generation; (2) scavenging of ROS; and (3) upregulation or protection of antioxidant defenses(9). Flavonoids can directly scavenge ROS and chelate metal ions due to their capacity to stabilize free radicals through phenolic hydroxyl groups. Indirect antioxidant effects of flavonoids are associated with the activation of antioxidant enzymes, suppression of pro-oxidant enzymes, and stimulation of the production of antioxidant enzymes and phase II detoxification enzymes. Both antioxidant and pro-oxidant activities contribute to the anticancer effects of flavonoids(10).

B. Method

Materials

Yacon (*Smallanthus sonchifolius*) was grown in Manoko plantation field in Lembang, West Java. All reagents, including gallic acid reference standard (Merck, Darmstadt, German); quercetin standard (MarkHerb, Bandung, Indonesia); ethanol, methanol, and Milli Q-water (Merck); and Folin Ciocalteau 10%, sodium chloride, sodium acetate, $AlCl_3$ 2%, 1,1-diphenyl-2-picrylhydrazyl (DPPH).

Equipment

The equipment utilized for the examination of the extract included the following: a Shimadzu UV-1800 spectrophotometer detector, a Zorbax SB-C18 column (4.6×250 mm, 5 µm), a Camag Chromato-Uve Cabinet UV Lamp 4, a Bransonic Ultrasonic Bath CPX2800H-E series, a Memmert Waterbath WNB 22, and an Eppendorf micropipette (10–100 µm).

Ethanol Extraction

Twenty kilograms of *Smallanthus sonchifolius* tubers were peeled, chopped, and subsequently dried to yield 1-2 kilograms of dried simplisia. Following the grinding process, the resultant powder weighed 1.172 kg. The procedure continued with the maceration of yacon tubers (Smallanthus sonchifolius) using a ratio of 500 grams of yacon tubers to 2500 ml of ethanol. The maceration mixture was stirred every 5-6 hours and filtered twice every 72 hours, resulting in a filtrate volume of 2.1230 ml. The evaporation of the yacon tuber extract with ethanol produced a yield of 101.8892 grams of ethanol extract.

Phytochemical Screening

Phytochemical screening was conducted on the 96% ethanol extract to identify the active compounds potentially exhibiting biological activity. The qualitative content of alkaloids, polyphenols, flavonoids, saponins, tannins, glycosides, and terpenoids was examined as parameters.

Antioxidant Activity

The antioxidant activity was assessed utilizing DPPH as the reactive agent. A stock solution was prepared by diluting the extract with ethanol to achieve various concentrations (2, 4, 6, 8, 10 ppm). Each extract was combined with 1 ml of DPPH solution stock, vortexed for 1 minute, and incubated at room temperature for 30 minutes. The absorbance of the solution was measured using a spectrophotometer at 515.5 nm, and the content was calculated using the linear equation derived from the DPPH standard curve. The results were expressed as the inhibition concentration percentage (%IC_{50})(11).

Time and Place

This research was conducted from July to August 2025 in the Pharmacy Laboratory at the Faculty of Mathematics and Natural Science, Bandung Islamic University.

C. Result and Discussion

From 1,172 kilograms of dried yacon tuber powder, 101,889.2 grams of ethanol extract were produced. The results of the phytochemical screening of yacon tubers, sourced from the Manoko plantation in Lembang, West Java, are presented in the following table:

Table 1. *Smallanthus sonchifolius* tubers Phytochemical Screening Result

Bioactive compound Parameter	Reagent	96% Ethanol Extract
Alkaloid	Mayer	-
	Dragendroff	-
	Wagner	-
Polyfenol	FeCl3	+
Flavonoid	Shinoda	+
Saponin	*Foam*	-
Tanin	FeCl3	+
	Gelatin	-
	Steasny	-
	Galat	-
Glycoside	Borntragner's	-
	Keller-Killiani	+
Monoterpena/ Seskuiterpena	Liebermann	-
Triterpenoid/ Steroid	Liebermann	+

Note : + : visible color change or sediment or foam;
- : no visible color change or sediment or foam

Antioxidant Activity

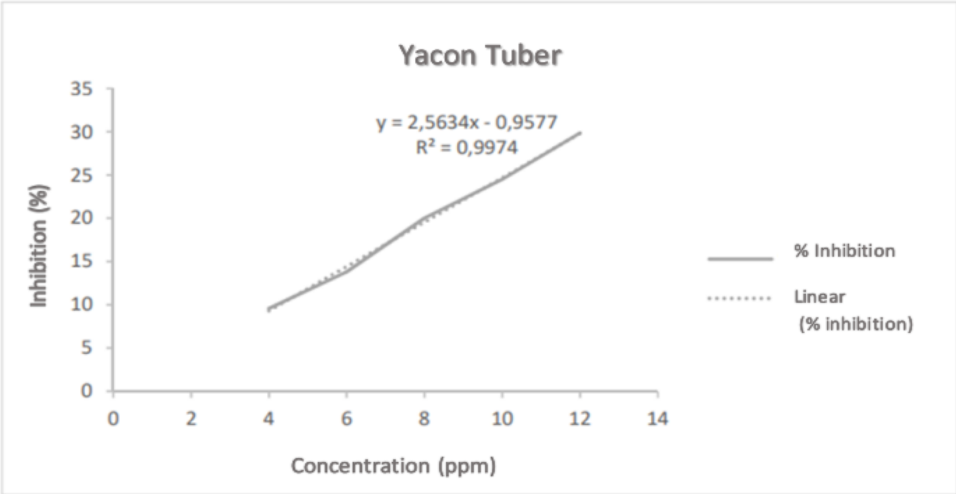

Figure 1. Antioxidant activity Of Yacon Tubers

The antioxidant activities of Yacon tubers root ethanol extracts was measured using the curve of % inhibition versus concentration in the sample (2, 4, 6, 8, 10 ppm). The measurements were conducted and the results are shown in Figure 1. The antioxidant activities were calculated using a linear regression equation from the DPPH inhibition curve, y = 2,5634x-0,9577, with R^2= 0,9974., from which the antioxidant activity of the ethanol extract was IC_{50} = 19,87 ppm (µg/ml) showed in table 2, below

Table 2: Inhibition percentage of *Smallanthus sonchifolius* tubers ethanol extract

Concentration (ppm)	Sample Absorbance	% Inhibition (IC_{50})
2	0.321	19,87
4	0.306	
6	0.284	
8	0.268	
10	0.249	
DPPH	0.355	

Analysis and Discussion

In an earlier study, Yang Cao et al., identified three primary components in fresh yacon root: water (over 70%), carbohydrates (which make up the majority of the dry matter), and protein. Additionally, bioactive compounds like flavonoids were detected in yacon tubers(2). This research was furthered by Simonovska et al., who also identified the flavonoid quercetin, along with caffeic acid and ferulic acid, using thin-layer chromatography during the acid hydrolysis of yacon tubers(6). Flavonoids, which are naturally occurring phenolic antioxidants, are part of the human diet and contribute to the antioxidant properties found in green vegetables, fruits, olive and soybean oils, red wine, chocolate, and teas. These compounds have garnered significant attention due to their beneficial antioxidant effects in preventing human diseases such as cancer and cardiovascular conditions, as well as certain pathological disorders like gastric and duodenal ulcers, allergies, vascular fragility, and viral and bacterial infections(7). The presence of polyphenol compounds in the ethanol extract of yacon tubers (*Smallanthus sonchifolius*) can enhance their benefits through antioxidant activities, which are linked to their ability to neutralize a wide range of reactive oxygen species (ROS). The mechanisms underlying the antioxidant capacity of polyphenols include the suppression of ROS formation by either inhibiting the enzymes involved in their production, scavenging ROS, or enhancing or protecting antioxidant defenses(5),(12).

This research also revealed that yacon tubers are rich in active compounds such as tannin, glycoside, and terpenes. Tannins, which are a type of polyphenolic compound and significant secondary metabolites in plants, play a crucial role in determining the sensory attributes and nutritional value of beverages, fruits, vegetables, and other plant-derived foods(13). Known for their antioxidant properties, tannins are extensively utilized in food applications. Numerous studies have thoroughly examined their antioxidant activity, indicating their potential in preventing cardiovascular diseases, cancer, and osteoporosis. In various studies, extracts from Japanese chestnut demonstrated the most notable DPPH-scavenging ability. The findings suggested that tannins, as a potential natural preservative, offered promising antioxidant capabilities. One study assessed the impact of forage conservation methods and condensed tannins from preserved forage on rumen fermentation, revealing that tannin from purple prairie clover reduced protein degradation in vitro but had limited effects on overall rumen fermentation(14),(15).

Glycosides, which are the predominant form of sugar found in nature, exhibit a variety of pharmacological effects. For instance, paeoniflorin-12, derived from peony, possesses anti-inflammatory, antipyretic, anti-spasmodic, neuroprotective, and cerebral properties. Similarly, polydatin-11, obtained from the rhizomes of *Polygonum cuspidatum*, demonstrates anti-inflammatory, oxidative-stress-reducing, and apoptosis-inhibiting effects in the context of ulcerative colitis. The diverse pharmacological activities of glycosides are linked to their structure–activity relationships. The removal of hydroxyl groups from glycoside ligands, along with hydroxymethylation and the elimination of phenylpropenyl or phenylethyl groups, tends to reduce pharmacological activity. In contrast, antioxidant activity is associated with the number of unsaturated bonds, the quantity and position of phenolic hydroxyl groups, and the length of carbon chains(16),(17). Flavonoid glycosides have been shown to exert antioxidant effects that protect cells from free radical damage and inhibit inflammatory pathways involved in the progression of these diseases(18).

Another significant compound identified from the ethanol extract of *S. sonchifolius* is a terpenoid derivative. Terpenoids are known for their diverse actions due to their ability to target various cellular components. For instance, plant-derived terpenoids can inhibit nuclear factor-kB signaling, showcasing their anti-inflammatory and anticancer properties(19). In general, terpenoids can influence multiple cancer progression mechanisms, including apoptosis, cell cycle regulation, ROS production, autophagy, and necroptosis(20). They play a crucial role in treating various diseases, as demonstrated in numerous in vitro and in vivo studies, where they are used as anticancer agents, antimicrobials, anti-inflammatories, antioxidants, antiallergics, neuroprotectives, anti-aggregators, anticoagulants, sedatives, and analgesics. This is achieved through the activity of monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, and glycoside compounds(21),(22).

Nevertheless, the hypothesis concerning the interaction among tannin, total phenol, and total flavonoid remains varied. A prior study by Antasionasti et al. examined the antioxidant activity comparison between a combination of *M. fragrans* flesh extract with different concentrations of egg white and its correlation with tannin, total flavonoid, and total phenolic contents. The findings indicated that *M. fragrans* flesh extracts without egg white addition exhibited strong antioxidant activity in scavenging the stable free radical ABTS (89.980±0.480 µg/mL) and moderate antioxidant activity in scavenging the stable free radical DPPH (105.669±0.102 µg/mL). This was followed by tannin, total flavonoid, and total phenolic contents, which were 14.034±0.100 %w/w TAE, 26.929±0.129 %w/w QE, and 53.164±0.129 %w/w GAE, respectively. The correlation of tannin, total flavonoid, and total phenolic contents with the inhibition of DPPH and ABTS radicals had R2 values ranging from 89.23% to 97.63%, indicating that antioxidant activity is significantly influenced by these contents. Consequently, the precipitation from the tannin-protein bond led to a decrease in antioxidant activities(23). Another study by Baranovska demonstrated that stepwise enrichment of model mixtures with antioxidants at concentrations equivalent to those in cocoa powder extract did not progressively enhance the total antioxidant activity of the samples; moreover, these model mixtures did not achieve the antioxidant potential of cocoa in either cell-free or cellular models(24). In contrast, research by Strati et al. revealed that the addition of tannin significantly increased the total phenolic content, antioxidant, and antiradical activity compared to the control and sulfited wines, while maintaining the sensory parameters and overall acceptance of Malagousia wine(25). Besides the interaction among various bioactive compounds, the antioxidant effect is also influenced by the part of the plant (leaves, root, tuber, flower),(2)extraction method (maceration, ultra-assisted extraction), and solvent (aqueous, methanol, ethanol, dichloromethane, acetone, etc.)(26)(27)(28)

D. Conclusion

The research indicated that the ethanol extract of *Smallanthus sonchifolius* contains polyphenols, flavonoids, tannins, glycosides, and terpenoids. These bioactive compounds were found to exhibit a very strong antioxidant effect, with an IC_{50} value of 19,87 ppm. This strong antioxidant activity could be attributed to several factors, such as the interactions among various bioactive compounds, the specific plant parts used, or the extraction method and solvent employed. Additionally, given the numerous promising health benefits, further development of Yacon tuber extracts could potentially offer a potential antioxidant effects that may help lower the risk of chronic diseases and enhance human health in the future.

Acknowledgement

The authors express their gratitude to the staff of the Pharmacy Laboratory, Faculty of Mathematics and Natural Science, Bandung Islamic University, West Java, Indonesia.

References

Yan MR, Welch R, Rush EC, Xiang X, Wang X. A sustainable wholesome foodstuff; health effects and potential dietotherapy applications of yacon. Vol. 11, Nutrients. MDPI AG; 2019.

Cao Y, Ma ZF, Zhang H, Jin Y, Zhang Y, Hayford F. Phytochemical propertiess and nutrigenomic implications of yacon as a potential source of prebiotic: Current evidence and future directions. Foods. 2018;7(4).

Silva IF da, Bragante WR, Junior RCM, Laurindo LF, Guiguer EL, Araújo AC, et al. Effects of Smallanthus sonchifolius Flour on Metabolic Parameters: A Systematic Review. Vol. 17, Pharmaceuticals. Multidisciplinary Digital Publishing Institute (MDPI); 2024.

Lin D, Xiao M, Zhao J, Li Z, Xing B, Li X, et al. An overview of plant phenolic compounds and their importance in human nutrition and management of type 2 diabetes. Molecules. 2016;21(10).

Hussain T, Tan B, Yin Y, Blachier F, Tossou MCB, Rahu N. Oxidative Stress and Inflammation: What Polyphenols Can Do for Us? Oxid Med Cell Longev. 2016;2016.

Simonovska B, Vovk I, Andrenšek S, Valentová K, Ulrichová J. Investigation of phenolic acids in yacon (Smallanthus sonchifolius) leaves and tubers. J Chromatogr A. 2003;1016(1):89–98.

Yao LH, Jiang YM, Shi J, Tomás-Barberán FA, Datta N, Singanusong R, et al. Flavonoids in food and their health benefits. Plant Foods Hum Nutr. 2004;59(3):113–22.

Khajehei F, Merkt N, Claupein W, Graeff-Hoenninger S. Yacon (smallanthus sonchifolius poepp. And endl.) as a novel source of health promoting compounds: Antioxidant activity, phytochemicals and sugar content in flesh, peel, and whole tubers of seven cultivars. Molecules. 2018;23(2).

Kumar S, Pandey AK. Chemistry and biological activities of flavonoids: An overview. Sci World J. 2013;2013.

Kopustinskiene DM, Jakstas V, Savickas A, Bernatoniene J. Flavonoids as anticancer agents. Nutrients. 2020;12(2):1–26.

de Torre MP, Cavero RY, Calvo MI, Vizmanos JLW. A simple and a reliable method to quantify antioxidant activity in vivo. Antioxidants. 2019;8(5):1–11.

Indriyanti RA, Ariyanto EF, Usman HA, Effendy RR, Dhianawaty D. Quantification of total polyphenols and flavonoids, antioxidant activity, and Sinensetin and Imperatorin contents of Imperata cylindrica root ethanol extract. Pharmacogn J. 2022;14(4):327–37.

Cosme F, Aires A, Pinto T, Oliveira I, Vilela A, Gonçalves B. A Comprehensive Review of Bioactive Tannins in Foods and Beverages: Functional Properties, Health Benefits, and Sensory Qualities. Molecules. 2025;30(4):1–28.

Tong Z, He W, Fan X, Guo A. Biological Function of Plant Tannin and Its Application in Animal Health. Front Vet Sci. 2022;8(January):1–7.

Nguyen CNM, Nirmal NP, Sultanbawa Y, Ziora ZM. Antioxidant and Antibacterial Activity of Four Tannins Isolated from Different Sources and Their Effect on the Shelf-Life Extension of Vacuum-Packed Minced Meat. Foods. 2023;12(2).

Niu Y, Zhang J, Shi D, Zang W, Niu J. Glycosides as Potential Medicinal Components for Ulcerative Colitis: A Review. Molecules. 2023;28(13).

Suo M, Ohta T, Takano F, Jin S. Bioactive phenylpropanoid glycosides from Tabebuia avellanedae. Molecules. 2013;18(7):7336–45.

Juan A. Glycoside-rich Herbal Medicines : Safety , Efficacy and Clinical Applications. J Pharmacogn Nat Prod. 2025;11:10–1.

Gupta NS. Therapeutic Efficacy of the Plant Bioactive Phytochemicals with Special Reference to Alkaloids, Terpenoids, Phenolics and Cardiac Glycosides. Int J Plant Environ. 2024;10(01):22–30.

Câmara JS, Perestrelo R, Ferreira R, Berenguer C V., Pereira JAM, Castilho PC. Plant-Derived Terpenoids: A Plethora of Bioactive Compounds with Several Health Functions and Industrial Applications—A Comprehensive Overview. Molecules. 2024;29(16).

Masyita A, Mustika Sari R, Dwi Astuti A, Yasir B, Rahma Rumata N, Emran T Bin, et al. Terpenes and terpenoids as main bioactive compounds of essential oils, their roles in human health and potential application as natural food preservatives. Food Chem X [Internet]. 2022;13(January):100217. Available from: https://doi.org/10.1016/j.fochx.2022.100217

Fan M, Yuan S, Li L, Zheng J, Zhao D, Wang C, et al. Application of Terpenoid Compounds in Food and Pharmaceutical Products. Fermentation. 2023;9(2).

Antasionasti I, Datu OS, Lestari US, Abdullah SS, Jayanto I. Correlation Analysis of Antioxidant Activities with Tannin, Total Flavonoid, and Total Phenolic Contents of Nutmeg (Myristica fragrans Houtt) Fruit Precipitated by Egg white. Borneo J Pharm. 2021;4(4):301–10.

Baranowska M, Suliborska K, Todorovic V, Kusznierewicz B, Chrzanowski W, Sobajic S, et al. Interactions between bioactive components determine antioxidant, cytotoxic and nutrigenomic activity of cocoa powder extract. Free Radic Biol Med [Internet]. 2020;154(February):48–61. Available from: https://doi.org/10.1016/j.freeradbiomed.2020.04.022

Strati IF, Tataridis P, Shehadeh A, Chatzilazarou A, Bartzis V, Batrinou A, et al. Impact of tannin addition on the antioxidant activity and sensory character of Malagousia white wine. Curr Res Food Sci [Internet]. 2021;4:937–45. Available from: https://doi.org/10.1016/j.crfs.2021.11.017

Aditya R, Santoso B, Widjiati. Comparative study of bioactive compound content and antioxidant activity in different extraction methods of Syzygium Polyanthum leaves. Bali Med J. 2023;12(3):3425–30.

Coyago-Cruz E, Guachamin A, Villacís M, Rivera J, Neto M, Méndez G, et al. Evaluation of Bioactive Compounds and Antioxidant Activity in 51 Minor Tropical Fruits of Ecuador. Foods. 2023;12(24).

Al Jumayi HA, Allam AY, El-Beltagy AED, Algarni EH, Mahmoud SF, Kandil AAEH. Bioactive Compound, Antioxidant, and Radical Scavenging Activity of Some Plant Aqueous Extracts for Enhancing Shelf Life of Cold-Stored Rabbit Meat. Antioxidants. 2022;11(6).