WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 10, Issue 11, 102-111. Research Article ISSN 2277– 7105

THE CHANGES IN THE CONTENTS OF POLYPHENOLIC COMPOUNDS OF TARO *(COLOCASIA ESCULENTA)* UPON DOMESTIC PROCESSING

Benson Boua Boua[1], Lanciné Traoré[1,2]*, Daniel Clinnanga Ouattara[1], Janat-Akhanovna Mamyrbekova-Békro[1] and Yves-Alain Békro[1]

[1]LCBOSN, Laboratoire de Chimie Bio Organique et de Substances Naturelles, Université Nangui Abrogoua, 02 BP 801 Abidjan 02, Côte d'Ivoire.

[2]Département de Sciences et Technologie, Université de Man, BP 20 Man, Côte d'Ivoire.

Article Received on
26 June 2021,

Revised on 16 July 2021,
Accepted on 06 August 2021

DOI: 10.20959/wjpr202111-21306

***Corresponding Author**
Dr. Lanciné Traoré
Laboratoire de Chimie Bio Organique et de Substances Naturelles, Université Nangui Abrogoua, 02 BP 801 Abidjan 02, Côte d'Ivoire.
Département de Sciences et Technologie, Université de Man, BP 20 Man, Côte d'Ivoire.

ABSTRACT

Taro (*Colocasia esculenta*) root is a great source of bioactive components such polyphenols and offers a variety of potential health benefits, including the prevention of major chronic non-infectious diseases such as cardiovascular diseases, cancer and diabete. The objective of this study was to investigate the effects of four cooking methods, namely boiling with peel, boiling without peel, grilling with peel, grilling without peel, on polyphenolic compounds of taro tubers. Determination of polyphenolic, flavonoid and tannin contents of raw and cooked taro tubers was carried out by using Folin-Ciocalteu reagent assay, Neu reagent method and tungstophosphoric acid/Na_2CO_3 test, respectively. Polyphenolic content of raw taro tuber ranged from 34.8 to 168.4 µgGAE/mg while boiling substantially increases the flavonoids (21.4 µgQE/mg for taro tuber with peel and 19.3 µgQE/mg for taro tuber without peel), whereas grilling allows increasing the tannins (18.4 µgCE/mg for taro tuber with peel and 18.0 µgCE/mg for taro tuber without peel). Four cooking methods in general caused increases in the polyphenolic content of taro tubers. The results of this study can be used for making recommendations on the processing methods to be chosen for optimizing the health benefits of taro tubers.

KEYWORDS: *Colocasia esculenta*, cooking methods, polyphenols, bioactive components.

INTRODUCTION

Taro [*Colocasia esculenta* (L.) Schott] is a tropical root crop cultivated in the first place for its underground stem or starchy corm. It is widely grown throughout the South Pacific, Asia, and Africa and it is one of the most important staple food crops in the Pacific Islands.[1] Taro is one of the root and tuber plants with a higher nutritional value. Both corms and leaves are good sources of calcium, potassium, phosphorus and readily available iron and contain good-quality protein. The corms also can be a fair source of oils.[2] It is also a rich source of vitamin C, thiamine, riboflavin and niacin, which are important constituents of human diets and have very fine-grained, easily digestible starch, a rich ash content. Corms are consumed roasted, boiled, or fried and are also used to produce flour or industrial starch.[3]

Food nutrition and cooking have a strong link, because cooking takes nutrition into account, and nutrition must be achieved from cooking. Their common goal is to study the relationship between food and humans and they cannot be separated. The human body needs nutrients for its well-being. After the cooking process, the food can be consumed and the nutrients it contains can be digested and used by the human body. The cooking process also can change vegetable ingredients, mainly vitamins, phenols, and antioxidants.[4]

Polyphenols are plant-derived dietary compounds and their health effects have been extensively studied in the past several decades. Their biological benefits are particularly interesting due to their role in the potential prevention of major chronic non-infectious diseases such as cardiovascular and cancer diabetes. These ailments are among the leading causes of death today, which indicates that phenolic compounds will continue to be object of scientific interest.[5,6]

It is known that cooking methods may cause changes in nutritional, chemical, physical-chemical, and sensory aspects in vegetables, influencing bio accessibility of these compounds and the concentration of bioactive compounds.[7] In contrast, data on the effects of cooking on phenolic compounds of taro are still limited. A more integrated analysis of polyphenols change of taro is needed to obtain insight into the effects of traditional cooking methods. In this context, the objective of this study is to investigate the effect of quatre different cooking procedures (boiling and grilling, with and without the peel) on the phenolics compounds (flavonoids, tannins) in taro tubers.

MATERIAL AND METHODS

Plant material

Taro tubers commonly available on the Ivoirian market were purchased from a local market named “marché Gouro” in Abidjan district (Côte d’Ivoire). Each tuber was processed and analyzed on the day of the purchase.

Chemicals

Tungstophosphoric acid, Neu reagent, Folin–Ciocalteau reagent, gallic acid and were purchased from Sigma Aldrich (Saint Louis, USA) and Carlo Erba Reagents (Val-de-reuil, France). All the other chemicals and reagents of analytical grade were purchased from local sources.

Processing and Cooking methods

The experiment involved four traditional cooking methods: boiling with peel, boiling without peel, grilling with peel and grilling without peel. Initially, taro was cleaned in flowing water for removal of macroscopic impurities. Then, they were subjected to different cooking methods, in accordance with the parameters set out in **Table 1**. Soon after, they were peeled and manually sliced with stainless steel knives into cubes. For the cooking procedures, it was weighed 250 g for each repetition.

Table 1: Different cooking methods.

Cooking method	Equipment	Temperature	Cooling
Boiling with peel	Heating plate + cooking pot	~ 100 °C	Room temperature (~25 °C)
Boiling without peel	Heating plate + cooking pot	~ 100 °C	Room temperature (~25 °C)
Grilling with peel	Heating plate + grill	-	Room temperature (~25 °C)
Grilling without peel	Heating plate + grill	-	Room temperature (~25 °C)

The cooking time tested for taro was 15 to 25 min. The cooking time was applied in the experiment, since cooking times showed vegetable with better texture. The degree of softening was evaluated subjectively as recommended, through the pressure of cooked taro his fingers.[7]

Preparation of extracts

After cooking, vegetables were separated from cooking water (for boiling) and let to cool down. They were ground to a coarse powder using mortar and pestle. Crushed taro (100 g)

was extracted using 80 % ethanol (150 mL). For each extraction, the samples were shaken for 30 min at room temperature, then mixtures were allowed to stand for 24 hours at room temperature (25 °C). The supernatants of each extraction were collected, pooled and filtered through a Buchner funnel containing Whatman filter paper into 1000 mL filtering flask. The filtrates were evaporated and placed in an oven to dry at 40 ºC. The residues obtained were used for the study. The extracts were kept at - 4 °C until it was used in the experiment.

The yield (%) of the samples was calculated as:

$$\% \text{ yield} = \frac{\text{Final yield (g)}}{\text{Initial sample weight (g)}} \times 100$$

Estimation of the total phenolic content

The taro extracts were used for the determination of the total phenolic content by using a modified Folin-Ciocalteu reagent assay. Each extract (1 mL) or a gallic acid standard (31, 62, 125, 250 and 500 mg/L) was added to a volumetric flask (50 mL) containing distilled water (20 mL). 1 mL of each sample was added to a test tube, and 0.5 N Folin-Ciocalteu Reagent (1.5 mL) was added and shaken. After 3 min in the dark, 1.5 mL of 17% Na_2CO_3 was added to the mixture. The mixture was incubated at room temperature for 30 min in a dark place. The absorbance of the different concentrations of each extract was measured against a reagent blank at 720 nm by using a UV-Vis spectrophotometer. The total phenolic content of each extract was determined using a conventional method and external calibration with gallic acid equivalent per milligram of extract (µgGAE/mg). All of the crude samples and the standards were analysed in triplicate.[8]

Estimation of total flavonoid content

The extracts and the quercetin in reaction with Neu's reagent were used for the determination of the total flavonoid content using a UV-Visible spectrophotometer. 1 mL of extract or of quercetin (0.05 mg / mL) was added to 100 µL of Neu reagent (1% methanolic solution of 2-diphenylboric acid-aminoethyl ester). The absorbance of the extracts was read at 404 nm and compared to that of quercetin. The content of flavonoids was calculated using the following formula:

$$F = \frac{0.05 \times A_{ext} \times d}{A_q \times C_{ext}} \times 100$$

A_{ext}: Extract absorbance

A_q: Standard absorbance

C_{ext}: Concentration of extracted plant material (mg/mL).[9]

Determination of condensed tannins

Proanthocyanidin content was determined with a tungstophosphoric acid/$NaCO_3$ test as described by Palici et al. with some modifications. 2 mL of aqueous extract (4 mg/mL) was added to 17 mL de $NaCO_3$ (50%, m/V). The tubes were covered and placed in a dark place for 3 min. A calibration curve was drawn in parallel in the same operating conditions using catechin (0-100 µg/mL).The absorbance was read at 750 nm and results were expressed as follows: micrograms of catechin equivalent/mg of extract (µgCE/mg).[10]

Statistical analysis

The assays were carried out in three repetitions to assess their reproducibility. Results are presented as mean ± S.E. SPSS 15.0 statistical software was used for statistical analysis. P values <0.05 were considered statistically significant.

RESULTS AND DISCUSSION

Effect of cooking on yield

In order to compare the extractability of taro phyto composites in terms of the impact of the cooking method, a table below gives the extraction yields according to the cooking process (**Table 2**).

Grilling resulted in products with the highest yields for either the taro with peel or the taro without peel examined. On the contrary, boiling at 100 °C caused significant reduction in extraction yields compared to the grilled samples. In addition, the peel increases the yield for boiled taro, while it decreases it for grilled taro.

Table 2: Extraction yields after cooking process (%).

Extract	With peel	Without peel
Raw	2	1.4
Boiling	1.6	1.1
Grilling	1.9	2

Changes in content of polyphenolic compounds

The concentrations of polyphenolic compounds in the cooked taro tubers are shown in **Figure 1** with comparison of raw taro tubers. The cooking method affected total polyphenolic compounds of tubers. Both boiling and grilling methods of cooking remarkably influenced polyphenol content on the tested taro tubers cooked with peel and without peel. But the

boiling method without peel resulted in the significant increase of total polyphenolic content with respect to the raw tuber: 195 µgGAE/mg, followed by the boiling with peel with 182 µgGAE/mg and the grilling methods. The grilling method seemed to cause the small increase of the total polyphenolic content. The values measured after grilling with peel and without peel were 169 µgGAE/mg and 126 µgGAE/mg, respectively. The results obtained indicated that the polyphenol contents were very sensitive to cooking or heat treatment.

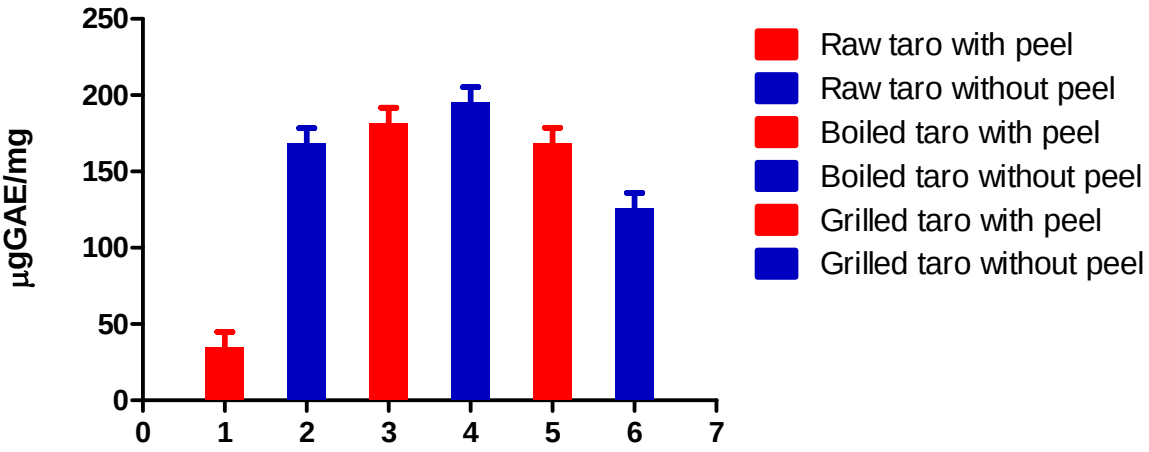

Figure 1: Effect of cooking temperature on the polyphenolic content of taro.

Figure 2 shows the values of total flavonoids content for taro tubers determined after different cooking treatments. For raw samples, the total flavonoid content ranged from 1.7 to 4.5 µgEQ/mg (raw tubers with peel and raw tubers without peel, respectively) and from 11.9 to 21.4 µgEQ/mg (braised tubers without peel and boiled tubers without peel, respectively) for cooked samples. These results show that the cooking method clearly influenced the content of total flavonoids.

The values of the contents of the tannins condensed in the taro are presented in **Figure 3**. Analysis by test with acid tungstophosphoric/$NaCO_3$ showed a very significant difference in the concentrations of tannin between samples of raw and cooked taro tubers. The average content of condensed tannins for the boiled samples was 1.5 to 4-fold higher compared to raw samples. Maximum values were obtained from grilled samples, 5 to 6-fold higher than raw samples. For all samples tested, the peel increased the content of condensed tannins.

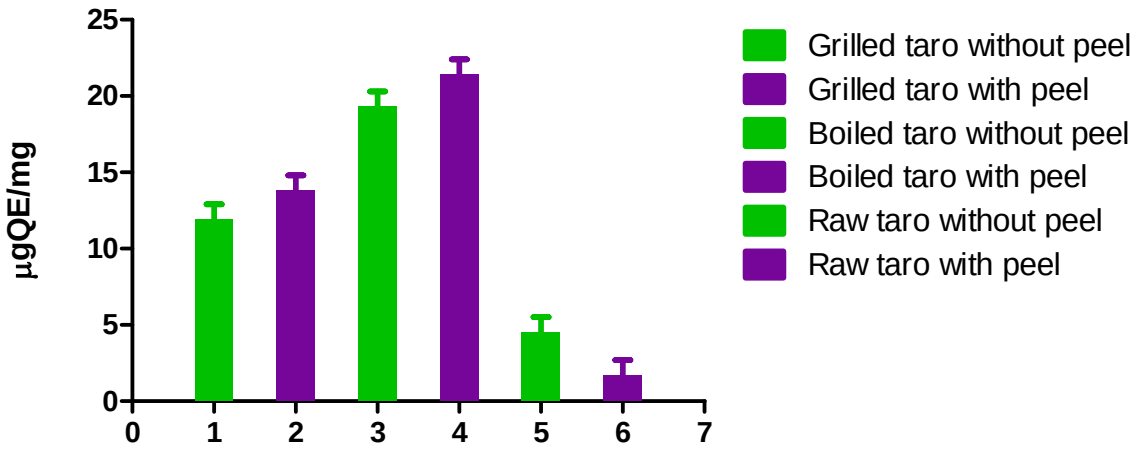

Figure 2: Effect of cooking temperature on the flavonoid content of taro.

Values obtained in this study with respect to the phenolic, flavonoid and condensed tannin contents of taro tuber suggest that taro tuber contains considerable amounts of these phenolic compounds. These results are in agreement with previous studies that indicate that taro tubers (*Colocasia esculenta*) are rich in polyphenols.[11–13] It is worth noting that the increase in the content of phenolic compounds after thermal processing has been found in other foods, such as sweet potato leaves after steaming and beans after the common and pressure-cooking processes, and this may be related to the release of soluble phenolic compounds.[14] In a similar study carried out on plantain, the levels of total phenols and total flavonoids increased significantly with cooking, while condensed tannins decreased significantly.[15]

Polyphenols are a large and diverse family of natural antioxidants commonly found in vegetables and fruits. Epidemiological studies show that regular consumption of foods rich in polyphenols induces a significant reduction in cellular oxidative stress.[16] Numerous epidemiological studies have shown the importance of the consumption of polyphenols on the prevention of certain diseases.[17] Literature evidence supports polyphenols as novel and strategic molecules in the prevention and treatment of metabolic diseases. This is explained not only by their anti-obesity, anti-oxidative, anti-inflammatory, anti-diabetes, and anti-hypercholesterolemic effects but also by their ability to improve and inhibit the growth of beneficial and pathogenic bacteria.[18] Furthermore, substantial experimental evidences support the hypothesis that dietary flavonoid intake has a favourable impact on cardiovascular diseases such as systemic, arterial hypertension and coronary artery diseases, which represent the leading cause of morbidity and mortality worldwide.[19] Tannins are a class of polyphenols widely present in the plant kingdom and possess various biological

activities, including antioxidant, antibacterial, antiparasitic, antiviral, anti-inflammatory, immunomodulatory, etc.[20]

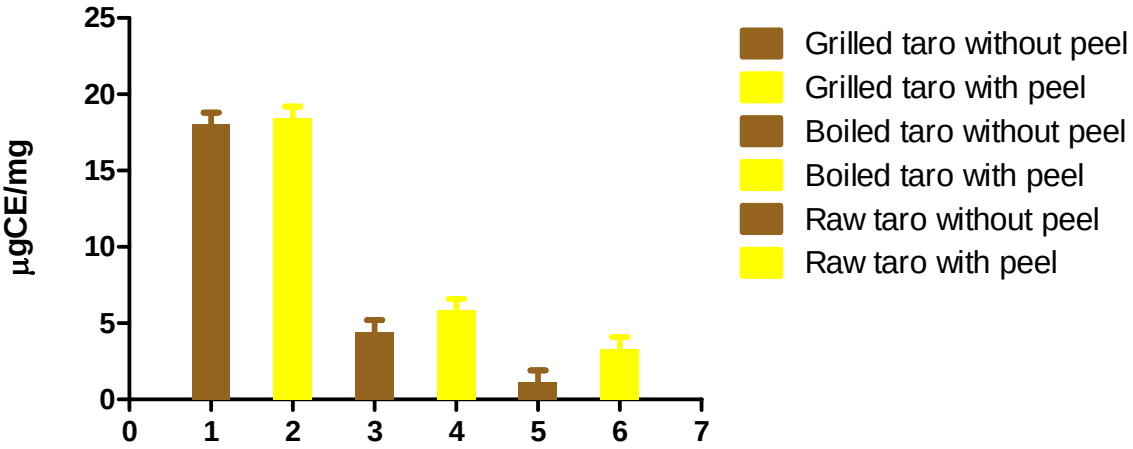

Figure 3: Effect of cooking temperature on the tannin content of taro.

CONCLUSION

The findings from the present study indicate that the polyphenolic compounds of taro tubers are significantly affected during domestic processing such as boiling and grilling. Among the thermal processing methods evaluated, boiling substantially increases the flavonoids in taro tubers studied, whereas grilling allows increasing the tannins. This is beneficial for health, especially since polyphenols become physiologically available for metabolic activities. It is an advantage for most African households with regard to the intake of polyphenols, because taro is an important food consumed daily. The results of this study can be used for making recommendations on the processing methods to be chosen for optimizing the health benefits of taro tubers.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

REFERENCES

1. Si H, Zhang N, Tang X, Yang J, Wen Y, Wang L, Zhou X. Transgenic Research in Tuber and Root Crops. In Genetic Engineering of Horticultural Crops; Elsevier, 2018; 225-248. https://doi.org/10.1016/B978-0-12-810439-2.00011-8.
2. Okonkwo CAC. Taro. In Genetic Improvement of Vegetable Crops; Elsevier, 1993; 709–715. https://doi.org/10.1016/B978-0-08-040826-2.50052-7.

3. Gerrano AS, Jansen Van Rensburg WS, Adebola PO, Manjeru P, Bairu MW, Venter SL. Evaluation and Selection of Taro [*Colocasia Esculentra* (L.) Schott] Accessions under Dryland Conditions in South Africa. Acta Agric. Scand. Sect. B-Soil Plant Sci, 2019; 69(3): 219-227. https://doi.org/10.1080/09064710.2018.1530296.
4. Yong W, Amin L, Dongpo C. Status and Prospects of Nutritional Cooking. Food Qual Saf, 2019; 3(3): 137–143. https://doi.org/10.1093/fqsafe/fyz019.
5. Hogervorst Cvejić J, Atanacković Krstonošić M, Bursać M, Miljić U. Polyphenols. In Nutraceutical and Functional Food Components; Elsevier, 2017; 203-258. https://doi.org/10.1016/B978-0-12-805257-0.00007-7.
6. Sakaki J, Melough M, Lee SG, Pounis G, Chun OK. Polyphenol-Rich Diets in Cardiovascular Disease Prevention. In Analysis in Nutrition Research; Elsevier, 2019; 259-298. https://doi.org/10.1016/B978-0-12-814556-2.00010-5.
7. de Lima ACS, da Rocha Viana JD, de Sousa Sabino LB, da Silva LMR, da Silva NKV, de Sousa PHM. Processing of Three Different Cooking Methods of Cassava: Effects on *in Vitro* Bioaccessibility of Phenolic Compounds and Antioxidant Activity. LWT - Food Sci Technol, 2017; 76: 253-258. https://doi.org/10.1016/j.lwt.2016.07.023.
8. Al-matani SK, Al-Wahaibi RNS, Hossain MA. *In Vitro* Evaluation of the Total Phenolic and Flavonoid Contents and the Antimicrobial and Cytotoxicity Activities of Crude Fruit Extracts with Different Polarities from *Ficus Sycomorus*. Pacific Sci Rev A Nat Sci Eng, 2015; 17 (3); 103–108. https://doi.org/10.1016/j.psra.2016.02.002.
9. Ridouane EG, Saida T, Amri O, Khadija EM, Abdelhakim H. Antioxidant Activity and Total Phenolic and Flavonoid Contents of 30 Medicinal and Aromatic Plants Located in the South of Morocco. Int J New Technol Res, 2015; 1(3): 7-11.
10. Palici I, Tita B, Ursica L, Tita D. Method for Quantitative Determination of Polyphenolic Compounds and Tannins from Vegetal Products. Acta Universatis Cibiniensis, 2005; 8(2): 21-32.
11. Akshatha M, Kavadikeri S, Rao NN. *In Vitro* Micropropagation and Antioxidant Assay in *Colocasia Esculenta*. Plant Tissue Cult Biotechnol, 2018. https://doi.org/10.3329/ptcb.v28i2.39677.
12. Eleazu CO. Characterization of the Natural Products in Cocoyam (*Colocasia Esculenta*) Using GC-MS. Pharm. Biol, 2016; 54(12): 2880-2885. https://doi.org/10.1080/13880209.2016.1190383.
13. Akyüz MG. [(Colocasia Esculenta (L.)] Yumrularının Etanol Ekstresinin Antioksidan Aktivitesinin Belirlenmesi. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa

Derg, 2019. https://doi.org/10.18016/ksutarimdoga.vi.589216.

14. Nickel J, Spanier LP, Botelho FT, Gularte MA, Helbig E. Effect of Different Types of Processing on the Total Phenolic Compound Content, Antioxidant Capacity, and Saponin Content of Chenopodium Quinoa Willd Grains. Food Chem, 2016; 209: 139-143. https://doi.org/10.1016/j.foodchem.2016.04.031.
15. Boua BB, Ouattara D, Traoré L, Mamyrbekova-Békro JA, Békro Y-A. Effect of Domestic Cooking on the Total Phenolic, Flavonoid and Condensed Tannin Content from Plantain of Côte d'Ivoire. J Mater Environ Sci, 2020; (3): 396-403.
16. Kesavan P, Banerjee A, Banerjee A, Murugesan R, Marotta F, Pathak S. An Overview of Dietary Polyphenols and Their Therapeutic Effects. In Polyphenols: Mechanisms of Action in Human Health and Disease; Elsevier, 2018; 221–235. https://doi.org/10.1016/B978-0-12-813006-3.00017-9.
17. Pathak S, Kesavan P, Banerjee A, Banerjee A, Celep GS, Bissi L, Marotta F. Metabolism of Dietary Polyphenols by Human Gut Microbiota and Their Health Benefits. In Polyphenols: Mechanisms of Action in Human Health and Disease; Elsevier, 2018; 347-359. https://doi.org/10.1016/B978-0-12-813006-3.00025-8.
18. Gowd V, Karim N, Shishir MRI, Xie L, Chen W. Dietary Polyphenols to Combat the Metabolic Diseases via Altering Gut Microbiota. Trends Food Sci Technol, 2019; 93: 81-93. https://doi.org/10.1016/j.tifs.2019.09.005.
19. Fusi F, Trezza A, Tramaglino M, Sgaragli G, Saponara S, Spiga O. The Beneficial Health Effects of Flavonoids on the Cardiovascular System: Focus on K+ Channels. Pharmacol Res, 2020; 152: 104625. https://doi.org/10.1016/j.phrs.2019.104625.
20. Huang Q, Liu X, Zhao G, Hu T, Wang Y. Potential and Challenges of Tannins as an Alternative to In-Feed Antibiotics for Farm Animal Production. Anim Nutr, 2018; 4(2): 137-150. https://doi.org/10.1016/j.aninu.2017.09.004