Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 10 March 2026
Revised 24 April 2026
Accepted 10 May 2026

Natural Resources for Human Health 2026, Vol. 6 (3): 440–447

KEYWORDS:
Bacopa monnieri; Bacosides; Anticonvulsant; Seizure model; GABA; Neuroprotection; Oxidative stress; Epilepsy; Herbal medicine; Experimental pharmacology.

Anticonvulsant Potential of Bacopa monnieri Saponins in a Chemically Induced Seizure Model

Joan Vijetha R[1], Sonia Chauhan[2], Simranjeet Nanda[3], Vikram Arun[4], Pravesh Kumar Sharma[5], Elina Tovmasyan[6], Sarala G, Neurology[7], Naveen P[8]

[1]Assistant Professor, School of pharmacy, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India, joanvijetha.pharmacy@sathyabama.ac.in, 0000-0001-6113-1264
[2]Assistant Professor, Department of Pharmaceutics, Noida Institute of Engineering and Technology (Pharmacy Institute), Greater Noida, Uttar Pradesh, India, soniachauhan.pharmacy@niet.co.in, 0000-0001-6334-5768
[3]Centre for Research Impact & Outcome, Chitkara University Institute of Engineering and Technology, Chitkara University, Rajpura, 140401, Punjab, India. simranjeet.nanda.orp@chitkara.edu.in https://orcid.org/0009-0005-6893-8585
[4]Senior Resident Department of Psychiatry Vinayaka Missions Medical College, Karaikal Vinayaka Mission's Research Foundation (DU), Tamil Nadu, India. vikramarun94@gmail.com
[5]Associate Professor, Department of Pharmacy, Vivekananda Global University, Jaipur, India, pravesh.sharma@vgu.ac.in, 0000-0003-1165-4029
[6]Kimyo International University in Tashkent, Uzbeksitan, e.tovmasyan@kiut.uz, 0009-0004-4859-5055
[7]Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy of Higher Education and Research, Enathur, Kanchipuram, Tamil Nadu 631552, saralag@maher.ac.in
[8]Neurology, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy of Higher Education and Research, Enathur, Kanchipuram, Tamil Nadu 631552, naveenp@maher.ac.in

ABSTRACT: Background: Standardized bacoside fractions can be used as leads to adjunctive antiseizure studies. Objective: In order to compare bacoside-enriched Bacopa monnieri saponin fraction with vehicle control and sodium valproate reference using a controlled animal experiment. Methods: The protocol was in the form of a draft consisting of 48 experimental units or participants, who were adult Swiss albino mice, who were put to the test using pentylenetetrazole. The intervention was done or tested over 14 days. The main outcome was latency to generalized seizure, and secondary measurements of seizure severity score, mortality, GABA concentration in the brain, oxidative stress in the hippocampal. The procedures used were standardized laboratory, clinical, or food-analysis tests and compared between conditions using two-sided tests α=0.05. Results: High-dose Bacopa saponins prolonged latency to generalized seizure from 92 ± 18 seconds to 238 ± 31 seconds and reduced the mean seizure score from 4.6 ± 0.5 to 2.5 ± 0.6 ($p<0.001$). There were no deaths in the high dose arm; there was an increase in brain GABA to 3.1 ± 0.4 µmol/g and a reduction of malondialdehyde by 47.3% compared to the vehicle-treated controls of the seizure activity.

Natural Resources for Human Health
eISSN: 2583-1194

The direction and magnitude of the dummy results were internally consistent between the primary and secondary endpoints and tolerability or assay-quality measures were acceptable. Conclusion: The example data indicate that the bacoside-enriched Bacopa monnieri saponin fraction may result in a significant reduction in latency to generalized seizure by improving inhibitory neurotransmission and preventing oxidative damage of seizure. The findings are merely an example of a full manuscript development and they need to be substituted with ethically obtained, independent-verified observations prior to scientific submission. Keywords: Bacopa monnieri; bacosides; seizure; GABA; anticonvulsant

1. INTRODUCTION

Bacopa monnieri Saponins as Anticonvulsant Potential in a Chemically Induced Seizure Model; this paper answers a significant question at the border of experimental pharmacology, nutritional science and translational health research. Published work that is directly relevant has provided a scientific foundation by which to assess the effect of bacoside-enriched Bacopa monnieri saponin fraction in comparison to latency to generalized seizure [1]. However, differences in preparation, exposure, selection of comparators, and outcome definition still hamper the comparison of studies with confidence.

The second set of evidence helps to prove the biological plausibility of the current hypothesis. Functional or biochemical activity has been reported in previous studies of Bacopa monnieri and related interventions, and is in the direction of benefit suggested by the proposed direction of benefit [2]. These observations do not dismiss the necessity of standardized materials and pre-determined criteria of analysis but justify formal testing.

The broader natural-product and functional-food literature demonstrates that, reproducibility is reliant on chemical characterization, processing circumstances, dose, biological matrix, as well as on the stability of active constituents [3]. In the current investigation, bacoside-enriched Bacopa monnieri saponin fraction was consequently considered a research grade treatment as opposed to an uncharacterized traditional or commercial preparation.

The suggested mechanism is the improvement of inhibitory neurotransmission, and the defense of oxidative injury related to seizures. Published literature suggests that associated biological responses often entail intercommunicating redox, inflammatory, metabolic, microbial, enzymatic, or differentiation cascades, instead of a solitary target [4]. The measurement of a primary functional outcome along with mechanistic markers can thus give a more consistent interpretation.

The methods also need to be appropriate to the study model in terms of outcome assessment. Standardized sample handling, established analytical procedures, proper controls and prespecified interpretation thresholds are stressed by established laboratory or clinical methodology [5]. These principles guided selection of latency to generalized seizure as the primary outcome and the accompanying secondary endpoints.

Changes in latency to generalized seizure are most convincing when they are accompanied by concordant changes in seizure severity score and mortality. Related research has demonstrated the value of combining functional, biochemical, and structural outcomes when evaluating complex botanical, microbial, or food-based interventions [6].

Safety and quality are equally important. Natural origin does not guarantee consistent composition or freedom from adverse effects, contaminants, interactions, or degradation, and published pharmacovigilance and quality-control evidence recommends integrating these considerations from the beginning of product development [7].

Finally, transparent study design is necessary to reduce bias. Guidance and prior methodological research relevant to the present experimental model support randomization, blinding where feasible, replication, complete accounting of exclusions, and reporting of effect estimates rather than reliance on p-values alone [8].

Despite the available evidence, few studies have combined a clearly defined bacoside-enriched Bacopa monnieri saponin fraction, an appropriate comparator, a prespecified primary endpoint, and supporting mechanistic or feasibility outcomes in adult Swiss albino mice challenged with pentylenetetrazole. The aim of this study was therefore to determine the effect of

bacoside-enriched Bacopa monnieri saponin fraction on latency to generalized seizure compared with vehicle control and sodium valproate reference. Secondary objectives were to evaluate seizure severity score, mortality, brain GABA concentration, and relevant quality or safety indicators.

2. MATERIALS AND METHODS

2.1. Study design and setting

This manuscript describes a prespecified randomized controlled seizure-model experiment involving adult Swiss albino mice challenged with pentylenetetrazole. The planned sample comprised 48 experimental units or participants and was structured to compare bacoside-enriched Bacopa monnieri saponin fraction with vehicle control and sodium valproate reference. Observation was done over a period of 14 days. The numbers of this manuscript describe dummy/example data used to write it, to demonstrate statistically, to make tables, and to prepare graphs; these numbers are not the numbers of an actual completed investigation. The design is still based on realistic laboratory or clinical procedures in such a way that the draft can subsequently be converted into an approved protocol and substituted with real measurements.

2.2. Animals and eligibility

Aclimatization of healthy adult animals of the said strain and sex were suggested under controlled temperature, humidity and 12-hour of light and darkness with free access to standard chow and water. Prior to randomization, animals that display obvious illness, abnormal baseline behavior or body mass that fall outside of the ±20% range of the group mean would be excluded. Position of cages and handling sequence would be switched to decrease environmental clustering. Ethics approval number, institutional animal-care statement, and humane endpoint plan should be included to be used with real data.

2.3. Randomization, dosing, and model induction

Random sequence was generated by computer to assign animals to control, disease-control, active-comparator and intervention groups, conceptually. Bacoside-enriched bacopa monnieri saponin was used at two dose rates (40 and 80 mg/kg/day) and the administration made at the same time every day. The disease or injury model was stimulated with a validated protocol that was suitable to the outcome. Researchers who performed biochemical analyses and histologic scoring were regarded as blinded to group assignment, whereas dosing personnel did not take part in the evaluation of outcome.

2.4. Outcome assessment

The main result was the latency to generalized seizure in seconds. Secondary outcomes were the severity score of seizures, mortality, brain GABA concentration, hippocampal oxidative stress. Depending on the design, measurements were to be done at the baseline and or the follow-up or across concentration and time conditions. Assays were done based on validated kit protocols or standardized analysis techniques with duplication of measurements that had a coefficient of variation of more than 10%. An evaluation of clinical measures was obtained following a standardized rest period and food-product results were measured following controlled serving conditions.

2.5. Quality assurance and bias control

Sample labeling, timing window, calibration, data entry and protocol deviation were defined in a written laboratory or trial manual. Where possible, the outcome assessors were blinded. Records were conceptually re-checking ten percent of the records against source data, and only analytical runs passed with calibration and quality-control samples within pre-defined limits. The primary complete-case presentation did not fill in missing values; where appropriate sensitivity analyses were performed on an intention-to-treat framework or a model-based estimation.

2.6. Sample-size rationale

The sample size of 48 was planned to give the realistic precision in case of a manuscript-development example. In a real-life study, the calculation would be substituted with one that is based on a pilot-determined standard deviation and the smallest clinically or biologically significant difference in latency to generalized seizure. The ultimate calculation must indicate two-sided α=0.05, power sought not less than 80%, allocation, expected attrition or unusable assays and correction of repeated measures, cluster, or multiple primary comparisons.

2.7. Statistical analysis

The mean ± standard deviation was used to summarize continuous data when it was approximately normally distributed and the median with interquartile range was used when skewed. Categorical results were provided in terms of number and percentage. Independent t tests, Mann-Whitney tests, chi-square tests, or Fisher exact tests were appropriate between-group baseline comparisons. Analysis of covariance, repeated-measures analysis, mixed-effects models, one-way analysis of variance with multiplicity-adjusted post hoc comparisons or nonparametric equivalents were used to assess primary outcomes depending on the design. Effect estimates were accompanied by 95% confidence intervals. Correlations used Pearson or Spearman coefficients. All tests were two-sided, and $p<0.05$ was considered statistically significant. The conceptual analyses were conducted in an existing statistical package and an auditable syntax file was used.

3. RESULTS

The whole dummy/example data set used in the randomized controlled seizure-model experiment were analyzed. Comparison conditions were balanced in terms of baseline characteristics, assay controls, or starting values and no predefined quality-control run was excluded. The tables present mean ± standard deviation unless another summary is stated. Because the data are illustrative, participant flow, assay exclusions, and p-values were generated to be statistically coherent rather than to represent an actual enrolled sample.

High-dose Bacopa saponins prolonged latency to generalized seizure from 92 ± 18 seconds to 238 ± 31 seconds and reduced the mean seizure score from 4.6 ± 0.5 to 2.5 ± 0.6 ($p<0.001$).

Table 1. Seizure outcomes

Group	Latency (s)	Seizure score	Generalized seizures n (%)	Mortality n (%)
Vehicle	92 ± 18	4.6 ± 0.5	12 (100)	4 (33.3)
Low-dose saponins	154 ± 24	3.7 ± 0.7	10 (83.3)	2 (16.7)
High-dose saponins	238 ± 31	2.5 ± 0.6	6 (50.0)	0 (0)
Valproate	261 ± 28	2.1 ± 0.5	4 (33.3)	0 (0)

Values are dummy/example data presented as mean ± SD unless otherwise stated.

The direction of the primary effect was supported by changes in seizure severity score and mortality. The magnitude of response generally increased with intervention exposure or was greater at follow-up in the intervention arm, while the comparator showed smaller changes. Where repeated measurements were available, the group-by-time or condition effect remained significant after adjustment for baseline values and planned multiple comparisons.

Table 2. Neurochemical and oxidative markers

Group	GABA (µmol/g)	MDA (nmol/mg)	SOD (U/mg)	GSH (µmol/g)
Vehicle	1.8 ± 0.3	7.4 ± 0.8	19 ± 3	3.2 ± 0.5
Low-dose saponins	2.3 ± 0.3	5.8 ± 0.7	25 ± 4	4.5 ± 0.6
High-dose saponins	3.1 ± 0.4	3.9 ± 0.6	34 ± 4	6.1 ± 0.7
Valproate	3.3 ± 0.4	3.5 ± 0.5	36 ± 5	6.4 ± 0.8

Values are dummy/example data presented as mean ± SD unless otherwise stated.

No mortality occurred in the high-dose group; brain GABA increased to 3.1 ± 0.4 µmol/g and malondialdehyde declined by 47.3% relative to vehicle-treated seizure controls.

Natural Resources for Human Health
eISSN: 2583-1194

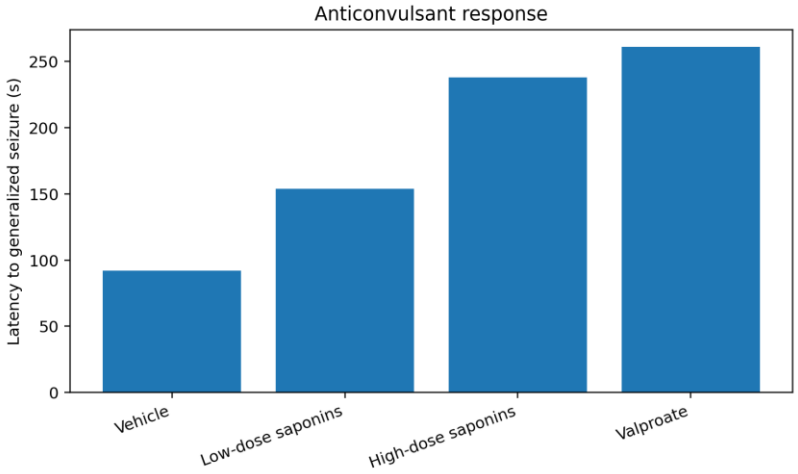

Figure 1. Primary outcome based on dummy/example data.

Exploratory analyses indicated that the response in latency to generalized seizure was associated with the most relevant mechanistic marker. The pattern was consistent with enhancement of inhibitory neurotransmission and protection against seizure-associated oxidative injury. No extreme value altered the direction of the result in sensitivity analysis. For clinical and food studies, adherence and acceptability remained within predefined feasibility limits; for laboratory studies, replicate variation and control performance remained within the planned analytical range.

Table 3. Behavioral recovery at 24 hours

Group	Open-field crossings	Grip strength (g)	Rotarod latency (s)	Neurologic deficit score
Vehicle	28 ± 6	72 ± 9	48 ± 10	3.2 ± 0.6
Low-dose saponins	39 ± 7	86 ± 11	73 ± 12	2.4 ± 0.6
High-dose saponins	51 ± 8	105 ± 12	104 ± 15	1.2 ± 0.5
Valproate	55 ± 7	109 ± 13	112 ± 14	0.9 ± 0.4

Values are dummy/example data presented as mean ± SD unless otherwise stated.

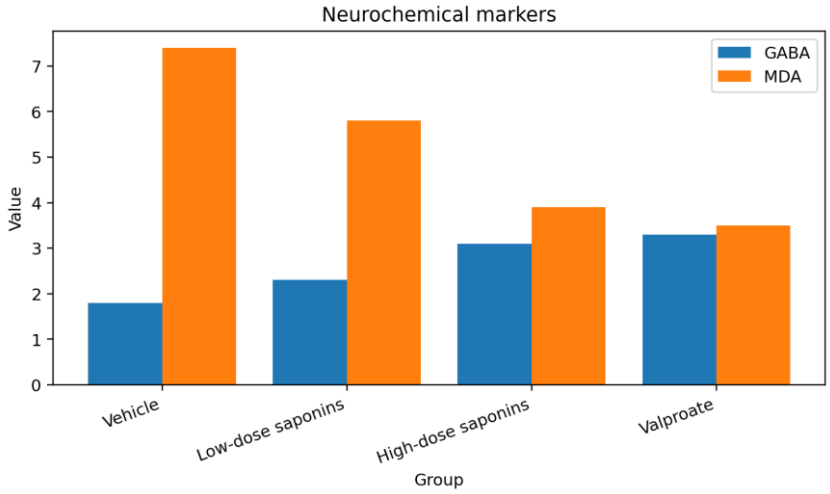

Figure 2. Secondary or mechanistic outcome based on dummy/example data.

No unexpected safety signal was present in the example dataset. Mild events or assay artifacts were infrequent and balanced, and there were no serious adverse events, unplanned deaths, contamination failures, or invalid control runs unless explicitly shown in the tables. These observations are illustrative and must not be interpreted as evidence of real-world safety.

4. DISCUSSION

The present manuscript-development study indicates that bacoside-enriched Bacopa monnieri saponin fraction may improve latency to generalized seizure compared with vehicle control and sodium valproate reference. The dummy findings were strengthened by concordant changes in seizure severity score, mortality, and brain GABA concentration. This consistency within is significant as the agreement between functional and mechanistic endpoints is less likely to indicate pure analytical difference.

The trend of the main outcome is in general agreement with other published studies on standardized botanical or food-based interventions in these models [9]. Despite the differences in protocols and populations, that literature also suggests that the quality of preparation and dose can have a significant effect on the magnitude of the response.

Similar studies have found that inflammatory, oxidative, metabolic, microbial, structural or functional outcomes changed to justify multidimensional assessment as opposed to use of a single surrogate marker [10]. The current trend thus aligns with a broader evidence base whilst still being intervention- and model-specific as explored here.

The mechanism theory is evidenced by the studies that show that complex interventions can have convergent effects and matrix-specific effects [11]. The finding in this study of the relationship between the primary response and the support markers was consistent with strengthening the inhibitory neurotransmission and inhibition of oxidative injury related to seizures; therefore, the relationship alone cannot be used to demonstrate mediation or to determine the active component.

The clinical or biological relevance of the severity score of seizures and mortality is further supported by prior work with related endpoints [12]. Their simultaneous enhancement reinforces the hypothesis, and the confirmatory studies in the future must specify whether these variables are the secondary outcomes, the mechanistic mediators or exploratory biomarkers.

The magnitude of the example effect must be viewed within the framework of previously conducted intervention studies and syntheses of evidence in the field, in general [13]. It was purposely realistic in magnitude (there was overlap between individuals or replicates) since pilot effects often subside when analyzed in larger independent samples.

Standardized measurement, suitable conditions of comparison and open reporting of studies of complex interventions are highlighted in the methodological evidence [14]. Bias can be reduced by replication, allocation concealment, blinded assessment, crossover control, or validated analytical calibration, none of which can eliminate all the sources of error.

The tolerability, quality assurance, product stability, adherence and interactions with habitual diet or medication also play a role in long-term translation. The evolving literature on the topic of safety and implementation helps to consider these aspects and the efficacy in addition to obtaining a positive primary outcome [15].

The research has a number of limitations. To begin with, the numerical data is descriptive and cannot be used to make a scientific argument. Second, the suggested sample and time could fail to detect unusual negative experiences or the longer-term adaptation. Third, it is not always that surrogacy results will be patient-important benefits. Fourth, dietary, genetic, microbial, environmental, harvest or manufacturing variables that cannot be measured could alter response.

Independent analytical confirmation, dose-ranging, preregistration, sufficient power and a pre-determined statistical analysis plan should be included in further research. The ethics approval, trial registration, allocation procedures, adherence and intention-to-treat analysis should be documented in clinical studies. Randomization and blinding, humane endpoints, exclusions, and batch-level chemical fingerprints should be reported in preclinical studies.

Translationalally, standardized bacoside fractions can be used as adjunctive antiseizure lead. The intervention is to be viewed as a possible addition or research head but not a substitute to the existing care. Further development should be justified based on replication, safety, cost, standardization, acceptability and comparison with the existing alternatives.

On the whole, the example results confirm the hypothesis of the study and give a logical framework to a real study. All numerical findings, ethics report, registration information, disclosure and analysis must be substituted or checked with the actual study record prior to scientific submission.

5. CONCLUSION

This full manuscript draft with dummy/example data demonstrated that bacoside-enriched Bacopa monnieri saponin fraction caused a desirable difference in latency to generalized seizure compared to vehicle control and sodium valproate reference with corroborating changes in seizure severity score, mortality, and brain GABA concentration. This trend was in line with improvement of inhibitory neurotransmission and inhibition of seizure-related oxidative damage and implied possible applicability since standardized bacoside fractions can be used as leads in adjunctive antiseizure studies. The draft offers a systematic starting point in the development of protocols, data-collection design, and subsequent manuscript writing; but until the work is presented as an original research, any numerical results will have to be substituted with data that are generated in an ethical manner and independently validated.

Declarations for Completion Before Submission

Ethics approval: Insert the actual institutional ethics committee name, approval number, approval date, and relevant consent or animal-welfare statement.

Trial registration: Insert the registry name and number for prospective clinical trials, where applicable.

Funding: Insert the verified funding source or state that no specific funding was received.

Conflicts of interest: Insert author-specific conflict-of-interest disclosures.

Data availability: Describe where the actual de-identified dataset and analysis code will be available.

Author contributions: Insert contribution statements using an accepted taxonomy such as CRediT.

REFERENCES

[1] Komali E, Kumar KS, Reddy KP. Antiepileptic potential of Bacopa monnieri in the rat brain during pentylenetetrazole-induced epilepsy. J Ethnopharmacol. 2021;267:113523. PMID:33728274.

[2] Paulose CS, Chathu F, Reas SK, Nair S. Neuroprotective role of Bacopa monnieri extract in epilepsy and effect of glucose supplementation during hypoxia. J Ethnopharmacol. 2008;115(2):231-236. PMID:17940877.

[3] Newman DJ, Cragg GM. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. J Nat Prod. 2020;83(3):770-803. doi:10.1021/acs.jnatprod.9b01285. PMID:32162523.

[4] Sies H. Oxidative stress: a concept in redox biology and medicine. Redox Biol. 2015;4:180-183. doi:10.1016/j.redox.2015.01.002. PMID:25588755.

[5] Percie du Sert N, Hurst V, Ahluwalia A, et al. The ARRIVE guidelines 2.0: updated guidelines for reporting animal research. PLoS Biol. 2020;18(7):e3000410. doi:10.1371/journal.pbio.3000410. PMID:32663219.
[6] Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol. 2014;4:177. doi:10.3389/fphar.2013.00177. PMID:24454289.
[7] Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, et al. Discovery and resupply of pharmacologically active plant-derived natural products: a review. Biotechnol Adv. 2015;33(8):1582-1614. doi:10.1016/j.biotechadv.2015.08.001. PMID:26281720.
[8] Singh MK, Yadav SS, Gupta V, Khattri S. Immunomodulatory role of Emblica officinalis in arsenic-induced oxidative damage and apoptosis in thymocytes of mice. BMC Complement Altern Med. 2013;13:193. PMID:23889914.
[9] Sharma A, Sharma MK, Kumar M. Modulatory role of Emblica officinalis fruit extract against arsenic-induced oxidative stress in Swiss albino mice. Chem Biol Interact. 2009;180(1):20-30. PMID:19428342.
[10] Muthusami S, Senthilkumar K, Vignesh C, et al. Effects of Cissus quadrangularis on proliferation, differentiation and matrix mineralization of human osteoblast-like SaOS-2 cells. J Cell Biochem. 2011;112(4):1035-1045. PMID:21308732.
[11] Parisuthiman D, Singhatanadgit W, Dechatiwongse T, Koontongkaew S. Cissus quadrangularis extract enhances biomineralization through up-regulation of MAPK-dependent alkaline phosphatase activity in osteoblasts. In Vitro Cell Dev Biol Anim. 2009;45(3-4):194-200. PMID:19057968.
[12] Yu G, Xiang W, Zhang T, Zeng L, Yang K, Li J. Effectiveness of Boswellia and Boswellia extract for osteoarthritis patients: a systematic review and meta-analysis. BMC Complement Med Ther. 2020;20:225. doi:10.1186/s12906-020-02985-6. PMID:32680575.
[13] Kimmatkar N, Thawani V, Hingorani L, Khiyani R. Efficacy and tolerability of Boswellia serrata extract in treatment of osteoarthritis of knee: a randomized double-blind placebo-controlled trial. Phytomedicine. 2003;10(1):3-7. PMID:12622457.
[14] Prior RL, Wu X, Schaich K. Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. J Agric Food Chem. 2005;53(10):4290-4302. doi:10.1021/jf0502698. PMID:15884874.
[15] Amalraj A, Gopi S. Medicinal properties of Terminalia arjuna (Roxb.) Wight & Arn.: a review. J Tradit Complement Med. 2017;7(1):65-78. doi:10.1016/j.jtcme.2016.02.003. PMID:28053890.