



International Journal of Pharmaceutical and Phytopharmacological Research (eIJPPR)

[Impact Factor – 0.852]

Journal Homepage: www.eijppr.com

Research Article

Comparative Analysis of Active Constituents in *Centella Asiatica* Varieties (Majjaposhak and Subhodak)

N CH. Madhusudhan¹, P. Neeraja², Prathibha Devi³¹Plant Biotechnology and Molecular Genetics Laboratory, Department of botany, Osmania University, Hyderabad, 500007, Andhra Pradesh, India.²Assistant Professor, Department of pharmaceuticals, Geethanjali College of Pharmacy, Hyderabad, Andhra Pradesh, India.³Professor, Department of botany, Osmania University, Hyderabad, Andhra Pradesh, India.

Article info

Article History:
Received 15 May 2014
Accepted 25 October 2014

Keywords:

Asiaticoside, Asiatic acid,
Centella asiatica, HPLC,
medicinal plants, T L C ,
3-O-glucuronide.

Abstract

Centella asiatica is an important medicinal plant of subtropical to tropical region. It grows widely in different habitats. A comparative quantitative analysis of chemical constituents in Majjaposhak and Subhodak varieties of *Centella asiatica* collected from CIMAP, Hyderabad was carried out by HPLC to evaluate the variability in the important constituents. Qualitative phytochemical analysis of the plant confirms the presence of various phytochemicals like alkaloids, flavonoids, tannins, terpenoids, saponin, steroids, carbohydrates and cardiac glycosides in its aqueous extracts. The two varieties of *C. asiatica* exhibited differences in terpenoid content especially of asiaticoside. The asiaticoside of interest was analysed and quantified by TLC and HPLC in crude ethanolic extracts. The chromatogram for the plant extracts of two varieties of *Centella asiatica* (Majjaposhak and subhodak) were developed using different solvent systems such as methanol: water (70:30) using isocratic program and Acetonitrile: water using Binary gradient program. Peak was not identified when methanol:water used as solvent system (isocratic elution). Finally, the Acetonitrile: water system (gradient elution) was used for the analysis of Asiaticoside A difference in bioactive triterpenoids was exhibited that was tissue specific and varied between the two varieties. Asiaticoside content was highest in leaves of Subhodak variety ($1.42 \pm 1.60\%$ dw) than the leaves of Majjaposhak variety ($0.78 \pm 0.02\%$ dw). However, the difference was statistically significant for asiaticoside ($p < 0.05$). Comparative study of two varieties of *Centella asiatica* showed a correlation between genomic diversity and asiaticoside content. The leaves of Subhodak variety of *Centella asiatica* found to contain around two times higher concentration of asiaticoside than those from Majjaposhak variety.

1. INTRODUCTION

Centella asiatica is used in different regions by diverse ancient cultures and tribal groups. In India, it is described under the name of Mandukaparni and used in Ayurveda medicine. It is also listed as one of the Traditional Chinese Medicine (TCM) in China (World Health Organization, 1989). It is used as a support for faster healing of small wounds^{1,6}. The plant extract is incorporated into the Indian pharmacopoeia and recommended not only for wound healing but also for the treatment of skin diseases such as eczema, leprosy and psoriasis. In addition to the above, it is also used in the treatment of burns, itching and insect bites. In contrast with other medicinal plants, this plant has been subjected to quite extensive experimental and clinical investigations due to its ability to heal relieve and help in the recovery from various pain and sickness.¹ It is used to modulate oxidative stress response that has been implicated in the neurodegenerative changes that occur with Alzheimer's disease^{2,7-11}.

1.1 Chemical composition of *Centella asiatica*

Triterpene is a major and the most important component of *C. asiatica*. It is used as a marker constituent in quality control analysis. The triterpenes obtained from *Centella asiatica* are mainly pentacyclic triterpenic acids and their respective glycosides, belonging to ursane-or oleanane-type, including asiatic acid, asiaticoside, madecassic acid, madecassoside, brahmoside,

brahmic acid, brahminoside, thankunside, isothankunside, centelloside, madasiatic acid, centic acid, cenellic acid, betulinic acid, indocentic acid etc^{3,4,12-18}.

Centellosides such as asiaticoside, madecassoside, asiatic acid and madecassic acid are found to be active metabolites of *Centella asiatica*. They have many medicinal and therapeutic properties. They are used for diseases associated with the skin, nervous system and blood. Centellosides are ursane-type triterpene saponins resulting from the cyclisation of 2, 3-oxidosqualene by amyrin synthase.^{5,6,19-23} Among the three triterpenes, asiatic acid is the most important ingredient for biological activity. The active principle of *Centella asiatica* especially asiaticoside has been studied extensively for use as antidepressant.^{7,8,24-30}

Being the chief bioactive substances in *C. asiatica*, triterpenoid derivatives play an important role in the aspect of medicinal application. Traditional uses of several triterpenoids have been scientifically validated and some of the active principles were reported.^{9,10,31,32} Three major triterpenoid glycosides, i.e. asiaticoside, madecassoside and asiaticoside-B were isolated by thin layer chromatography method in *Centella asiatica* extracts.^{11,33}

Asiaticoside and madecassoside may be effective in treating arthritis. Asiatic acid induces apoptosis and cell cycle arrest in several types of cancer in rats.^{12,13,34-38}

Other components isolated from *C. asiatica*, such as brahmoside and brahminoside, may be responsible for CNS and utero relaxant actions, but are yet to be confirmed by clinical studies^{14,39-43}. Centelloside and its derivatives were found to be effective in the treatment of venous hypertension^{15,16,44}. The present research work has been undertaken to isolate and identify Asiaticoside (Fig.1) from *Centella asiatica* plant extracts by High Performance Liquid Chromatography^{17,45}. The study comprises the qualitative and quantitative analysis of the chemical components of *Centella asiatica* by qualitative tests followed by

*Corresponding Author:

N. C H Madhusudhan,
H No: 11-3-359/5, flat no 301,
Nomula Saptagiri Towers, Srinivas Nagar,
Secunderabad - 500061, Andhrapradesh, India.
Email: madhusudhan.nch@gmail.com
Contact no.: +91-9885189150

chemical analysis (especially Asiaticoside) by Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography.

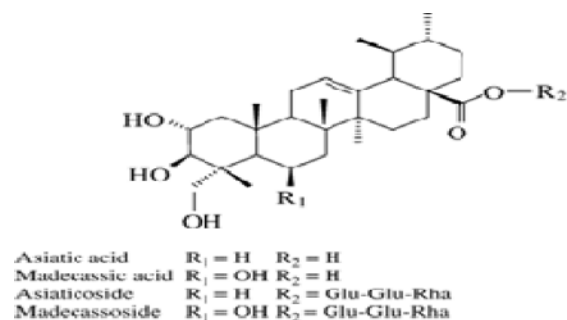


Figure 1: Asiaticoside structure

2. MATERIALS AND METHODS

2.1 Materials required

Pre-coated silica gel (Aluminium sheet) as an adsorbent, Chloroform, Glacial acetic acid, Methanol, water, Acetonitrile and Sulphuric acid etc.

2.2 Chemicals and glassware

Chemicals required are Ethanol, methanol, acetone, acetonitrile, HPLC grade water, Liquid nitrogen, Chloroform, Standard asiaticoside etc.

2.3 Instruments

Freeze drier, Vortexes, HPLC equipment with RP C₁₈ Column. In the present work, the modular LC (LC 20-A) from Shimadzu available in central facilities for research and development was used. The equipment consists of Dual plunger with modular flow line, Auto injectors (for injection of sample), RP C₁₈ Column ovens (CTO 20A/20AC) and Photo Diode Array (PDA) detector.

2.4 Plant material

The two varieties of *Centella asiatica* (L.) Urban (syn.: *Hydrocotyle asiatica* L.) of the Apiaceae (Umbelliferae) family were collected from CIMAP (Hyderabad) and from the Forest Academy, Dhulapally, on the outskirts of Hyderabad and GHMC Herbal Garden, Hyderabad. and grown in the botanical and experimental garden, Department of Botany, Osmania University, Hyderabad. The two varieties have been referred to as Majjaposhak and Subhodak.

2.5 Processing of plant samples

The leaves of the *Centella asiatica* (L.) Urban plants were properly washed using tap water and then rinsed with distilled water. The rinsed leaves were dried in an oven at a temperature of 35-40°C for 3 days. The dried leaves of each plant were pulverized, using a sterile electric blender, to obtain a powdered form. The powdered form of these plants was stored in airtight glass containers, protected from sunlight until required for analysis.

2.6 Preparation of aqueous extract of plant samples

The aqueous extract of each plant sample was prepared by soaking 10 g of powdered samples in 200 ml of distilled water for 12 h. The extracts were then filtered using filter paper or Whatman filter paper.

2.7 Phyto chemical analysis

Chemical tests were conducted on the aqueous extract of each plant sample and also of the powdered form of the plant samples using standard methods.^{18,19} Test for tannins, phlobatannins, saponins, flavonoids, terpenoids and cardiac glycosides was performed. The plant extract was analysed for the estimation of several phytochemical constituents by quantitative analysis and for the estimation of asiaticoside by thin layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC).

2.8 Special method of extraction for TLC and HPLC analysis

The leaves of *Centella asiatica* were freeze-dried and 1 gram of powdered tissue was dissolved in Ethanol (70ml): water (30ml) (7:3) and kept for 48 hours. The extract was filtered through Whatman No.1 filter paper and was transferred into separating funnel. To this extract, 20 ml petroleum ether was added, to separate the aqueous layer. The aqueous layer was collected, and acetone (20 ml) and 20 ml Di ethyl ether were added to it. After that, the aqueous layer was collected and vortexed for 3 minutes followed by centrifugation at 5800g for 1 minute to remove particulate matter. Supernatant was collected and filtered through 0.22µm membrane filter and then subjected to TLC, HPLC analysis.

The requirements of TLC includes adsorbent, mobile phase, TLC plates, developing tank and detecting agents.

a) TLC: TLC profile of leaf extract of two varieties of *Centella asiatica* was performed by using pre-coated silica gel (Aluminium sheet as an adsorbent). Chloroform: Glacial acetic acid: Methanol: water (60:32:12:8) was used as mobile phase. Standard is prepared by dissolving 10 mg of asiaticoside in 10 ml of methanol. 1 ml of *Centella asiatica* was dissolved in 10 ml methanol. 10 µl applied on TLC plate. Solvent front was run up to 9 cms. Anisaldehyde Sulphuric acid reagent was used for detection of spots. The RF Value of standard asiaticoside was 0.4 (Green spot). The spots with same RF value were identified with leaf extract of two varieties of *Centella asiatica*.

b) HPLC: Standard asiaticoside is procured from Sigma™. Shimadzu's Prominence HPLC system was used for the analysis. The Column used in HPLC analysis was RP C₁₈ RP-Reverse Phase and PDA (Photo Diode Array) as detector. The Mobile Phase used is Methanol: water (70:30), Acetonitrile: water (Gradient elution). The flow rate used was 1 ml/min., sample injection volume 20µl at a temperature of 25°C and the detector wavelength was 214nm.

c) Standard preparation

Weigh accurately 1 mg of asiaticoside in a 25 mL volumetric flask. Dissolve in 15 mL of Acetonitrile and make up to 25 mL with Acetonitrile.

d) Procedure

The mobile phase (mixture of solvents) was introduced into the column with the help of plunger reciprocating pump. The instrument consists of Dual plunger with tandem flow line (LC 20-A) to reduce pressure fluctuations. Temperature is maintained at 25°C with the help of column ovens. Initially standard asiaticoside is placed in auto injector (SIL 20-AC) and the chromatogram was run. Then the column was washed with HPLC grade water. Later the extract is auto injected. The components are separated in RP C₁₈ Column and detected by PDA. Finally, the chromatograms were recorded.

3. RESULTS AND DISCUSSION

Centella asiatica leaf extract was brownish green in coloration when treated with 0.1% FeCl₃ that shows the presence of tannins. The frothing was converted into emulsion with 3 drops of olive oil, which indicates the presence of saponins. Plant extract has shown yellow coloration when treated with 1% NH₃, which indicates the presence of flavonoid compounds. An interface with a reddish brown coloration is formed when plant extract was treated with concentrated H₂SO₄, which indicates the presence of tanins. Brown ring is appeared when plant extract was treated with FeCl₃ and concentrated H₂SO₄, which indicates the presence of cardiac glycosides. The percentage of phytochemicals in Majjaposhak and Subhodak varieties of *Centella asiatica* were reported (Table 1 and 2).

Standard asiaticoside and Leaf extract of Majjaposhak and Subhodak variety of *Centella asiatica* (C1, C2) were loaded on pre-coated silica gel. Solvent front was found to be 9 cms. The R_f value of standard asiaticoside was 0.4. The R_f values of C1 and C2 were identical to the R_f value of asiaticoside. All the spots were appeared in green colour. Hence, asiaticoside was confirmed in leaf extracts of *Centella asiatica*. Chloroform: Glacial acetic acid: Methanol: water (60:32:12:8) was used as mobile phase. In HPLC studies, initially the chromatogram was recorded for standard asiaticoside (procured from Sigma™) using Acetonitrile: water (70:30) solvent system. Standard Asiaticoside fraction was eluted in between 8-10

minutes and peak was identified (Figure 2). The chromatogram for the plant extracts of two varieties of *Centella asiatica* (Majjaposhak and subhodak) were developed using different solvent systems such as methanol: water (70:30) using isocratic program (polarity is constant) and Acetonitrile: water using Binary program (polarity increases gradually). Peak was not identified when methanol: water used as solvent system (isocratic elution). Finally, the Acetonitrile: water system (gradient elution) was used for the analysis of Asiaticoside (Table 3). The retention time of asiaticoside is around 8-10 minutes (Figure 3 and 4). The asiaticoside content present in two plant extracts were calculated from peak areas. The mean asiaticoside content in Majjaposhak variety was found to be

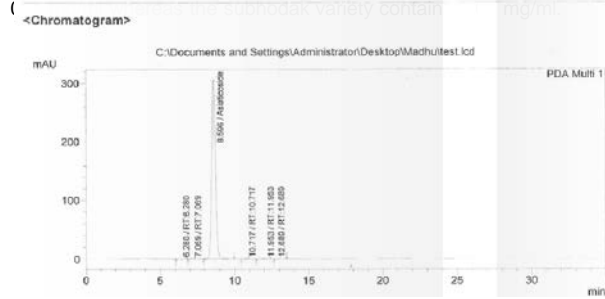


Figure 2: HPLC of standard Asiaticoside

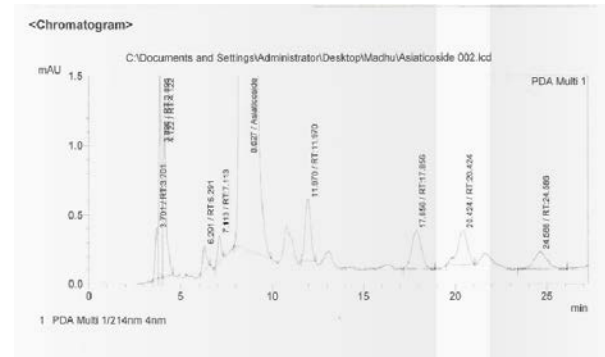


Figure 3: HPLC of *Centella asiatica* leaf extracts (Majjaposhak)

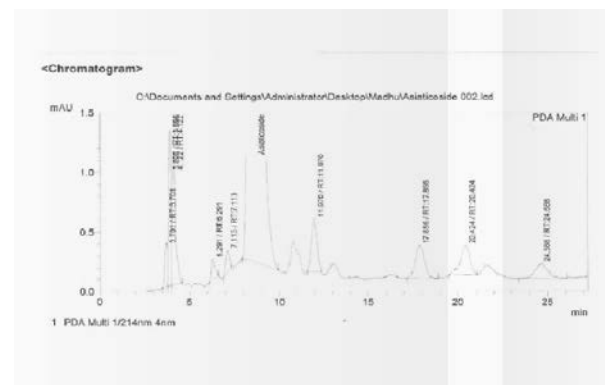


Figure 4: HPLC of *Centella asiatica* leaf extracts (Subhodak)

Table 1: Qualitative analysis of leaf extract

S. No	Test	Inference
1.	Test for tannins	Positive
2.	Test for phlobatannins	Positive
3.	Test for saponins	Positive
4.	Test for flavonoids	Positive
5.	Test for terpenoids	Positive
6.	Test for cardiac glycosides	Positive
7.	Test for alkaloids	Positive

Table 2: Quantitative analysis of leaf extract

S. No.	Test	Majjaposhak	Subhodak
1.	Test for tannins	10.1±0.14	0.9±0.13
2.	Test for phlobatannins	0.9±2.03	0.7±2
3.	Test for saponins	2.3±0.12	2.6±0.11
4.	Test for flavonoids	0.53±0.21	0.50±0.22
5.	Test for terpenoids	0.7±1.21	0.6±1.01
6.	Test for glycoside	0.5±0.7	0.6±0.9
7.	Test for Phenols	0.71±0.20	0.720±0.19

Table 3: Gradient conditions used in HPLC analysis of *C. asiatica* leaf extract

Time (minutes)	Water (%)	Acetonitrile (%)
0-10	20	80
10-15	30	70
15-20	40	60
20-25	60	40
25-35	70	30

3.1 Data analysis

The results were analyzed to know the difference in measured attributes among the two varieties by one way analysis of variance (ANOVA) and the Duncan's homogeneity test using Statistical Package for Social Science, version 11.5 (SPSS 2002). Content of asiaticoside varied greatly in different varieties. However, the difference was statistically significant for asiaticoside ($p < 0.05$) (Table 4). Samples collected from Majjaposhak variety showed the highest asiaticoside. Asiaticoside was the most dominant constituent (mean 1.42% dw); its value ranged from 1.42% in Majjaposhak to 0.78% in Shubodak variety (Table 4).

Table 4: Asiaticoside content of *Centella asiatica* varieties

<i>Centella asiatica</i> variety	Asiaticoside content (dw).%	Mean (dw).%	F value	P value
CA-M1	1.42 ± 1.10	1.42 ± 1.60	10.334	0.030
CA-M2	1.31 ± 1.03			
CA-M3	1.51 ± 1.03			
CA-S1	0.83 ± 0.01	0.78 ± 0.02	0.604	0.012
CA-S2	0.78 ± 0.02			
CA-S3	0.73 ± 0.11			

For each parameter, significant difference between mean among the sites are indicated by different letters (Duncan homogeneity test, $\alpha = 0.05$). F and P values were obtained by one way analysis of variance (ANOVA).

Therefore, the present study revealed that the asiaticoside content in leaves of the two ecotypes varied. Asiaticoside was not detected in undifferentiated cells including cultured cell suspensions and calluses. The distribution of asiaticoside throughout the plant was organ specific; with leaves of both varieties, containing the higher content of this compounds. The distribution of asiaticoside is more in leaves of *Centella asiatica*. The phytochemical screening on qualitative and quantitative analysis shows that the leaves of the *C. asiatica* are rich in alkaloids, tannins, saponins, terpenoids and flavonoids, which are popular phytochemical constituents. Significant difference in contents of asiaticoside has been observed in samples of *C. asiatica* originating from different varieties, such as Shubodak and Majjaposhak. Comparative study of two varieties of *Centella asiatica* from different regions of India showed a correlation between genomic diversity and asiaticoside content. In

present study, mean asiaticoside content in samples of Majjaposhak variety *Centella asiatica* was 1.42% (dw). The leaves of Majjaposhak variety of *C. asiatica* found to contain around two times higher concentration of asiaticoside than those from Shubodak variety.

4. CONCLUSION

Although the present study provides a lead, many more studies are needed to confirm the efficacy of the use of *Centella asiatica* as a source of phytomedicine. There is a long way to go before its establishment as a phytomedicine since studies on animals and human clinical research must be completed successfully.

5. ACKNOWLEDGEMENTS

Authors sincerely acknowledge the University Grants Commission (UGC), India for the financial assistance granted and department of botany, Osmania University, Hyderabad.

REFERENCES

- Shukla A, Rasik AM, et al "In vitro and in vivo wound healing activity of asiaticoside isolated from *Centella asiatica*", *J Ethnopharmacol*, 1999, 65:1–11
- Flora, "Beneficial effects of *Centella asiatica* aqueous extract against arsenic-induced oxidative stress and essential metal status in rats" *Phytother Res*, 2007, 21:980-8.
- Jacinda T. James Ian A. Dubery, "Pentacyclic Triterpenoids from the Medicinal Herb, *Centella asiatica* (L.) Urban", *Molecules*, 2009,14, 3922-3941.
- Dhanasekaran M, Holcomb LA, et al " *Centella asiatica* extract selectively decreases amyloid beta levels in hippocampus of Alzheimer's disease animal model" *Phytother Res*. 2009 ;23(1):14-9.
- Quan Lin Yu, Hong Quan Duan, et al "A new triterpene and a saponin from *Centella asiatica*" *Chinese Chemical Letters*, 2007, Volume 18, Issue 1, Pages 62-64.
- R. Subban, A. Veerakumar, et al "Two new flavonoids from *Centella asiatica* (Linn.)" *Journal of Natural Medicines*, 2008, vol. 62, no. 3, pp. 369–373.
- Zheng, C.J, Qin LP, "Chemical components of *Centella asiatica* and their bioactivities", 2007, 3: 348-351.
- Liu Yu, "Chemical Studies on the Saponin Compounds of *Centella asiatica*" [J]; *Modern Chinese Medicine*, 2008, PP123-162.
- Tiwari KN, Sharma NC, et al "Micropropagation of *Centella asiatica* (L.), a valuable medicinal herb", *Plant Cell Tiss Org*
- Bonfill M, Mangas S, et al "Identification of triterpenoid compounds of *Centella asiatica* by thin-layer chromatography and mass spectrometry", *Biomed Chromatogr*, 2006, 20:151–153.
- Edeoga HO, Okwu DE, et al "Phytochemical Constituents of some Nigerian plants", *Afri. J. Biotechnol* 2005. 4 (7):685-688.
- Gohil K H, Patel J A, et al "Pharmacological Review on *Centella asiatica*: A Potential Herbal Cure", *all. Indian J Pharm Sci.*, 2010 Sep-Oct; 72(5): 546–556.
- Williamson EM, "Synergy and other interactions in phytomedicines", *Phytomedicine*, 2001, 8, 401–409.
- Heidari M, Jamsheidi AH, et al "Evaluating the effects of *Centella asiatica* on spermatogenesis in rats", *Med J Reprod Infertility*, 2007, 7:367–7.
- Arora D, Kumar M, et al " *Centella asiatica* A review of its medicinal uses and pharmacological effects," *Journal of Natural Remedies*, 2002, .vol.2,no.2,pp.143–149.
- Nyuk Jet Chong, Zorah Aziz, "A Systematic Review of the Efficacy of *Centella asiatica* for Improvement of the Signs and Symptoms of Chronic Venous Insufficiency", *Evidence-Based Complementary and Alternative Medicine*, 2013, Volume 2013, Article ID 627182, 10 pages.
- Schaneberg, B.T., Mikell, J.R., et al "An improved HPLC method for quantitative determination of six triterpenes in *Centella asiatica* extracts and commercial products." *Pharmazie*, 2003, 58, 381–384.
- NA Zainol, Voo SC, et al "Profiling of *Centella asiatica* (L.) Urban extract.", *The Malaysian Journal of Analytical Sciences*, 2008, Vol 12(2): 322-327,
- Deshpande HA, Bhalsing SR, "Phytochemical Analysis Of *Cassia Obtusifolia*, *Cassia Auriculata*, *Tephrosia Purpurea*, *Helictres Isora* And *Centella asiatica*", *International Journal of Pharma and Bio Sciences*, 2011, vol 2(3): 363-
- Lubin AS, Snyderman DR, Ruthazer R, Bide P, Golan Y. Predicting high vancomycin minimum inhibitory concentration in methicillin-resistant *Staphylococcus aureus* bloodstream infections. *Clin Infect Dis*. 2011 Apr 15;52(8):997-1002. doi: 10.1093/cid/cir118.
- Salari MH, Sohrabi N, Kadkhoda Z, Khalili MB. Antibacterial effects of enoxolone on periodontopathogenic and capnophilic bacteria isolated from specimens of periodontitis patients. *Iranian Biomedical Journal*. 2013. 7(1), pp. 39-42
- Badri R, Shushizadeh MR A new method for the oxybromination of aromatic compounds with copper(II)bromide and potassium dichromate. 2005. Phosphorus, Sulfur and Silicon and the Related Elements. 180(2), pp. 533-536.
- Badri R, Shushizadeh MR. An efficient tandem oxidative-protection reaction of benzylic alcohols to corresponding arylhydrazones and oximes. 2007. Phosphorus, Sulfur and Silicon and the Related Elements. 182(3), pp. 601-605
- Assareh M, Moghaddam M F, Rakhshani T, Nikoo M A, Effatpanah M, Rai A, Rezaie L. The motives behind the decision for choosing self-immolation as a method for suicide. 2013. *Life Science Journal*. 10(4), pp. 1610-1614.
- Semnani S, Roshandel G., Abdolahi N, Besharat S, Keshtkar AA, Joushaqani H, Danesh A. HBV/HCV co-infection in Iran: A seroepidemiological based study. 2006. *Pakistan Journal of Biological Sciences*. 9(13), pp. 2538-2540.
- Aghamohammadzadeh N, Aliasgarzadeh A, Baglar L, Abdollahifard S, Bahrami A, Najafipour F, Niafar M. Comparison of metformin and cyproterone/estradiol compound effect on hs c-reactive protein and serum androgen levels in patients with polycystic ovary syndrome. 2010. *Pakistan Journal of Medical Sciences*. 26(2), pp. 347-351.
- Moghadam MYA, Moradian M, Givtaj N, Mozaffari K. Intraluminal ascending aorta fibroma. 2011. *Journal of Tehran University Heart Center*. 6(1), pp. 45-47
- Moradian M, Shahmohammadi A, Yoosefnia MA, Mozaffari K. One and a half ventricular repair for Uhl's anomaly with one year follow up. 2011. *Iranian Cardiovascular Research Journal*. 5(1), pp. 35-38
- Shushizadeh MR, Mostoufi A, Fakhriani M. Marine sponge/cuo nanocrystal: A natural and efficient catalyst for sulfonamides synthesis. 2012. *Jundishapur Journal of Natural Pharmaceutical Products*. 7(4), pp. 134-139.
- Taymoori P, Moshki M, Roshani D. Facilitator psychological constructs for mammography screening among Iranian women. *Asian Pacific Journal of Cancer Prevention*. 2014. 15(17), pp. 7309-7316
- Macoioe AA, Pashapoor N, Yekta Z, Karamyar M. Serum prolactin level after febrile seizure versus epileptic seizure in 6-month-old to 5-year-old children. *Iranian Journal of Medical Sciences*. 2009. 34(3), pp. 177-180.
- Nazer MR, Ghanadi K, Goodarzi G, Sajedi Y, Pournia Y, Darvishi M. Prevalence of Chlamydia pneumoniae by Real time PCR in referred patients with respiratory syndrome to clinic center of infectious diseases. *Life Science Journal*. Volume 11, Issue 1 SPECL. ISSUE, 2014, Article number 15, Pages 87-92.
- Nazer MR, Ghanadi K, Goodarzi G, Sajedi Y, Pournia Y, Darvishi M. Prevalence of Chlamydia pneumoniae by Real time PCR in referred patients with respiratory syndrome to clinic center of infectious diseases. *Life Science Journal*. Volume 11, Issue 1 SPECL. ISSUE, 2014, Article number 15, Pages 87-92.
- Samadian M, Alavi E, Sharifi G, Rezaee O, Faramarzi F. Extension of Echinosoccal spinal infestation extra- and intradurally after a decade of extinction. *Journal of Neurosurgical Sciences*. 2010 54(4), pp. 143-148.
- Badri R, Shushizadeh MR. Silica sulfuric acid as an efficient reagent for bamberger rearrangement of phenyl hydroxylamine derivatives in solvent-free conditions. *Asian Journal of Chemistry*. 2007 19(6), pp. 4661-4664.
- Moradian M. Fetal circulation. *Comprehensive Approach to Adult Congenital Heart Disease*. 2014, pp. 13-17.
- Moazen B, Rezaei F, Lotfizadeh M, Darvishi M, Farzadfar F. Mind the gap in reporting the outdated statistics. *Int J Health Policy Manag*. 2014 Oct 2;3(5):295-6.
- Mohaghegh Shalmani H, Noori A, Shokoohi M, Khajavi A, Darvishi M, Delavari A, Jamshidi HR, Naderimaghani S. Burden of Hepatitis C in Iran Between 1990 and 2010: findings from the Global Burden of Disease Study 2010. *Arch Iran Med*. 2015 Aug;18(8):508-14.
- Kocharian A, Shabani A, Rahimzadeh M, Kiani A, Hosseini A, Zanjani KS, Heidari-Bateni G, Hosseini-Navid N. N-terminal Pro-B-type natriuretic peptide and ventricular dysfunction in children and adolescents. 2009. *Cardiology in the Young*. 19(6), pp. 580-588.
- Taymoori P, Lubans D, Berry TR. Evaluation of the health promotion model to predict physical activity in Iranian adolescent boys. *Health Education and Behavior*. 2010. 37(1), pp. 84-96
- Piranfar MA, Karvandi M, Yazdani S, Pishgahi M, Mehdizadeh M, Hajfathali A, Tabarraee M. Bone marrow transplantation may augment cardiac systolic function in patients with a reduced left ventricular ejection fraction. *Journal of Cardiovascular Disease Research*. 2012. 3(4), pp. 310-314
- Moshki M, Hassanzade T, Taymoori P. Effect of life skills training on drug abuse preventive behaviors among university students. *International Journal of Preventive Medicine*. 2014. 5(5), pp. 577-583
- Taymoori P, Berry T, Roshani D. Differences in health beliefs across stage of adoption of mammography in Iranian women. *Cancer Nursing*. 2014. 37(3), pp. 208-217
- Moradian M, Nokhostin-Davari P, Merajie M, Pourniaakbar HR. Aortic runoff as a sign of intracranial arteriovenous malformation: Report of two cases. 2013. *Iranian Journal of Pediatrics*. 23(2), pp. 229-232.
- Moradian M, Fard MZ, Mozaffari K. Atrial rhabdomyoma: A case report. *Iranian Heart Journal*. 2014 15(2), pp. 39-42