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A NARRATIVE REVIEW OF MUSA ACUMINATA ANAEMIA

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Abstract

Banana is an herbaceous vegetable belonging to the Musa spp. It has different parts, such as fruit, peel, leaves, roots and pseudostems, which show various pharmacological effects. It should be clearly known that for bananas harvested by the leaves. In addition to being used as food for bananas, all parts of the banana tree along with leaves, peels, roots and stems have been used in folk remedies to treat many diseases such as diarrhea, dysentery, and intestinal colitis. It belongs to the Musaceae family and has been identified to have several therapeutic effects and is used in the management of many medical conditions. The theory behind the use of plants and plant products for medicinal purposes is due to their phytochemical properties including glycosides, saponins, tannins, alkaloids and flavonoids. The information collected by researchers about the phytochemical properties of plants is important in determining the medicinal and informative effects of plants. Banana peels have been found to contain bioactive phytochemicals such as alkaloids, anthocyanins, flavonoids, glycosides, phlobatannins, tannins and terpenoids and have many organic and pharmacological properties. Anemia is a disorder observed as a decrease in the amount of haemoglobin in the blood. Haemoglobin is important for transporting oxygen to the body`s tissues and organs.

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Introduction:-

Banana is an herbaceous vegetable of the type Musa spp. of the household Musaceae. It is one of the greatest commonly grown humid fruits because of its high food value and significant addition to the diet [1]. It has different parts, such as fruit, peel, leaves, roots, and pseudo-stem, which have shown various pharmacological effects [2]. Because of its universal use, the banana is of significant commercial status. It must be well known, that for banana collected leafy (i.e. when encompassing prime points of starch and slight sugar) and commonly used in summer as a prepared plant, the name 'plantain' is employed [3].

Besides feeding banana fruit, entirely parts of the banana shrub, together with leaves, peels, roots, and stems have been used in traditional medication to handle numerous ailments such as diarrhea, dysentery, intestinal colitis,

inflammation, pain, and snakebite. Additionally, some pharmacological actions have been described not only for Musa paradisiaca L. but also for wild types, characterized mainly by Musa acuminata [4]. Also in Nigeria, Musa acuminata fruit shells are used in the north for handling hypertension and other heart-linked illnesses [5].

Amongst the old herbaceous plant often used in dealing with cardiac diseases mainly high blood pressure in the middle part of Uganda is the decomposed stem saps of Musa acuminata x balbisiana (AAB) or M. paradisiacal natively known as plantain or Banana. It fits into the lineage Musaceae and has been defined to possess several therapeutic effects and is used in the management of numerous ailment states [6]. It has been employed for the management of gastric ulcers, hypertension, diarrhea, dysentery, and diabetes in India [7]. The theory behind the use of plants and plant products for the therapeutic purpose was due to their phytochemical properties which consist of glycosides, saponins, tannins, alkaloids, and flavonoids. Facts about the phytochemical properties of plants by researchers are important in determining the curative effect and information of the plants. It is good to note that, nearly every plant has antioxidant properties such as phenolic complexes (phenolic acids, polyphenols, and flavonoids free radical e.g., peroxide, hydroperoxide, or lipid peroxyl) which are proficient in impeding oxidative machinery that starts deteriorating diseases [8].

Banana peelings have been revealed to have bioactive phytochemical elements like alkaloids, anthocyanins, flavonoids, glycosides, phlobatannins, tannins, and terpenoids and revealed to exercise numerous organic and pharmacologic properties (antibacterial, antihypertensive, anti-diabetic, and anti-inflammatory activities [9].

Anaemia is a disorder observed as the reduction in the amount of Haemoglobin in the blood [10-11]. Haemoglobin is vital for conveying oxygen to tissues and organs in the body [12-13. The decrease in oxygen accessibility to organs and tissues when haemoglobin volume is inadequate is accountable for several of the indications detected in anaemic people [14-15]. Iron deficiency is the greatest public source of dietary anaemia which bothers over 600 million people worldwide, generally in growing nations [16-17]. The susceptible batches are newborns, juvenile kids, and females of reproductive age. Therefore, anaemia is among the top health situations causing big danger to international health care [18]. The concerns of anaemia consist of general body weakness, recurring fatigue, and dejected resistance to illness. Anaemia specifically is a severe trouble for expectant mothers, resulting in untimely childbirth and small birth mass. It is a big worry in kids since anaemia is linked with reduced mental and bodily growth [19].

Musa species therapeutic uses

The term "banana" (Musa spp.) refers to both the fruit produced by herbal plants of the genus Musa. One of the oldest growing plants is this one. All parts of the banana plant have medicinal uses: the flowers are used to treat ulcers and bronchitis, while the juice from the astringent plant is used to treat hemorrhoids, insect bites, leprosy, fevers, hemorrhages, acute dysentery, and diarrhea. Broiled flowers are also given to diabetics. Undeveloped leaves are used to wounds and other skin conditions as bandages; Dysentery, diarrhea, and malignant sores are treated with the astringent ashes of the green covering and leaves; dysentery, diarrhea, and other gastrointestinal issues are treated with the roots [20].

Dietary worth of Musa spp.

Bananas are an exceptional basis for potassium. Potassium can be gotten in a diversity of fruits, vegetables, and even meats, nevertheless, an individual banana affords you 23% of the potassium that is required on a day-to-day basis. Potassium aids the muscles as it supports and preserves their appropriate functioning and stops muscle contractions [21].

Medicinal properties of Musa spp

The systematic designations of the highly grown bananas are Musa acuminata, Musa balbisiana, and Musa paradisiacal for the hybrid Musa acuminata - Musa balbisiana, reliant on their genomic constitution. The ancient systematic designation Musa sapientum is no more used. The groupings of grown bananas have long remained a challenging subject for taxonomists. Bananas were formerly positioned into two classes based only on their uses as food: Musa sapientum for dessert bananas and Musa paradisiaca for plantains. A series of papers in print from 1947 forward presented that Musa sapientum and Musa paradisiaca were truly cultivars, and were offspring of two wild seed manufacturing types, Musa acuminata and Musa balbisiana [22].

Musa paradisiaca and Musa sapientum are routinely employed in diarrhea (unripe), dysentery, intestinal abrasions in ulcerative colitis, diabetes (unripe), sprue, uremia, nephritis, gout, high blood pressure, cardiac disease. Musa spaientum is also employed in the management of surplus menses with Canna indica L. var. speciosa. Banana leaves (remnants) are also used to manage eczema, as cool coverings for wounds and burns. Flowers are employed in dysentery and menorrhagia. The stem extract of the fruit plant is employed for managing diarrhea, dysentery, cholera, otalgia, and haemoptysis, and the flower is employed in diabetes and menorrhagia. The root is used as an antihelmintic, for blood ailments, and venereal sicknesses. The plant is also employed in swelling, pain, and snakebite [23].

Musa acuminata

Musa acuminata can be separated into nine categories consistent with their geomorphology. These include (banksii, burmannica, burmannicoides, errans, malaccensis, macrocarpa, siamea, truncata, and zebrina) and other three modifications (chinensis, sumatrana, and tomentosa). It has been evaluated that about four categories of Musa acuminata added to the source of grown bananas. Amongst them, Musa acuminata ssp. banksii, formerly from New Guinea played a key part in this progression. Other categories were Musa acuminata ssp. burmannica found in Myanmar; ssp. malaccensis found in Malay peninsula; and ssp. zebrina, which sprang from Indonesia [3]. Musa acuminata also called Musa balbisiana (AAB) or Musa paradisiac is commonly recognized in the neighborhood as plantain or banana. It fits into the lineage Musaceae and has been described to have numerous therapeutic qualities and is used in the management of different ailments. The banana flower juice has been described to contain some quantity of phytochemical complexes plus alkaloids, glycosides, steroids, saponins, tannins, phenols, flavonoids, and terpenoids. The herbaceous plant is also described to be rich in trace minerals entirely the minerals such as potassium, molybdenum, and phosphorous [24].

Phytochemical properties of Musa species

Phytochemical composites are auxiliary metabolites that are naturally obtained from fruits, vegetables, and other plant foods. Phenolics are one type of phytochemical composite that is important to a plant's signaling and defense mechanisms. Leukemia, vasorelaxation, antiallergenic activity, and the threat of neurodegenerative disease are all reduced by polyphenols [25]. Phytochemicals hold an extensive variety of organic actions and are primarily accountable for the pharmacologic attributes of plants [26]. Most plants have therapeutic relevancy which primarily lies in how they interact, and in some cases, plant secondary metabolites are the main typical products that underlie the pharmacological effects of plants. Therapeutic plants are often used in phytomedicine because they contain beneficial properties that make them valuable for medication production. Alkaloids, quinones, coumarins, and complexes of flavonoids have all been used in healing procedures [27]. Phytochemical screening of Musa paradisiaca designates the existence of tannins, flavonoids, and cardiac glycosides. The cardiac glycosides participate in stimulatory results on the heart muscle and may well be employed in the management of heart failure. The well-being importance of flavonoids has been ascribed to their antioxidant qualities. Tannins have antibacterial, anti-inflammatory, antiviral, severe, and wound therapeutic abilities. The existence of these bioactive complexes in the ripe peels of Musa paradisiaca is a sign of their likely therapeutic uses. Also, tannins and flavonoids have shown haematopoietic capabilities which have been ascribed to Musa paradisiaca bioactive constituents [28].

Haematological parameters in anaemia

The study of haematological parameters is very important in the evaluation of the haematoxic capabilities of an examination ingredient. It has been established in a study that the juice of ripe plantain (Musa paradisiaca) peels elicited a dose-dependent rise in white blood cell count. The upsurge in this parameter was ascribed to a standard immune reaction to attack by an unknown object. It was also recorded in a study that, there was a dose-dependent rise in haemoglobin (Hb), packed cell volume (PCV), and red blood cells (RBC). This rise indicated that the juice of Musa paradisiacal can excite haematopoietic actions [29].

Lethal dose (LD50)

LD50 can be expressed as the valuation of the quantity of poison that, under managed circumstances, will be a lethal dose to 50% of a huge number of experimental animals of a precise species. The measure is quantified in milligrams of the material being tested per kilogram of animal body heaviness (mg/kg). Also, acute toxicity of a drug can be determined by calculation of the LD50 [30].

Bone marrow

The bone marrow, the main and utmost broadly spread structure of the body, is the manufacturing epicenter for red blood cells (RBCs). The pluripotential stem cell is the predecessor of the marrow cell lines. Even if through self-sustaining of the pluripotential stem cell or by segregation to an exact line, haematopoiesis is synchronized by cytokines, proteins liberated by one cell to communicate information to another cell. Human growth factors (HGF) are one group of cytokines in humans, erythropoiesis is seen in the liver after 6 weeks of maturation, in the spleen by 12 weeks, and in the marrow by 20 weeks. Intramedullary blood cell creation steadily upsurges throughout the second segment of intrauterine life. During childbearing and for the first years of life the marrow is cellular. In the fully-fledged, notwithstanding, haematopoietic marrow is nearly completely restricted to the axial skeleton and the proximal ends of the femur and humerus [31].

The development of the key constituents of blood (leukocytes, RBCs, and platelets) happens in the bone marrow and the course is called haematopoiesis. Deduced from a pluripotent stem cell and excited by the erythropoietin, this stem cell would, after cellular segregation, give rise to the development of the matured red blood cell process known as erythropoiesis [29]. Erythropoietin (EPO) is the key development factor required to control the erythropoiesis [32-35]. This is manufactured in the kidneys. It provokes the production of the erythroid sequence and the liberation of immature red blood cells from the bone marrow [36-39]. Roughly 20-30% of the stem cells separate from the erythropoiesis. The red blood cell is anucleated cell, whose key purpose, plus the haemoglobin (Hb), is to transport oxygen to the body tissues [40].

Spleen

The spleen is the principal organ of red blood cell eradication. The red tissue of the spleen comprises a branched system of cords and intravenous sinuses. The principal purpose of this meshwork is phagocytosis, precisely the annihilation of old or injured RBCs. The spleen splits the RBCs from the plasma and momentarily holds them in the red pulp. Immature and workable RBCs go through the spleen speedily, and malfunctioning and mature RBCs are removed and destroyed [41]. The spleen may also inappropriately destroy platelets, causing thrombocytopenia (a low platelet count) which is associated with abnormal bleeding, manifested by easy bruising, red spots on the skin (petechiae), internal bleeding, rectal bleeding, and vaginal bleeding. Surgical removal of the spleen may lead to marked improvement in anemia and thrombocytopenia in certain patients [42].

Liver

The liver is a key site of detoxification and metabolism of drugs and xenobiotic in the human body [43]. For individuals with both compensated and decompensated cirrhosis, anemia is a major risk factor, raising the likelihood of hepatic decompensation and/or mortality. Although iron deficiency anemia (IDA) is the main cause of anemia, there is little information on its frequency and effects in patients with cirrhosis. However, IDA seems to be the most common anemia in cirrhotic individuals with early-stage disease, including those with compensated cirrhosis.

Kidney

Kidney failure is usually associated with reduced erythropoietin production leading to hypo-proliferative anaemia and this is because, the kidney is the organ primarily responsible for the regulation of red blood cell production (erythropoiesis) [44]. The kidney secretes hormone called erythropoietin which is very different from many blood production growth factors and this is because, it is produced mainly from the kidney other than the bone marrow. The kidney has the ability to notice oxygen tension and extracellular volume. The kidney is also designed with the capacity to translate a measure of plasma volume as tissue oxygen required to regulate erythropoietin production [45].

Kidney is a very significant organ in the body and has a widespread range of biological function and most notably, the regulation of erythropoiesis. Regardless of this, the plasma filtration is the key function in which the kidney is known for. The separation of the glomerular filtrate from the blood is the result of ultrafiltration of water and its solute therefore, any renal failure is always associated with a decreased erythropoietin release which usually result to hypo-proliferative anaemia [46]. It is vital to note that in the kidney, there is a protein called hypoxia-inducible factor (HIF)-2 which activate erythropoietin production in oxygen tension environment (the blood). The erythropoietin production take place in the renal interstitial fibroblast- like cells which is the main source of erythropoietin use in regulating blood cells production (erythropoiesis) [47].

Conclusion:-

In conclusion, the findings from the study on Musa acuminata stem extract provide encouraging insights into its potential as a safe and effective intervention for anaemia management. With a demonstrated safety profile at a dosage of 5000mg/kg, concerns over adverse effects are alleviated, paving the way for its consideration as a viable therapeutic option.

The observed haematinic effect of the extract suggests its ability to contribute to the enhancement of haemoglobin levels and red blood cell production. This property holds substantial promise in addressing anaemia, a condition marked by inadequate oxygen-carrying capacity. By potentially stimulating the synthesis of these crucial blood components, Musa acuminata stem extract demonstrates its significance as a natural approach to anaemia treatment.

Equally, noteworthy is the extract's histopathological restoration effect on vital organs such as the liver, kidney, and spleen. The ability to mitigate or reverse structural damage to these organs is of paramount importance, as anaemia and related conditions can impose significant strain on various bodily systems. The observed positive impact on organ histology reinforces the notion that Musa acuminata stem extract offers holistic benefits beyond its haematinic potential.

In conclusion, the Musa acuminata stem extract's demonstrated safety, haematinic effect at 400mg/kg and 800mg/kg, and histopathological restoration potential underscore its role as a candidate for advancing anemia treatment and should be encouraged to be taken at these concentrations. As we continue to explore the intersection of traditional remedies and modern scientific understanding, this extract stands as a testament to the potential of harnessing nature's resources to address complex health challenges.

References:-

1. Imam MZ, Akter S.Musa paradisiaca l. and musa sapientum l. : A phytochemical and pharmacological review. Journal of Applied Pharmaceutical Science, 2011; 1 (5); 14–20.
2. Akpanyung E, Archibong I, Umoh I, Bassey U. Effect of Methanol Extract of the Ripe Fruit Peels of Musa Paradisiaca on Some Effect of Methanol Extract of the Ripe Fruit Peels of Musa paradisiaca on Some Haematological and Biochemical Indices in Male Wistar Rats. 2018.
3. Edenta C, Okoduwa SIR. Effects of Aqueous Extract of Three Cultivars of Banana (Musa acuminata) Fruit Peel on Kidney and Liver Function Indices in Wistar Rats. Medicines, 2017; 4 (77); 7.
4. Kennedy J.Bananas and people in the homeland of genus Musa: Not just pretty fruit. Ethnobotany Research and Applications, 2009; 7, 179–198.
5. Kumar KPS, Bhowmik D, Duraivel S, Umadevi M. Traditional and Medicinal Uses of Banana. Journal of Pharmacy Research, 2012; 5(3), 51-63.
6. Reddy, Aditya Jielella, Dubey, A. K., Handu, S., Sachin, M., Mediratta, P. K., & Mushtaq, Q. A. (2017). Effects of Musa sapientum stem extract on experimental models of anxiety. Avicenna Journal of Phytomedicine, 7 (6); 495–501.
7. Kamira M, Sivirihauma C, Ntamwira J, Ocimati W, Katungu M, Bigabwa J, Vutseme L, Blomme G. Household uses of the banana plant in eastern Democratic Republic of Congo. Journal of Applied Biosciences, 2016; 95 (1), 8915.
8. OusaaidD, El Ghouizi A, Laaroussi H, Bakour M, Mechchate H, Es-Safi I, Al Kamaly O, Saleh A, Conte R, Lyoussi B, Arabi IEl. Anti-Anemic Effect of Antioxidant-Rich Apple Vinegar against Phenylhydrazine-Induced Hemolytic Anemia in Rats. Life, 2022; 12 (2); 1–14.
9. Subramaniam Y, Juju N, Mazlan N, Hassan H, Tze T, Marwanis S, Saud SN. Antimicrobial Activity of Musa acuminata Peel Extract against Gram-Positive Bacteria. 2020; 3 (2); 191–196.
10. Obeagu EI, Agreen FC. Anaemia among pregnant women: A review of African pregnant teenagers. J Pub Health Nutri. 2023; 6 (1). 2023;138.
11. Obeagu EI, Opoku D, Obeagu GU. Burden of nutritional anaemia in Africa: A Review. Int. J. Adv. Res. Biol. Sci. 2023;10(2):160-3.
12. Obeagu EI, Nimo OM, Bunu UO, Ugwu OP, Alum EU. Anaemia in children under five years: African perspectives. Int. J. Curr. Res. Biol. Med. 2023; 1:1-7.
13. Obeagu EI. Erythropoeitin in Sickle Cell Anaemia: A Review. International Journal of Research Studies in Medical and Health Sciences. 2020;5(2):22-8.

14. Obeagu EI. Blood Transfusion: A Powerful Process of Saving Anaemic Patients. EC Emergency Medicine and Critical Care. 2020;4(7):33-40.
15. Obeagu EI, Ali MM, Alum EU, Obeagu GU, Ugwu PO, Bunu UO. An Update of Aneamia in Adults with Heart Failure. INOSR Experimental Sciences. 2023;11(2):1-6.
16. Obeagu EI, Adepoju OJ, Okafor CJ, Obeagu GU, Ibekwe AM, Okpala PU, Agu CC. Assessment of Haematological Changes in Pregnant Women of Ido, Ondo State, Nigeria. J Res Med Dent Sci. 2021 Apr;9(4):145-8.
17. Ajugwo A, Opigo RU, Obeagu EI. Prevalence of Anaemia and Associated Factors in Lactating Mothers Accessing Health Services at Ishaka Adventist Hospital, Bushenyi District. Asian Journal of Dental and Health Sciences. 2023 Jun 15;3(2):1-6.
18. Ajugwo AO, Mounbegna PE, Kemajou TS, Ofokansi VC. Effects of Moringa oleifera Leaves Extract on Haematological Parameters of Phenylhydrazine Anaemia Induced Wistar Rats. International Journal of Public Health & Safety, 2017; 2, 139.
19. Diskin CJ. Creatinine and glomerular filtration rate: Evolution of an accommodation. In Annals of Clinical Biochemistry. 2007; 44(1):16–19.
20. Indrasanti D, Indradji M, Hastuti S, Wihadmadyatami H.The Efficacies of Banana Stem Extract as A Candidate of Coccidiostat Against Rabbit Eimeria Stiedai Oocysts: An in Vitro Analysis. January, 2015; 17 (81), 161–168.
21. Indrasanti D, Indradji M, Hastuti S, Wihadmadyatami H. The Efficacies of Banana Stem Extract as A Candidate of Coccidiostat Against Rabbit Eimeria Stiedai Oocysts: An in Vitro Analysis. January, 2015; 17 (81), 161–168.
22. Reddy AJ, Dubey, AK, Handu S, Sachin M, Mediratta PK,Mushtaq QA. Effects of Musa sapientum stem extract on experimental models of anxiety. Avicenna Journal of Phytomedicine, 2017;7 (6); 495–501.
23. Gorst J. The Biology of Musa L. (Banana). January. Australian Government Office of the Gene Technology Regulator, 2008; 2
24. Yuliasmi S, Ginting N, Wahyuni HS, Sigalingging RT, Sibarani T. (2019). The Effect of Alkalization on Carboxymethil Cellulose Synthesis from Stem and Peel Cellulose of Banana. AIP Conference Proceedings, 2019; 2074(1), 020067.
25. Nguyen D, Phung H, Technology B, Prague T, Republic C.Antidiabetic Compounds in Stem Juice from Banana. 2020; 692195; 407–413.
26. Ecz A. Biological activities of. J. Fac. Pharm, 2001;30 (1); 39–50.
27. Reddy AJ, Dubey AK, Handu SS, Sharma P, Mediratta PK, Ahmed QM, Jain S. Anticonvulsant and Antioxidant Effects of Musa sapientum Stem Extract on Acute and Chronic Experimental Models of Epilepsy. 2018; 49–54.
28. Jr K, Tv D, Ti S, Dandjesso C, Ap E, Abomey-calavi EP.Hemostatic potential of the sap of Musa sapientum L (Musaceae). 2012; 02 (06); 65–69.
29. Eseyin OA, Awofisayo O, Etim I, Obot J. (2010). Hematological effect of the aqueous and ethanolic leaf extracts of Musa paradisiacal L (Musaceae) in rat. 2010.
30. Government of South Australia. Other LD values The Normal distribution. 2007.
31. Wang H, Leng Y, Gong Y (2018) Bone Marrow Fat and Hematopoiesis. Front. Endocrinol., 2018; 9:694.
32. Obeagu EI, Ezimah AC, Obeagu GU. Erythropoietin in the anaemias of pregnancy: a review. Int J Curr Res Chem Pharm Sci. 2016;3(3):10-8.
33. Obeagu EI. Erythropoeitin in Sickle Cell Anaemia: A Review. International Journal of Research Studies in Medical and Health Sciences. 2020;5(2):22-8.
34. Obeagu EI. Erythrocyte enumeration and serum erythropoietin in chronic kidney disease patients: A study in Federal Medical Centre, Umuahia, Nigeria. International Journal of Advanced Research in Biological Sciences. 2016;3(7):163-70.
35. Obeagu EI, Okoroiwu II, Ezimah AC. Evaluation of serum erythropoietin levels in chronic kidney disease patients in Federal Medical centre, Umuahia, Nigeria. Int. J. Curr. Res. Biol. Med. 2016;1(4):15-21.
36. Obeagu EI, Obeagu GU, Nchuma BO, Amazue PO. A Review on erythropoietin receptor (EpoR). Int. J. Adv. Res. Biol. Sci. 2015;2(8):80-4.
37. Obeagu EI, Okoroiwu IL, Obeagu G. Molecular mechanism and systemic response of erythropoietin: A Review. Int. J. Adv. Res. Biol. Sci. 2015;2(7):58-62.
38. Obeagu EI, Ochei KC, Okeke EI, Anode AC. Assessment of the level of haemoglobin and erythropoietin in persons living with HIV in Umuahia. Int. J. Curr. Res. Med. Sci. 2016;2(4):29-33.
39. Ifeanyi OE. A review on erythropoietin. Int J Adv Res Biol Sci. 2015;2(4):35-47.
40. Erukainure, O. L., Ebuehi, O. A. T., Adeboyejo, F. O., Aliyu, M., and Elemo, G. N. (2013). Hematological and biochemical changes in diabetic rats fed with fiber-enriched cake. Journal of Acute Medicine, 3 (2); 39–44.

41. Boes KM,Durham AC. Bone Marrow, Blood Cells, and the Lymphoid/Lymphatic System. Pathologic Basis of Veterinary Disease, 2017; 724–804.e2. https://doi.org/10.1016/B978-0-323-35775-3.00013-8
42. Bowdler AJ, Prankerd TAJ. Splenic mechanisms in the pathogenesis of anaemia. Postgraduate Medical Journal. 1965; 41(482):748–752.
43. Gu X,Manautou JE. Molecular mechanisms underlying chemical liver injury. Expert reviews in molecular medicine, 2012;14, e4. https://doi.org/10.1017/S1462399411002110
44. Tsagalis G. Renal anemia: a nephrologist's view. Hippokratia,2011; 15(Suppl 1), 39–43.
45. Donnelly S.Why is erythropoietin made in the kidney? The kidney functions as a critmeter. American journal of kidney diseases : the official journal of the National Kidney Foundation, 2001; 38(2); 415–425. https://doi.org/10.1053/ajkd.2001.26111
46. Fissell WH, Miner JH. What Is the Glomerular Ultrafiltration Barrier? Journal of the American Society of Nephrology: JASN, 2018; 29(9); 2262–2264. https://doi.org/10.1681/ASN.2018050490
47. Haase VH. Hypoxic regulation of erythropoiesis and iron metabolism. American journal of physiology. Renal physiology, 2010; 299(1), F1–F13. https://doi.org/10.1152/ajprenal.00174.2010.