Phthalic acid esters (PAEs) have been employed in polymer materials as a plasticizer to form them more flexible, adhesive, and soluble. These compounds are mainly used in paints, varnishes, personal cares, cosmetics, paper coatings, and adhesives even in bottled waters, shampoo, body deodorant, hairspray, and gels. Phthalates are able to possess remarkable toxic variations depending on their structures. So far, Di-(2-EthylHexyl) Phthalate DEHP and Di-n-Butyl Phthalate DBP have been found to cause reproductive and developmental toxicities. The U.S. Environmental Protection Agency (EPA) classified DEHP as probable human carcinogen. To the best of our knowledge, phthalates showed diverse toxicity profiles according to their structures in the liver, kidneys, thyroid, and testes, which are involved in general toxicity. Furthermore, they are introduced as hormonally-active agents, because they can interfere with the endocrine system in human. Incidence of developmental abnormalities (like skeletal malformations and cleft palate, and undescended testes, lowering testes weight and anogenital distance) seems increasing via high exposure to phthalate metabolites. Although, increasing the capacity for phthalate free plasticizer productions is the first step to restrict the distribution of these toxic manmade compounds, finding the new ways for phthalate absorption from the soil in agricultural fields may have benefits. Also, evaluation and examination of diverse sources of medicinal and food plants to determine the level of phthalate accumulation in their organs are extremely recommended to avoid creating toxicity particularly in reproductive systems.
children had been prolonged even enhanced until 4–9 years old [4]. Another group in risk, is children exposed to phthalates via mouthing items as well as breast milk, infant formulas, plastic food container and toys, cups and bowls, and even indoor air. Epidemiological evidence revealed that boys, whose mothers exposed to phthalates during pregnancy, showed an augmented incidence of inborn genital malformations and spermatogenic dysfunction [5]. Regarding to the broad range of phthalate toxicity in human, animals and marines, their distribution in various parts of plants including agricultural and medicinal herbs could be a serious concern. Interestingly, plants receive both nutrients and toxic substances through the roots as well as above-ground green parts. High accumulation of phthalates in stems of some types of crops has been reported [6]. For instance, three important food plants such as agricultural crops (Triticum aestivum, Brassica napus, Zea mays) have been specifically mentioned [2]. Actually in one study on seedlings of radish (Raphanus sativus) and wheat (T. aestivum) exposed to the vapor of DBP, the accumulation of phthalate (106 times per 3 days) was observed significantly in the cuticular and wax layers [7].

Surprisingly, some species of the genus Phyllanthus, the famous medicinal plants, have been reported to produce phthalates (bis (2-ethylhexyl) phthalate and bis (2-ethylhexyl) phthalate), which most often exhibited antimicrobial activities [8]. Moreover, phytochemical investigation on flowers of Calotropis gigantea led to separation of DEHP. The minimum inhibitory concentration (MIC) of this compound was measured between 13 and 128 μg/mL against Staphylococcus aureus, Bacillus subtilis, B. megaterium, Sarcina lutea, Escherichia coli, Shigella sonnei, S. shiga, S. dysenteriae, Aspergillus niger, A. flavus, A. fumigatus and Fusarium sp. This compound showed toxicity against Artemia salina larvae (IC_{50} = 9.2 μg/mL) too [9]. In addition, the leaves of Pongamia pinnata, an Indian medicinal plant, have been reported to consist of bis (2-methylheptyl) phthalate and the mentioned compound exhibited inhibitory activity against White Spot Syndrome Virus (WSSV) [10]. There is an increase in employment of commercial herbal extracts, particularly liquid preparations, which are packaged in plastic containers. Although there are some phyto-analytical techniques for detection and quantification of DEHP in herbal remedies, the quality of these products, regarding to their safety, remains under question [11].

Nevertheless, the presence of phthalates in plant and algae sources might be associated with environmental
exposure, production or formation of new brands of phthalates in plants is still in doubt and case of discussion between scientists. Additionally, it is proved that brown algae (like Sargassum) can synthesize phthalate esters, but their production process and physiological role have not been clear so far [12]. Dimethyl terephthalate has been also identified as pollutants in various red algae such as Phyllophora nervea, Acanthophora delilei and Hypnea musciformis, while DBP is isolated from brown and green algae (Undaria pinnatifida, Laminaria japonica, and Ulva sp.) raised a concern that DBP might be generated naturally [13]. The challenge will be raised when many of these plants and marine algae are consumed as food or medicinal resources.

Based on our unpublished data, accumulation of phthalates can occur in some medicinal plants e.g. Lythrum, that are usually grown in water flow in rivers and canals. In such cases, wastewater might be the origin of pollution and phthalate exposure to these plants. Sometimes, high exposure to phthalates resulted in about half part of essential oil extraction, which can cause worries to consume such medicinal plants, crops or vegetables. Although, increasing the capacity for phthalate free plasticizer productions is the first step to restrict the distribution of these toxic manmade compounds, finding the new ways for phthalate absorption from the soil in agricultural fields may have benefits. Also, evaluation and examination of diverse sources of medicinal and food plants to determine the level of phthalate accumulation in their organs are extremely recommended to avoid creating toxicity particularly in reproductive systems.

Competing interest
The authors declared that there is no conflict of interest.

Authors’ contributions
Both authors contributed equally to the paper. Both authors read and approved the final manuscript.

Author details
1 Medicinal Plants Research Center, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran 1417614411, Iran. 2 Department of Toxicology and Pharmacology, Faculty of Pharmacy and Pharmaceutical Sciences Research Center, Tehran University of Medical Sciences, Tehran 1417614411, Iran.

Received: 24 March 2013 Accepted: 16 April 2013 Published: 29 May 2013

References
1. Al-Saleh I, Shinwari N, Alsabbaheen A: Phthalates residues in plastic bottled waters. J Toxicol Sci 2011, 36:469–478.
2. Zomilova G, Jarosova A, Hrivna L: Distribution of phthalic acid esters in agricultural plants and soil. Acta Univ Agri Silvic Men Brnu 2011, 31:233–238.
3. Herr C, Nieden A, Koch HM, Schuppe HC, Fieber C, Angerer J, Ekman T, Stillanakis Nl: Urinary di (2-ethylhexyl) phthalate (DEHP) metabolites and male human markers of reproductive function. Int J Hyg Env Health 2009, 212:648–653.
4. Walter J, Cinnion ND: Toxic effects of the easily avoidable phthalates and parabens. All Med Rev 2012, 15:190–196.
5. Carbone S, Sawarcarb B, Ponzo O, Reynoso R, Cardoso N, Dequiz L, Mogyilevsky JA, Scacchi P: Impact of gestational and lactational phthalate exposure on hypothalamic content of amino acid neurotransmitters and FSH secretion in peripubertal male rats. Neurotoxicology 2010, 31:747–751.
6. Yin R, Lin XG, Wang SG, Zhang HT: Effect of DBP/DEHP in vegetable planted soil on the quality of capsicum fruit. Chromosphere 2003, 50:801–805.
7. Virgin Hl: Accumulation of di-n-butylphthalate in plants and its effect on pigment and protein content. Physiol Plantarum 1988, 72:190–196.
8. Saleem M, Nazir M, Akhtar N, Onocha PA, Riaz N, Jabbar A, Shaq Ali M, Sultana N: New phthalates from Phyllanthus muellerianus (Euphorbiaceae). J Asian Nat Prod Res 2009, 11:974–977.
9. Rowshanul Habib M, Rezaul Karim M: Antimicrobial and cytotoxic activity of di-(2-ethylhexyl) Phthalate and anhydroisophoradiol-3-acetate isolated from Colotropis gigantea (Linn.) Flower. Mycobiology 2009, 37:31–36.
10. Rameshthangam P, Ramasamy P: Antiviral activity of bis(2-methylheptyl) phthalate isolated from Pongamia pinnata leaves against White Spot Syndrome Virus of Penaeus monodon Fabricius. Virus Res 2007, 126:38–44.
11. Ndhlala AR, Ncube B, Van Staden J: Ensuring quality in herbal medicines: Toxic phthalates in plastic-packaged commercial herbal products. South Afr J Bot 2012, 82:60–66.
12. Chen CY: Biosynthesis of di-(2-ethylhexyl) phthalate (DEHP) and di-n-butyl phthalate (DBP) from red alga Bangia atropurpurea. Water Res 2004, 38:1014–1018.
13. Kuan Ql, Zhao WY, Cheng SP: Toxicity of dibutyl phthalate to algae. Bull Env Contam Toxicol 2003, 71:602–608.

doi:10.1186/2008-2231-21-43
Cite this article as: Saeidnia and Abdollahi: Are medicinal plants polluted with phthalates? DARU Journal of Pharmaceutical Sciences 2013 21:43.