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Review Article

Study on the Effect of Rainfall Level on the Size of Silver Nanoparticles Synthesized by Plants of the Lamiaceae Family in Different Regions of Iran

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ABSTRACT

Nanotechnology could be a very important field of recent research dealing with medical, industrial, environment. Silver nanoparticles are the topics of researchers because of their distinctive properties (size, shape depending optical, antimicrobial, and electrical properties). The synthesis of safe nanoparticles by biological organisms is recommended due to the environmental friendliness and low costs compared to physical and chemical methods. Recently, researchers tend to use a biological synthesis of nanoparticles by biological methods such as plants. This research aimed to study on the rainfall level on the biosynthesis of silver nanoparticles by Lamiaceae family plants in different regions of Iran. T-test student was used to examining the relationship between the size of nanoparticles and rainfall, using spss version 22 software. The study shows phenol concentration in low rainfall areas is more than high rainfall area, which is the main factor for the synthesis of nanoparticles. The result of the study demonstrated that the highest size of synthesized nanoparticle is 50 nm and the lowest size 10 nm, which are related to high rainfall and low rainfall regions respectively. The results showed the relationship between synthetic nanoparticles sizes and rainfall are significant p-value<0.05. As the present study could be, conclude that the rainfall amount is effectively factor for the synthesis of the nanoparticle while other factors such as temperature, altitude and climate play a key role for properties of the plant, which is affect for size of nanoparticles.

Keywords: Plant, Green synthesis, Nanoparticle, Climate

Introduction

Nanotechnology is emerging as a new field of research dealing with the synthesis of nanoparticles (NPs) for their applications in various fields such as electrochemistry, catalysis, sensors, biomedicines, pharmaceutics, healthcare, cosmetics, food technology, textile industry, mechanics, optics, electronics, space industry, energy science, and optical devices. The particles size lie in the dimension area of 1–100 nm is called nanomaterials. These materials are found to show enhanced properties based on size, distribution and morphology. Metal NPs and metal oxide NPs are considered as most efficient as these contain remarkable enhanced properties such as antimicrobial properties due to their increased surface area [1-10]. Physical and chemical methods for the synthesis of nanoparticles have been taken into consideration in recent decades, but many techniques are inefficient in terms of energy consumption and are considered as environmental pollutants. In most chemical methods, toxic and hazardous substances for humans and the environment . In addition, the chemical stability of particles in the chemical synthesis method is controversial and scale is very difficult. In addition, physical methods need to provide favorable conditions such as high temperature or high pressure. For this issue, the demand for nanoparticle synthesis has increased with environmentally friendly methods .Nanobiotechnology is a potential technology emerging from the combination of biotechnology and nanotechnology, which aims to produce nanoscale materials by developing environmentally friendly bio-based methods. Much Synthesis of nanoparticles using microorganisms, fungi, plants and algae, is a substitute for physical and chemical methods.Green synthesis is safe, simple, non-toxic and efficient compared to other mechanical strategies. The most necessary advantage of the plant extracts for nanoparticle synthesis is merely gettable, safe, and nontoxic [11-18]. Plant having chemical materials such as phenol, terpenoids, flavones, ketones, aldehydes, amides, and carboxylic acids, Flavones, organic acids, and quinones that are water-soluble and responsible for the immediate reduction of the ion. Recently Nanoparticles have been synthesized using Lamiaceae family products extract such as Rosmarinus officinalis, phlomis, Mentha,Thymus vulgarisL., Mentha longifolia (L.), Origanum vulgare. The Plants of Lamiaceae family showed the most dispersal in the world, and so far, about 5000 species have been introduced, and these plants produce a variety of terpenoids and aromatic compounds that are mainly stored in their leaves. These plants use as flavors, disinfectants, stimulants, and analgesics. The main constituents of the aerial part of the plant include parsing, gamma, Trencin, carvacrol, thymol. These cases have active functional groups that can play a role in the biosynthesis of nanoparticles. Studies of the extract of the Plants of Lamiaceae family showed the behavior of phenolic compounds mainly flavonoids to attribute many of the antioxidant properties, due to their hydrogen donation ability and structural requirement considered essential for effective radical scavenging and production of nanoparticles. Naturally, it should note that any other varieties containing the antioxidant phenolics can used for the biosynthesis of the nanoparticles. What is important here is the class and category of the antioxidant phytochemicals? Because with those reducing effect to produce the nanoparticles they adsorb on nano surface and determine the size, shape and morphology of the biosynthesized nanoparticles Lamiaceae family contains compounds such as polyphenols, which used to synthesize nanoparticles as reducing agents and stabilizing those There are reports that there is a relationship between habitat conditions and chemical composition of plants, and there is a high correlation between the geographical origin of the plants and the active compounds. The result of the research by showed that in moderate climatic conditions, compared to warm and dry climates, the percentage of active compounds in *Anisum Pimpinella* .L significantly increased. In other research, Rai-Dehagi (2014) reported a significant difference between genotypes of three types of mint between percent and essential oil yield.The aim of this study is about a synthesis of silver nanoparticles by Lamiaceae family plants grown in different amount of rainfall in Iran [19-29].

Phenolic acids in the Lamiaceae family

Studies of the extract of the Plants of Lamiaceae family showed the demeanor of phenolic compounds mainly flavonoids to which are attributed many of the antioxidant properties, due to their hydrogen donation ability and structural requirement considered to be essential for effective radical scavenging and production of nanoparticles. Based on the new records, the Lamiaceae family appears to be a valuable reference of plant species including large numbers of phenolic acids (Phys), particularly their depside forms, e.g. rosmarinic acid. Phenolic acids are from a wide group of naturally occurring organic compounds with a wide spectrum of pharmacological activities. It discovered that they possess not just an antioxidant, but also antibacterial and antiviral properties. The antioxidant activities of phenolics usually combine with hydroxyl groups of their molecules. There are Phenolic acids in different concentrations at plants.

Use of Lamiaceae family in nanoparticle synthesi

The reduction of silver and violet ions to nanoparticles is attributed to phenolic compounds in plant extracts. The most important advantages of using plant extracts for synthesized nanoparticles are compounds that reduce metal ions and thus synthesize nanoparticles. The use of plant extracts for synthesis, in addition to the benefits described, accelerates the synthesis reaction. Synthesized nanoparticles by plant (Lamiaceae family) extracts are far more resistant and stable than other nanoparticles synthesized by other biological methods (Mittal et al., 2013). Fig. 1 shows the picture of different plants of Lamiaceae family used for the biosynthesis of nanoparticles.

Table 1 presents a short review at plant synthesis of silver nanoparticles from the Lamiaceae family that grows in different regions of Iran; we tried to compare the effect of two high rainfall and low rainfall climates on the size of nanoparticles synthesized by plants.

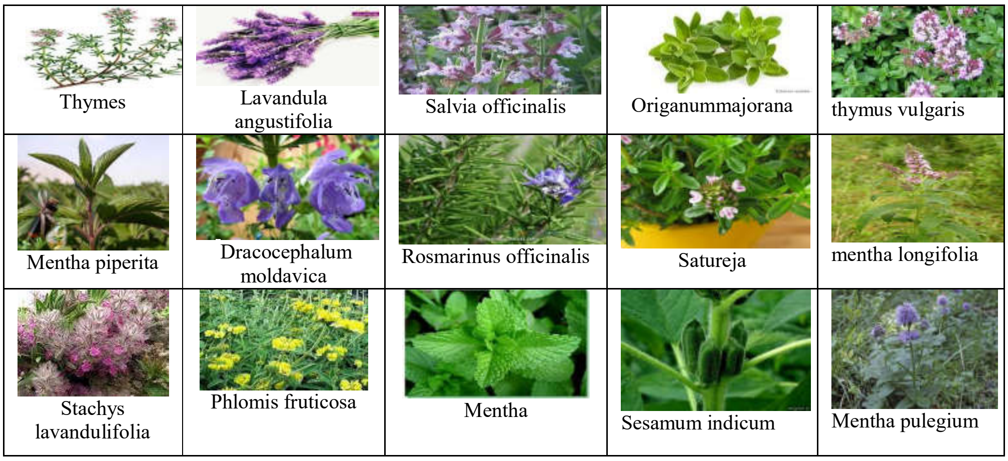

Figure 1. Various types of plants of Lamiaceae family used for the biosynthesis of nanoparticles

Table 1. Biosynthesis of silve nanoparticles using plant extracts.

Growing area	Lamiaceae family	Geographical coordinates	Climate	Nano particle sizes	Average rainfall	Average size	References
Zahedan	Mentha	29.4519° N, 60.8842° E	Low rainfall	10-20	90.6	10	(Rahmatian *et al.*,2017)
Sari	Salvia officinalis	36.5659° N, 53.0586° E	High rainfall	50	789.2	50	(Nikrui and Ali Mehdiyan, 2015)
Ardebil	Origanum majorana	38.4853° N, 47.8911° E	High rainfall	30-70	303.9	50	(Ya'qub and Kavoosi, 2017)
Khorramabad	thymus vulgaris	33.4647° N, 48.3390° E	High rainfall	22	509	22	(Shahzamani *et al.*,2017)
Tehran	Sesamum indicum	35.6892° N, 51.3890° E	High rainfall	18-70	426.0	44	(Dehghan Nayeri *et al.*, 2016)
Isfahan	Phlomis	32.6546° N, 51.6680° E	Low *rainfall*	25	122.8	25	(Allafchian *et al.*,2016)
Zabul	Dracocephalum	30.8849° N, 61.1403° E	Low rainfall	11	74	11	(Mehrabi , 2016)
Mashhad	Rosmarinus officinalis	36.2605° N, 59.6168° E	Low rainfall	21	198.2	21	(Ghorbani and Bahraini ,2014)
Kerman	Sesamum indicum	29.4850° N, 57.6439° E	Low rainfall	14	152.9	14	(Mohsali and Porseyedi , 2015)
Kerman	Satureja	29.4850° N, 57.6439° E	Low rainfall	~20	152.9	10	(Masters, 2013)
Khorram abad	Rosmarinus officinalis	33.4647° N, 48.3390° E	High rainfall	20-40	509	20	(Heidari *et al.*, 2016)
Tehran	Mentha pulegium	35.6892° N, 51.3890° E	High rainfall	~100	426.0	50	(Ali Akbari and Larijani, 2016)
Varamin	Mentha longifolia (L.)	38.0962° N, 46.2738° E	High rainfall	21.1	288.9	21.1	(Kalaki *et al*., 2017)
Yasuj	Rosmarinus officinalis	30.6684° N, 51.5875° E	High rainfall	10-33	864.9	21.5	(Ghaedi *et al.*, 2015)
Tabriz	hyssopus officinalis L.	35.3252° N, 51.6472° E	High rainfall	~50	426.0	25	(Jafarirad and.Kosari-Nasab 2017)
Sabzevar	Saliva officinalis	36.2152° N, 57.6678° E	Low rainfall	27	188.6	27	(Baghayeri *et al.*, 2017)
Isfahan	Dracocephalum	32.6546° N, 51.6680° E	Low rainfall	5–50	122.8	27.5	(Haghighi Pak *et al.*, 2016)
Isfahan	Melissa officinalis	32.6546° N, 51.6680° E	Low rainfall	34.6	122.8	34.64	(Pirtarighat *et al.*, 2017)

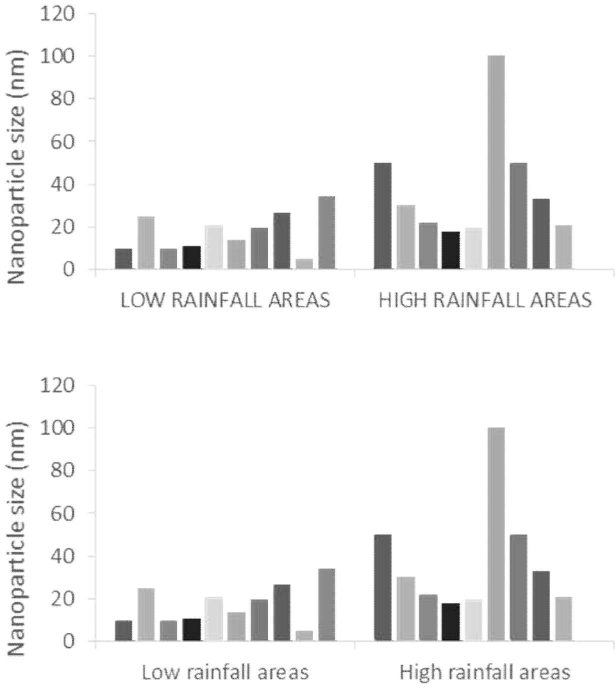

Figure 2. The average size of Silver Nanoparticles Synthesized by plants of the Lamiaceae family in Low rainfall areas and High rainfall areas

Figure 2 shows the difference between sizes of nanoparticles in different rainfall level. As shown figure 2 the mean sizes of nanoparticles in the low rainfall area are smallest than the high rainfall area. Fig3. Shows the distribution of the size of silver nanoparticles synthesized by Lamanese family plants Grown up in different geographical locations of Iran.

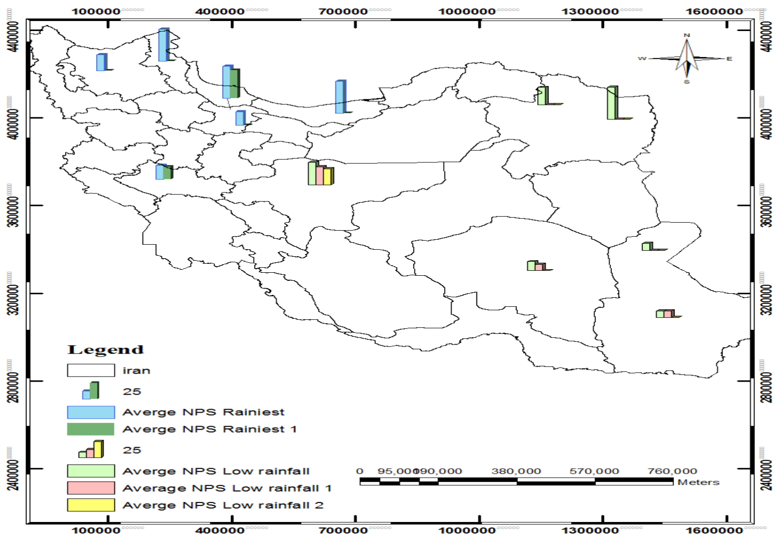

Figure 3. Geographical location of the growing site of the studied plants

Results and discussion

Active compounds such as polyphenols are the agents of nanosilver synthesis in plants. One of the most important characteristics of these active compounds is their antioxidant properties, which allows them to lose a hydrogen and trap free radicals. Metal ion is reduced by the use of plant extracts much faster than other chemicals. Lamiaceae family plants are grown up throughout Iran and contain phenols as the largest group of secondary metabolites of the plants. High amounts of phenolic compounds are found in the tissue of plants of the family of Lamiaceae, which increases the ability of the cell extracts of these plants to synthesize stable silver nanoparticles. These compounds can also be attached to the surface of the nanoparticles and act as a stabilizing agent. The amount of phenolic compounds in different regions is influenced by climatic factors the impact of climate factors on plants is different. Environmental factors such as temperature, rainfall, altitude and physical and chemical properties of soil are effective on the quality and quantity of plant compounds. Table 1 shows۸ cases of investigated studies related to low rainfall plants Including (Zahedan, Isfahan, Zabol, Mashhad, Kerman, Sabzevar) and 10 other related Plants of rainy areas Including (Sari, Ardabil, Khorram Abad, Tehran, Tabriz, Yasouj)The smallest size of silver nanoparticles synthesized was 10 nm, which is related to the Kerman and Zahedan cities with rainy climates and average annual rainfall of 90.6 and 152.9 ml, and the largest size of synthesized nanoparticles is 50 nm, which is related to the cities of Sari, Tehran and Ardebil With rainy climates with an average annual rainfall of 789.2, 426.0 and 303.9 that shows the size of the nanoparticles in the low rainfall is smaller than the high rainfall areas and statistic analysis shows the results of an independent T-test for the relationship between rainfall and sizes of silver nanoparticles synthesized at 5% is significant.

Conclusion

The potential of applying metal nanoparticles in different areas increases the need to provide them on an industrial scale and in stable formulations with environmental friendly processes. Green synthesized silver nanoparticles have important aspects of nanotechnology with the unmatched attention. A growing experience towards green chemistry and application of greenway for a synthesis of metal nanoparticles lead a want to improve the environmental friendly techniques. The natural route of synthesizing nanoparticles has many benefits, such as the stable creation of nanoparticles with controlled sizes and patterns, the lack of subsequent complex chemical synthesis, the lack of toxic contaminants. The different the L factors influenced the properties of the nanoparticles synthesis. In the present study, the plants of amiaceae family in two climates of high rainfall and low rainfall investigated the effect of a climatic factor on the size of nanoparticles synthesis.

SUGGESTION

Considering that other environmental factors such as height, temperature, soil properties and ets affect the quality and quantity of antioxidants in plants. It is suggested that further research into the effect of these factors on the Phyto synthesis of metal nanoparticles is considered.

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