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Comparative Analysis of Phenolic Profile and Mineral Constituents of *Datura stramonium* L. and *Datura innoxia* Mill.

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HIGHLIGHTS

- Two medicinal plant species (cultivated same plot) were compared belongings genus Datura.
- Total Phenolic and Flavonoid content, Total antioxidant activity of *D. stramonium* and *D. innoxia* was examined.
- Macro and Micro element content, as well as heavy metal content of *D. stramonium* and *D. innoxia* was clarified.

Abstract

Datura sp. is a genus of 14 species, poisonous plants belonging to the family *Solanaceae*. Distributed throughout the world and it is widely cultivated in Asia, America, Europe, South Africa and other tropical and subtropical regions and primarily used as an intoxicant and hallucinogen. *Datura stramonium* and *Datura innoxia* two medicinal plant known as Jimson weed and Thorn apple cultivated all over the world for many properties. This study revealed that total phenolic content (196.52 and 183.08 mg GAE g^{-1}), total flavonoid content (16.72 and 17.12 mg QE 100 g^{-1}), total antioxidant activity (91.74 and 88.97µmol TE g^{-1}) and nutritional element content (Mg, K, Ca, Fe, Mn, Zn, Cu, Ni, As, Cd, Co, Cr and Pb) of two different medicinal plant species *Datura stramonium* and *Datura innoxia*.

Keywords: Alkoloids; dualex value; heavy metal content; mineral content; nutritional properties

1. Introduction

Datura sp. is a genus of 14 species, poisonous flowering plants belonging to the family Solanaceae distributed throughout the world (Bhardwaj et al. 2016). Primarily used as an intoxicant and hallucinogen (Alabri et al. 2014). It is widely cultivated in Asia, America, Europe, South Africa and other tropical and subtropical regions (Gaire and Subedi 2013).

Datura stramonium is annual, leafy herbaceous, poisonous, medicinal plant commonly known as Jimson weed or Datura. *D. stramonium* is an plant that is a powerful hallucinogen that causes health problem. Its combination of atropine, scopolamine, and hyoscyamine also results in anticholinergic toxicity. Tachycardia, hyperthermia, dry skin and mucous membranes, skin reddening, visual impairment, speech impediment,

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reduction in intestinal sounds, urine retention, agitation, disorientation, and hallucinations are the classic signs of poisoning. Depending on gastric depletion, the symptoms typically start 1-4 hours after consumption and last for 24-48 hours (Vanderhoff and Mosser, 1992).

Datura innoxia Mill. also belonging to the family Solanaceae, commonly named as Thorn-Apple and native of Asia, United States, Mexico and China (Fatima et al. 2015). Many illnesses, including tumors, earaches, headaches, and asthma, have been treated with plant parts (Vermillion et al. 2011). The plant's antibacterial, anticancer, antihyperglycemic, and antioxidant qualities have enormous potential. (Arulvasu et al. 2014; Banu et al. 2014; Tandon et al. 2016).

The objective of the current study was to investigate total antioxidant, total phenolic and total flavonoids content, nitrogen balance index (NBI), cholorophyll, flavonol, anthocyanin, nutrient elements and heavy metal content of *D. stramonium* and *D. innoxia*.

2. Materials and Methods

2.1. Plant material

The study material consists of *Datura stramonium* and *Datura innoxia* grown in the Medicinal and Aromatic Plants Garden of Van Yuzuncu Yil University, Faculty of Agriculture, Department of Field Crops. The samples were taken first week of July (10.00 am) then shade dried. The dried samples were then cut into smaller pieces and grounded into moderately coarse powder.

2.2. Determination of heavy metal, and nutrient contents

The minerals (including macro elements: K, Ca and Mg; micro elements: Fe, Zn, Cu and Mn) and some heavy metals (As, Cd, Co, Ni, Cr and Pb) were determined. The mineral constituents of the plant samples were investigated as follows: Dried samples were ashed in a furnace with hydrochloric acid and nitric acid (AR) (AOAC 2000). Then, distilled water (50 ml) were added to samples in a volumetric flask. All assays were performed triplicate and the standard materials were being utilized for chemical analyses. Atomic Absorption Spectrometry (AAS) was used to estimate the K, Ca, Mg, Fe. ICP-OES (Inductively coupled plazma-Optical emission spectrometer) was used to determinate for other micro element and heavy metals constituents (Mn, Zn, Cu, Ni, As, Cd, Co, Cr and Pb). The results and standard deviations (Sd) of chemical analyses have been shown in Table 2.

2.3. Total antioxidant, total phenolic and total flavonoids content

Total phenolic compounds content was measured according to Obanda, Owuor (1997) method. The antioxidant activity was also performed based on the Antioxidant Power (FRAP) (Iron (III) antioxidant power reduction) method (Benzie, Strain 1996) followed by readings the absorbance at 593 nm and antioxidant activity values were recorded as Trolox equivalent (TE)/mg. The total flavonoids content was determinated with some modifications according to the method developed by Quettier-Deleu et al. (2000). The total amount of flavonoid was measured at 415 nm and calculated in mg quercetin equivalent (QE) 100 g-1 DM by using the calibration curve prepared using standard quercetin.

2.4. Determination of Nitrogen balance index, cholorophyll, flavonol and anthocyanin Evaluation of Data

The Nitrogen balance index (NBI), chlorophyll, flavonol and anthocyanin content were measured on the leaf non-destructively using and in real time the Dualex scientific+ (FORCE-A, France) device before harvesting.

2.5. Evaluation of Data

All data were subjected to Analysis of Variance and the significance of mean values was tested by Duncan Multiple Range Test using COSTAS (version 6.3) software.

3. Results and Discussion

Phytochemicals are the bioactive substances that are produced by plants as secondary metabolites. Both edible and medicinal plants frequently contain phenolic compounds, which have been shown to have a variety of biological effects, including anti-inflammatory and antioxidant properties as well as anti-aggregatory and vasodilating properties (Kahkonen et al. 1999). Total phenolic content obtained from the *D. stramonium* and D. innoxia are presented in Table 1. Total flavonoid content in *D. stramonium* and *D. innoxia* was found to be 16.72 ± 2.82 mg QE 100 g^{-1} and 17,12 ± 2,37 mg QE 100 g^{-1}, respectively. Presence of total flavonoids reported in the previous studies for *D. innoxia* 19 ± 0.17 mg QE g^{-1} (Bagewadi et al. 2019) and for *D. stramonium* 13.19 mg QE g^{-1} (Alper and Cennet 2022). Our obtained result of flavonoid content for both Datura species are in accordance with literature. Total antioxidant content of *D. stramonium* 91,74 ± 6,59 μmol TE g^{-1} and *D. innoxia* 88,97 ± 5,53 μmol TE g^{-1}. İn a previous study, antioxidant activity of *D. innoxia* reported 221.25 ± 1.06 mg AAE g^{-1} (Bhardwaj et al. 2016) and *D. stramonium* 63.19±1.02 mg TEs g^{-1} (Alper and Cennet 2022). Total phenolic content of *D. stramonium* and *D. innoxia* found 196,52 ± 9,69 mg GAE g^{-1} and 183,083 ± 0,95 mg GAE g^{-1}, respectively. Alper and Cennet (2022) reported total phenolic content of *D. stramonium* as 25.77 mg GAE g^{-1} and Bhardwaj et al. (2016) reported total phenolic content of *D. innoxia* as 70.26 ± 1.12 mg GAE g^{-1}. Phenolic profile of plants may vary depending on many factors. Some of our results are compatible with previous studies and some of them do not seem to be compatible. This may be due to environmental conditions, harvesting or extraction method. In general, our results seem to bein accordance with the literature.

Table 1. Phenolic profile of *D. stramonium* and *D. innoxia*

Properties	*Datura stramonium*		*Datura innoxia*		CV
	Mean	S.D.	Mean	S.D.	
Total Flavonoid Content (mg QE 100 g^{-1})	16.72	± 2.82	17.12	± 2.37	4.17ns
Total Antioxidant Activity (μmol TE g^{-1})	91.74 a	± 6.59	88.97 b	± 5.53	1.10*
Total Phenolic Content (mg GAE g^{-1})	196.52 a	± 9.69	183.083 b	± 0.95	1.58**
Nitrogen Balance Index (NBI)	23.57 a	± 1.15	21.86 b	± 2.23	0.06**
Chlorophyll	43.47 a	± 2.39	37.23 b	± 3.51	3.50**
Flavonoid	31.05 a	± 0.02	1.7 b	± 0.09	4.34**
Anthocyanin	0.04 b	± 0.01	0.123 a	± 0.038	19.63**

S.D. represents Standard Deviation for three replications (n = 3)

Dualex value of *D. stramonium* and *D. innoxia* were found as Nitrogen balance index 23.57 and 21.86, Chlorophyll 43.47 and 37.23, Flavonoid 31.05 and 1.7, Anthocyanin 0.04 and 0.123, respectively. In a study by Uçar et al. (2023), NBI 26.32 dx, chlorophyll 21.32 dx, flavonoids 0.71 dx, and anthocyanin 0.074 dx were detected in the control group of Salvia officinalis plants. It was determined that the obtained results were different from the relevant literature. This situation is thought to be due to genetic structure and environmental condition.

Macro nutrients Mg, K and Ca levels of *D. stramonium* and *D. innoxia* found to be 4.33 ± 0.16 g kg^{-1} and 5.5 ± 1.35 g kg^{-1}, 31.01± 3.73 g kg^{-1} and 23.67 ± 2.62 g kg^{-1}, 30.99 ± 2.53 g kg^{-1} and 17.66 ± 1.03 g kg^{-1}, respectively. *D. stramonium* has higher value in case of macro nutrients except Mg. Micro nutrients Fe, Mn, Zn and Cu results respectively; 623.60 ± 18.42 mg $kg^{-1}$and 819.64 ± 20.57 mg kg^{-1}, 74.96 ± 2.60 mg kg^{-1} and 83.88 ± 21.21 mg kg^{-1}, 69.32 ± 1.04 mg $kg^{-1}$and 51.53 ± 13.22 mg kg^{-1}, 21.29 ± 0.84 mg $kg^{-1}$and 13.92 ± 1.27 mg kg^{-1}. In a previous study while mineral content of *D. stramonium* reported as K 49.6 mg g^{-1}, Ca 23.1 mg g^{-1}, Mn 0.132 mg g^{-1}, Cu 0.032, Fe 1.91 mg g^{-1}, Zn 0.89 mg g^{-1} (Butnariu et al. 2012), *Datura metel* nutrient content reported K 37.9 g kg^{-1}, Ca 30.0 g kg^{-1}, Mg 11.5 g kg^{-1}, Zn 66.8 mg kg^{-1}, Mn 77.6 mg kg^{-1}, Cu 12.5 mg kg^{-1}, Fe 0.9 mg kg^{-1} (Bhattacharjee et al. 2004).

Table 2. Mineral and Heavy metal content of *D. stramonium* and *D. innoxia*

Elements	*Datura Stramonium*		*Datura innoxia*		CV
	Mean	S.D.	Mean	S.D.	
Mg (g kg^{-1})	4,33 b	± 0,16	5,5 a	± 1,35	7.19*
K (g kg^{-1})	31,01 a	± 3,73	23,67 b	± 2,62	5.78**
Ca (g kg^{-1})	30,99	± 2,53	17,66	± 1,03	10.84ns
Fe (mg kg^{-1})	623,60 b	± 18,42	819,64 a	± 20,57	2.71**
Mn (mg kg^{-1})	74,96 b	± 2,60	83,88 a	± 21,21	4.47*
Zn (mg kg^{-1})	69,32 a	± 1,04	51,53 b	± 13,22	1.65**
Cu (mg kg^{-1})	21,29 a	± 0,84	13,92 b	± 1,27	4.01**
Ni (mg kg^{-1})	1,12 b	± 0,24	1,84 a	± 0,56	1.98**
As (mg kg^{-1})	0,57 b	± 0,28	0,97 a	± 0,15	2.59**
Cd (mg kg^{-1})	0,12	± 0,16	0,156	± 0,17	13.05ns
Co (mg kg^{-1})	0,19 b	± 0,26	0,44 a	± 0,06	9.18**
Cr (mg kg^{-1})	1,68 b	± 1,91	3,2 a	± 0,08	6.47**
Pb (mg kg^{-1})	0,78 b	± 0,78	2,53 a	± 0,57	4.35**

S.D. represents Standard Deviation for three replications (n = 3)

The presence of heavy metals differed for both species studied. In *D. stramonium*, the heavy metal content was Cr >Ni >Pb >As >Co >Cd (1.68 mg kg^{-1}, 1.12 mg kg^{-1}, 0.78 mg kg^{-1}, 0.78 mg kg^{-1}, 0.57 mg kg^{-1}, 0.57 mg kg^{-1}, 0. 19 mg kg^{-1}, 0.12 mg kg^{-1}), while Cr >Pb >Ni >As >Co >Cd in *D. innoxia* (3.2 mg kg^{-1}, 2.53 mg kg^{-1}, 1.84 mg kg^{-1}, 0.97 mg kg^{-1}, 0.44 mg kg^{-1}, 0.15 mg kg^{-1}, respectively). Ibiam et al. (2017) in research that different part of *D. stramonium* plant investigated, reported that Cd and Pb not detected on leaves of plant. Bhattacharjee et al. (2004) revealed that level of Co and Ni in *Datura metel*, 25.4 mg kg^{-1} and 8.3 mg kg^{-1}, respectively. Content of heavy metal in plant vary, depend on their contamination of environment such as soil, water or air. In this case, our obtained results in accordance with previous study.

4. Conclusions

Genus Datura have widely used in phytomedicine and popular all over the world for their antispasmodic and hallucinogenic properties. This study revealed the phenolic content and the presence of some minerals and heavy metals in two species belonging to the genus Datura. The two studied medicinal plants did not show major differences in the observed parameters. The variation in results are may be attributed to the differences in genetic structure. Further studies on the concentrations of active ingredients, especially the presence of alkaloids and the level of toxicity are recommended.

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