Seasonal Effects on Photosynthetic Pigments, Nutrients, Flavonoids, Polyphenol and Antioxidant Activity of *Abrus precatorius* L. (Kunch)

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**Abstract**: Seasonal effects on photosynthetic pigments, nutrients, flavonoids, and polyphenol and antioxidant activities of *Abrus precatorius* L. were studied in three different growing seasons within a year. An experiment was conducted during January, 2019 to March, 2020 at the Botanical Garden, University of Chittagong. The highest foliar photosynthetic pigments, nutrients were observed in monsoon (June-August) and the lowest in late monsoon (September-November) whilst maximum flavonoid content was determined in the leaf extract of early monsoon (March-May) and minimum in late monsoon (September-November) respectively. In contrast the highest polyphenol content and antioxidant activity were estimated in the leaf extract of late monsoon (September-November) and minimum in early monsoon (March-May) respectively. The present study concludes that monsoon (June-August) is suitable for efficient photosynthesis as well as nutrient accumulation in *Abrus* and early monsoon (March-May) is favourable for flavonoid synthesis. Considering the amount of the all studied elements late monsoon (September-November) is the right time for harvesting the leaves of *Abrus* to be obtained maximum polyphenol and antioxidant activity for medicinal use.

**Keywords**: Seasonal effect, Kunch, pigments, nutrients, flavonoids, polyphenols, antioxidant.

**INTRODUCTION**

*Abrus precatorius* L. is an ornamental, rare, perennial, twinning, deciduous woody medicinal vine belonging to family Fabaceae normally known as kunch in Bengali [1–4]. Southeast Asia is the place of origin of this plant [5]. It is one of the most impressive medicinal plant [6, 2]. It has diverse biological activity viz. anticancer [7, 8], anti-diabetic [9, 10], anti-inflammatory [11, 12], anti-fertility [13, 14], anti-oxidant [15, 16], nephroprotective [17], neuroprotective [18], antimalarial [19], cytotoxic [20], pest management [21], anti-microbial [22; 23] and anti-viral [24, 25]. The leaf of *Abrus precatorius* is the source of different alkaloids [26], flavonoids [27], tri-terpenoids [28], carbohydrates and amino acids [29]. Roots and leaves of this plant carry sweet tasting glycyrrhizin [30, 2].

So far the literature review is concerned; no specific study has yet been done on the dynamics of active components in Kunch plant in respect to seasons and habitats in Bangladesh. The present study was undertaken to assess the seasonal effect on foliar photosynthetic pigments, nutrients, flavonoids, and polyphenol and antioxidant activity of *Abrus precatorius* L. in three different growing seasons.

**MATERIALS AND METHODS**

The experimental plant samples (leaf of *Abrus precatorius* L.) were collected in three different seasons (EM: Early monsoon – March, April and May; M: Monsoon-June, July and August; LM: Late Monsoon-September, October and November) from the Botanical garden, University of Chittagong. Leaves were dried in the laboratory under current air at room temperature (28°C) and then after twenty four hours the materials were put in to the oven maintained at 60°C for 48 hours. All the samples were then weighed in an electric balance and ground to pass through 0.2 mm sieve and preserved in airtight plastic vial for analysis.

Foliar photosynthetic pigments were determined by Wettstein method [31]. For this purpose fresh leaves (3rd and 4th pairs) were collected from the plants. Foliar nutrients (viz, N, P and K) were extracted with sulfuric-peroxide (H₂SO₄+H₂O₂) digestion mixture and determined by standard method [32]. The foliar iron content was determined by spectrophotometric method [33]. The foliar protein content was measured sensitive spectrophotometric method [34]. Flavonoids was measured using an UV-visible spectrophotometric (Shimadzu UV-160A PC, Shimadzu Corporation, Kyoto, Japan) method [35]. The polyphenol content was measured based on Roberts [26] with modification.
from the recent work of some researchers [37, 38]. The radical scavenging activity of the leaf extracts was determined by the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical using a modified method [39]. The assay is based on the measurement of the scavenging ability of antioxidants towards the stable DPPH radical [40]. There were three replications for each set of experiment. Experiments were designed on CRD method. Statistical analyses were done according to MS excel.

**RESULT AND DISCUSSION**

The results (Table-1, Fig.1) reveal that the foliar photosynthetic pigments varied with the change of seasons. Chlorophyll-a, Chlorophyll-b, Carotenoids, total chlorophyll and total pigments ranged from 3.262 mgg⁻¹ FW (Monsoon) to 2.045 mgg⁻¹ FW (Late Monsoon); 1.372 mgg⁻¹ FW (Early Monsoon) to 0.827 mgg⁻¹ FW (Late Monsoon); 1.010 mgg⁻¹ FW (Monsoon) to 0.640 mgg⁻¹ FW (Early Monsoon); 4.518 mgg⁻¹ FW (Monsoon) to 2.873 mgg⁻¹ FW (Early Monsoon) and 5.528 mgg⁻¹ FW (Monsoon) to 3.759 mgg⁻¹ FW (Late Monsoon) respectively and chlorophyll-a, total chlorophyll and total pigments showed the following trend as M>EM>LM. ANOVA of chlorophyll content in early monsoon and minimum in late monsoon in the leaf of Rauwolfia serpentina, Santalum album and Adhatoda vasica. Sauceda et al. [43] enumerated maximum carotenoids content in monsoon and minimum in early monsoon in Acacia regidula and Prosopis laevigata. Prajapati and Tripathi [44] observed maximum total chlorophyll content in monsoon and minimum in late monsoon in the leaf of Ficus religiosa, Mangifera indica, Psidium guajava and Dalbergia sissoo. In case of plucked shoots of clonal agroteypes of tea and kalomegh, photosynthetic total pigments were found to be changed with plucking seasons and maximum value was obtained in monsoon [48, 55] which are similar to this finding.

The results of foliar nutrients viz. Nitrogen, Phosphorus, Potassium, Iron and Protein are shown in Table 2. Foliar Nitrogen, Phosphorus, Potassium and protein contents ranged from 1.022% (Monsoon) to 0.6392% (Late Monsoon); 0.0687% (Monsoon) to 0.0337% (Late Monsoon); 0.9886% (Monsoon) to 0.4688% (Late Monsoon); and 6.387% (Monsoon) to 3.995% (Late Monsoon); respectively and showed the following sequence as M>EM>LM. Foliar Iron contents varied from 0.0594% (Early Monsoon) to 0.0268% (Late Monsoon) and showed the following trend as EM>M>LM. ANOVA of foliar N, P, K, Fe and protein showed significant value (P<0.01) with seasons (Table-2). Patarapanich et al. [45] and Uddin et al. [46] reported that the foliar nutrients of Andrographis paniculata changed with seasons as well as growing conditions. These reports also bear a resemblance to the findings of the present experiment.

### Table-1: Change of foliar pigments of Abrus precatorius L. in three different seasons

| Seasons | Pigments, mg/g FW | Ratio of pigments |
|---------|------------------|-------------------|
|         | Chl-a            | Chl-b             | Car               | Total Chl | Chl-a/Chl-b | Chl-a/Car | Chl/Car |
| EM      | 2.198±0.10       | 1.372±0.18        | 0.640±0.05        | 3.570±0.08 | 1.624±0.27  | 3.440±0.11 | 5.61±0.55 |
| M       | 3.262±0.07       | 1.257±0.18        | 1.010±0.06        | 4.518±0.11 | 2.637±0.44  | 3.235±0.13 | 4.49±0.37 |
| LM      | 2.045±0.09       | 0.827±0.23        | 0.886±0.08        | 2.873±0.14 | 2.629±0.86  | 2.316±0.12 | 3.27±0.47 |
| F value | 171.2±24.29**    | 6.45±0.08         | 3.27±0.11         | 167.2±3.04 | 77.71±2.47  | 18.33±2.47 |

Legend: Chl= Chlorophyll; Car= Carotenoids; **= Significant at 1% level; *= Significant at 5% level; ns= Non-significant; FW= Fresh weight. In each rows, values with same superscript are non-significant and with different superscript are significant by DMRT (Duncan Multiple Range Test).

### Table-2: Change of foliar nutrients of Abrus precatorius L. in three different seasons

| Seasons | Nutrients |
|---------|-----------|
|         | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Iron (%) | Protein (%) |
| EM      | 0.878±0.011 | 0.0492±0.002 | 0.7250±0.06 | 0.0594±0.004 | 5.887±0.071 |
| M       | 1.022±0.073 | 0.0687±0.003 | 0.9886±0.11 | 0.0357±0.002 | 6.387±0.081 |
| LM      | 0.6392±0.012| 0.0337±0.002 | 0.4688±0.03 | 0.0268±0.001 | 3.996±0.076 |
| F value | 47.26±25.57**| 72.62±25.57** | 71.34±25.57**| 51.65±25.57**|

Legend: EM= early monsoon; M= Monsoon; LM= Late monsoon; DW= dry weight; ** denotes significant at 1% level in ANOVA. In each column, values with same superscript are non-significant and with different superscript are significant by DMRT (Duncan Multiple Range Test).
Table-3: Analyses of variance of total pigments, flavonoids, polyphenol and antioxidant content in leaf of *Abrus precatorius* L. in three different seasons

| Source of variance | Degree of freedom | Total pigments | Flavonoids | Polyphenol | Antioxidant |
|--------------------|------------------|----------------|------------|------------|-------------|
| Seasons            | 2                | 124.6**        | 17.66**    | 61.81**    | 63.76**     |
| Error              | 6                | -              | -          | -          | -           |

Legend: ** denotes significant at 1% level.

Fig-1: Change of total foliar pigments of *Abrus precatorius* L. in three different seasons.

Fig-2: Change of flavonoids in the leaves of *Abrus precatorius* L. in three different seasons

Fig-3: Change of polyphenol content in the leaves of *Abrus precatorius* L. in three different seasons
The results of flavonoid contents are exposed in Fig. 2. Foliar flavonoid contents varied from 3.94 mgg\(^{-1}\)DW (Early Monsoon) to 2.63 mgg\(^{-1}\)DW (Late Monsoon) and showed the following trend as EM>M>LM. ANOVA of flavonoid contents showed significant value (P<0.01) with seasons (Table 3). Zhu et al. [47] reported that the highest content of total flavonoids of Vaccinium ashei leaves was obtained in the month of May (Early Monsoon). Cezarotto et al. [48, 54] observed that the highest content of total flavonoids of Vaccinium ashei leaves was obtained in the month of April (Early Monsoon) which corroborate with this finding.

The results of polyphenol contents are presented in Fig. 3. Foliar polyphenol contents ranged from 2.223% (Late Monsoon) to 1.475% (Monsoon) and showed the following succession as LM>EM>M. ANOVA of foliar polyphenol showed significant value (P<0.01) with seasons (Table 3). Polyphenol content was maximum in late monsoon and minimum in monsoon. Walha et al., [49] in Cynara cardunculus noticed maximum polyphenol in early monsoon (May) than monsoon (June). A possible cause of maximum polyphenol content in late monsoon and minimum in monsoon due to the enzyme polyphenol oxidase (PPO) shows the high activity in monsoon (rainy season) and minimum activity in late monsoon suggested by Thakur and Kapila [50]. In liverworts Thakur & Kapila [50] estimated maximum phenolic content in winter (late monsoon) and minimum in rainy season (monsoon). Liao et al. [51] determined maximum phenolic content in winter (late monsoon) in the shoot extract of Oxalis corymbosa which are analogous to this finding.

The results of antioxidant activity are displayed in Fig. 4. Foliar antioxidant activity varied from 72.67% (Late Monsoon) to 58.67% (Early Monsoon) and showed the following progression as LM>M>EM. ANOVA of foliar antioxidant activity showed significant value (P<0.01) with seasons (Table 3). Zhu et al., [47] showed that the rabbiteye blueberry leaves from November had the highest antioxidant capacity and Rekha et al., [52] and Cao et al., [53] also showed that one of the maximum antioxidant activities was obtained in the month of November (Late Monsoon) in the leaf extracts of Ligularia fischeri and Cyclocarya paliurus respectively. These observations are consistent with the present findings.

**CONCLUSION**

The present study concludes that monsoon (June-August) is suitable for efficient photosynthesis as well as nutrient accumulation in Abrus and early monsoon (March-May) is favourable for flavonoid synthesis. Considering the amount of all studied elements late monsoon (September-November) is the right time for harvesting the leaves of Abrus precatorius to be obtained maximum polyphenol and antioxidant activity for medicinal use.

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