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***J. Nat. Prod. Plant Resour*., 2016, 6 (3):13-20**
(http://scholarsresearchlibrary.com/archive.html)

ISSN : 2231 – 3184
CODEN (USA): JNPPB7

Antioxidant profile of *Buteamonosperma*: Phenological Variation

Vijayalakshmi Ojha[1], A. K. Pandey[2] and P. K. Singhal[1*]

[1]*Department of Post Graduate Studies and Research in Biological Sciences, Rani Durgavati University, Jabalpur (MP), India*
[2]*Silviculture and NTFP management division, Institute of Forest Productivity, Ranchi (Jharkhand), India*
Corresponding E mail: pksinghalrdvv@gmail.com

ABSTRACT

Medicinal plants rich in phenolic compounds possess numerous biological activities including antioxidants. Antioxidants are substances that help our body to defend against cell damages caused by various free radicals. Therefore, the need for the search of antioxidants from natural origin has been greatly felt in the recent years. In the present study, phytochemicals such as total phenols, flavanoids and tannins were estimated in different plant parts of diverse age group populations of Buteamonosperma. The phenolic content ranged from 1.53 ± 0.63 to 38.51± 7.65 mgg^{-1}, flavanoids from 0.59 ± 0.17 to 20.48 ± 1.11 mgg^{-1}, and tannins from 6.48 ± 1.05 to 175.25 ± 9.15 mgg^{-1} with a significant variation among different girth class populations. The phenols, flavanoids and tannins content in different plant parts were found to increase with the increase in girth class except in flowers for phenols and flavanoids. The maximum concentration of phenols and tannins was found in stem bark while flavanoid content was found to be the highest in flowers. The potential of these easily accessible sources of natural antioxidants can be exploited by the pharmaceutical, medical and health food industries.

Key Words: Age, Flavanoids, Girth class, Phenols, Plant parts, Tannins

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INTRODUCTION

Plants in all facet of life have served as valuable material for medicinal purpose [1] and provide important bioactive compounds for development of various drugs [2].In India, drugs of plant origin have been used in traditional systems of medicines such as *Unani*, *Siddha* and *Ayurveda* since ancient times[3,4]. The active ingredients are isolated either from whole plant or different plant parts like leaves, stem, bark, root, flowers and seeds, and are either used directly as therapeutic agents or as starting material for the synthesis of drugs. The *Allopathic* system of medicine has also adopted number of plant derived drugs.

The herbal medicines are safe in contrast to the synthetic drugs, as the later are regarded as unsafe to human and environment. The dependence of people on synthetic medicines is now decreasing and they are returning to the naturals with hope of safety and security. World Health Organization (WHO) has also emphasized the need for wider use of traditional medicines in its resolutions (WHO 29.72, 32.42, 30.49, and31.33) due to shortcomings of the modern health system. Thus, attention is focused on the importance of medicinal plants in health care systems worldwide. Of the 252 drugs considered as basic and essential by the WHO, 11% are exclusively of plant origin and a significant number are synthetic drugs obtained from natural precursors [5]. It is estimated that 60% of antitumor and antiinfectious drugs already in the market or under clinical trial are of natural origin [6]. Thus, plants have proven to be an irreplaceable important component of modern medicine.

Phytochemicals are the non-nutrient plant components that are responsible for protecting the plant against microbial infections or infestations by pests [7,8]. They also provide health benefits to humans better than those attributed to macro- andmicro-nutrients [9]. The phytochemicals (i.e. phenolic acids, flavanoids, tannins, quinines, ligans, stilbenes, coumarins etc.) are rich in antioxidant activity and act as free radical scavenging molecules [10-13]. The intake of these natural antioxidants has been reported to reduce risk of cancer, cardiovascular disease, diabetes and diseases associated with ageing [14,15] since these possess antiinflammatory, antiatherosclerotic, antitumor, antimutagenic, anticarcinogenic, antibacterial and antiviral activities [16,17]. However as natural oxidant mechanisms are inadequate for our body, the supply of antioxidants through dietary ingredients is of great importance for leading a healthy life. The use of plant materials as a source of natural oxidants and other applications is important as they are more readily acceptable by the consumers. These compounds can be exploited for the preparation of pharmaceutical products [18,19].

Buteamonosperma Lam. belonging to family Fabaceae is a wild medium sized tree found throughout India. It is one of the most beautiful tree bearing attractive flower clusters and is commonly known as "flame of the forest" [20,21]. The tree starts shedding leaves with the onset of flowering in the month of February-March and is on full bloom and completely leafless during March-April. Fruits get matured by the end of April and new leaves start appearing in the month of June. Itis known to possess many medicinal properties and has also been referred as a wonder drug. Its different plant parts like stem bark, leaf, flower, seed, root and gum have been used to cure various ailments [22] and are extensively used in Ayurveda, Unani and Homeopathic medicine as they have properties of reducing imbalance in the body elements (Srivastavaet al. 2002). Moreover, the tree is used for ethno-veterinary medicine and as a traditional medicine in various parts of India and South Asia [24-27]. It is reported to possess antidiabetic [28], chemopreventive and anticancer [29], antihepatotoxic [30], anticonvulsive [31], antioxidant [32-34], astringent, pungent, alliterative, aphrodisiac properties [22]. Thus, the present study was undertaken with the objective to determine major antioxidant constituents present in different plant parts of *B. monosperma* at different phenological stages.

MATERIALS AND METHODS

The stem bark, leaves, flowers and fruits of *B. monosperma* were collected from Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, India (23º 5´ N, 79º 59´ E and395 mAMSL). The samples were collected at different time of year. Flowers were collected in the month of March, fruits in April, juvenile leaves in June, young leaves in September, mature leaves and stem bark in December. The trees were grouped according to girth class (0-30, 31-60, 61-90, 91-120 and >120 cm) representing different age groups. The bark was collected following sustainable harvesting practices. All the collected samples were brought to the laboratory and shade dried to constant weight. The dried plant material was finely powdered and used for analysis.

Total phenols were determined by Folin Ciocalteau method [35], flavanoids by Aluminiumchloride method [36] and tannins by Vanillin hydrochloride method [37]. Results are expressed as Mean ± Standard Deviation of triplicates and analyzed using statistical package for social sciences (SPSS) version 16. One way analysis of variance (ANOVA) was performed and statistically best treatment was determined using Duncan's multiple range test at significance level of $p<0.05$.

RESULTS

The concentration of phenols in different plant parts of *B.monosperma* increased with the increase in girth class except in flowers, where it decreased with age. The phenolic content ranged from 22.30 ± 3.56 to 38.51± 7.65 mgg^{-1}in stem bark, 17.45 ± 2.77 to 21.80 ± 1.73 mgg^{-1}in flowers and 6.03 ± 0.45 to 12.76 ± 1.30mgg^{-1}in fruits, with a significant variation among different girth classes. In leaves, the phenolic content ranged from 2.31 ± 0.82 to 9.03 ± 0.63 and was found to increase from juvenile to young leaves but decreased in mature leaves. Lowest concentration of phenols was found in the youngest girth class (0-30 cm) of all plant parts while maximum in the oldest girth class (>120 cm).

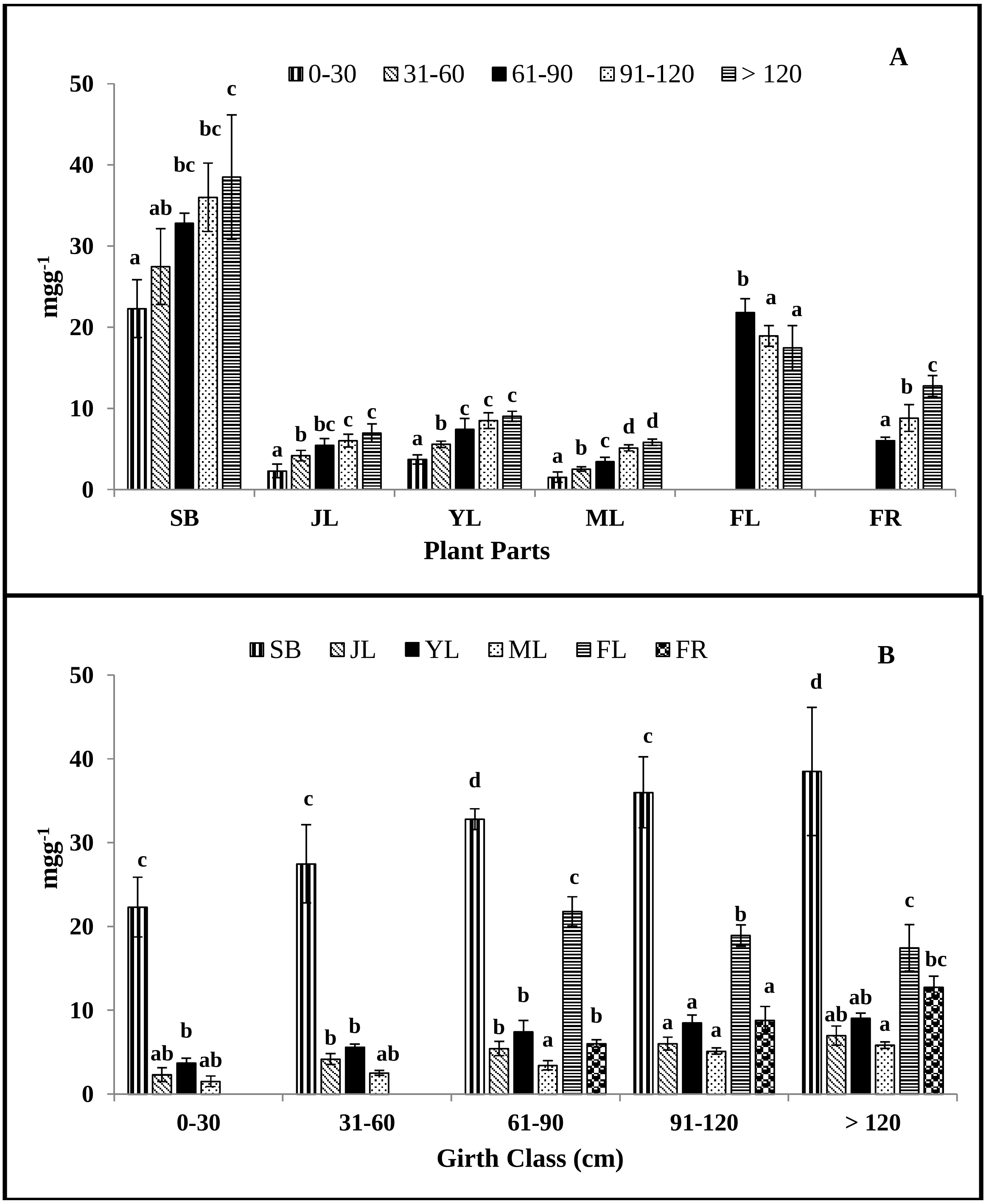


Fig. 1: Phenol content in *Buteamonosperma* according to plant parts (A) and girth class (B)
(SB: Stem bark, JL: Juvenile leaves, YL: Young leaves, ML: Mature leaves, FL: Flower, FR; Fruit)
(The significantly different means (at p = 0.05) are indicated by different alphabets within a plant part (A) and within a girth class (B).

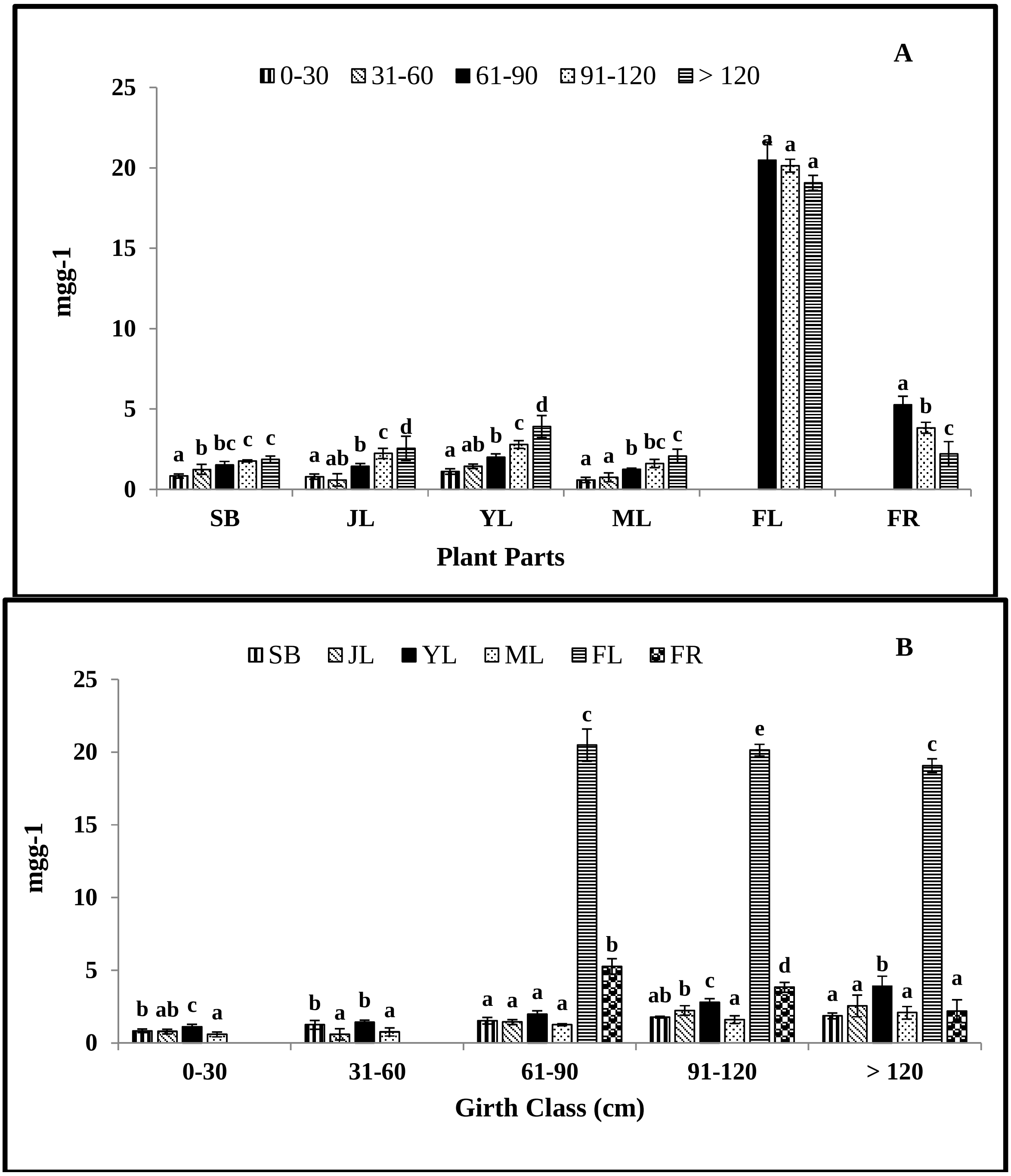
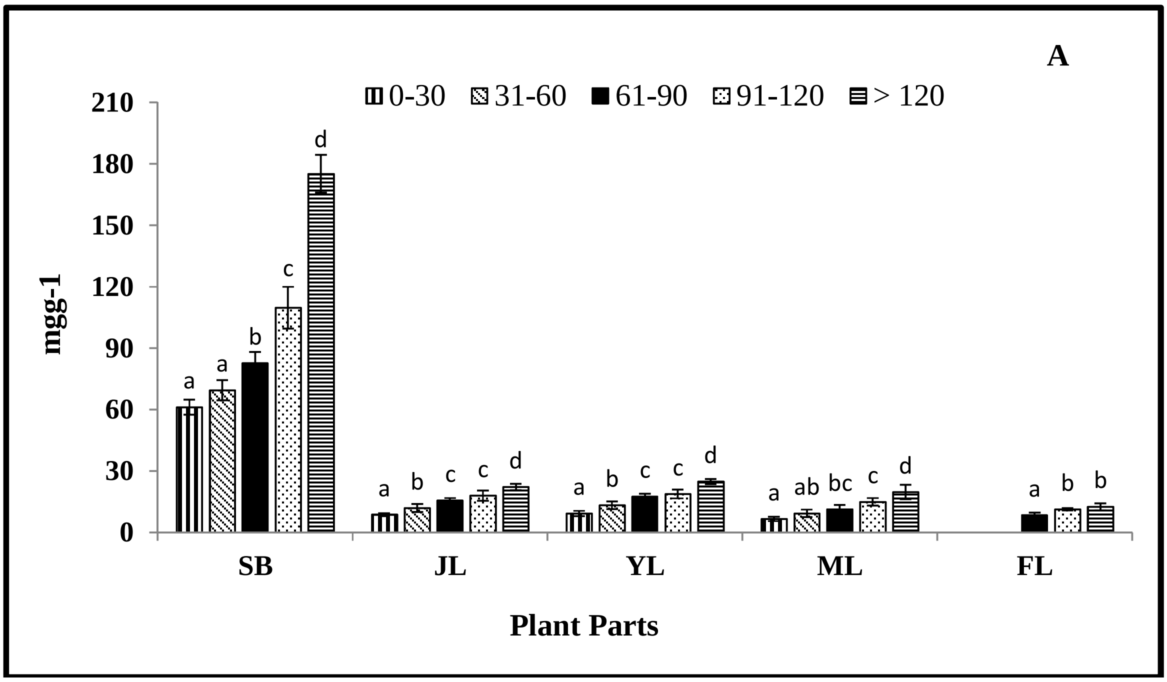


Fig. 2: Flavanoid content in *Buteamonosperma* according to plant parts (A) and girth class (B)
(SB: Stem bark, JL: Juvenile leaves, YL: Young leaves, ML: Mature leaves, FL: Flower, FR; Fruit)
(The significantly different means (at p = 0.05) are indicated by different alphabets within a plant part (A) and within a girth class (B).

However, in flowers the maximum concentration was found in younger girth class (61-90 cm) and minimum in oldest (>120 cm) (Fig. 1 A). The phenols varied significantly among different plant parts within a girth class (Fig. 1 B). Stem bark was found to possess highest concentration of phenols in each girth class followed by flowers and fruits, while all the three phenological stages of leaves (i.e. juvenile, young and mature leaves) didn't vary significantly except in girth class 61-90 cm where the phenolic content in mature leaves was very less (3.43 ± 0.55 mgg^{-1}) as compared to other two stages of leaves.

The concentration of flavanoids in different plant parts of *B. monosperm*a ranged from 0.59 ± 0.17 to 20.48 ± 1.11 mgg^{-1}. The flavanoid content in different plant parts was found to increase with the increase in girth class except in flowers. In stem bark, the flavanoid content ranged from 0.83 ± 0.13 to 1.86 ± 0.20 mgg^{-1} but didn't vary significantly (Fig. 2 A). In the three stages of leaves, the concentration of flavanoids ranged from 0.59 ± 0.17 to 3.91 ± 0.68 mgg^{-1}. It varied significantly according to girth classes of 61-90, 91-120 and >120 cm, in juvenile and young leaves, but insignificantly in mature leaves. In flowers, the flavanoid concentration ranged from 19.06 ± 0.47 to 20.48 ± 1.11 without any significant variation. While in fruits, flavanoid content ranged from 2.19 ± 0.77 to 5.26 ± 0.53 mgg^{-1} with a significant variation. In stem bark and leaves lowest concentration of flavanoids was found in the youngest girth class (0-30 cm) while maximum in the oldest girth class (>120 cm). However, in flowers and fruits the maximum concentration was found in younger girth class (61-90 cm) and minimum in oldest (>120 cm). Flavanoid concentration didn't vary significantly among different plant parts within a girth class except in flowers and fruits (Fig. 2 B). Maximum concentration of flavanoids was found in flowers followed by fruits in girth class 61-90 cm and 91-120 cm. While in girth class >120 cm, young leaves contained more concentration of flavanoids than fruits.



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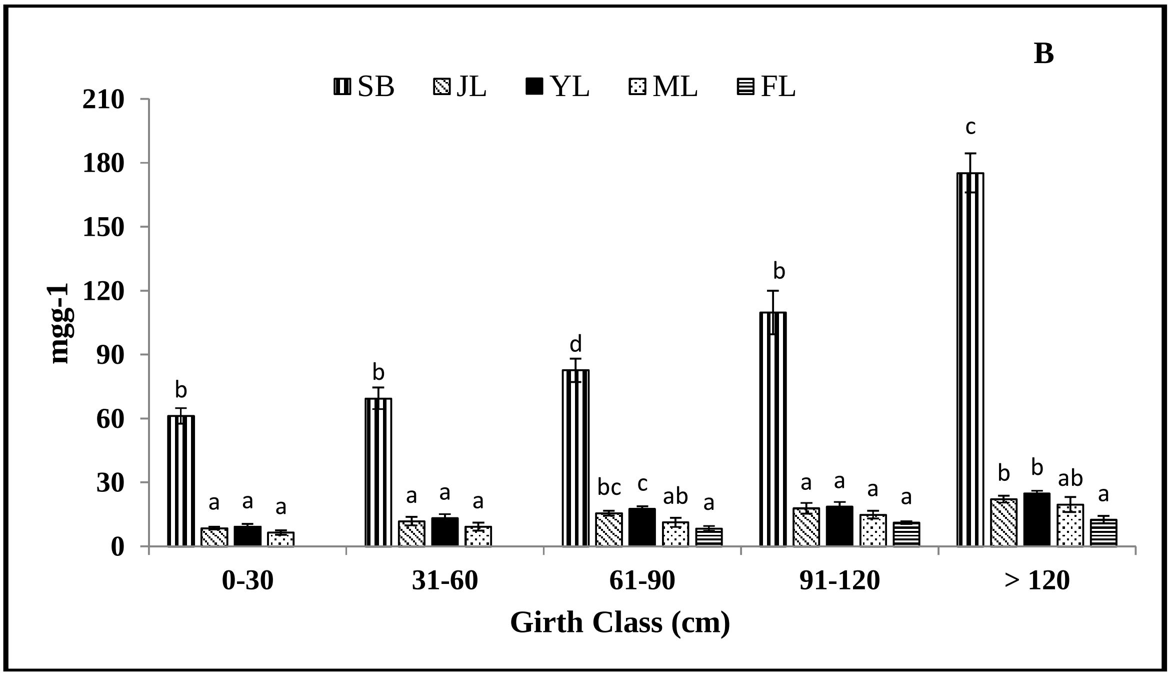

Fig. 3: Tannin content in *Buteamonosperma* according to plant parts (A) and girth class (B)
(SB: Stem bark, JL: Juvenile leaves, YL: Young leaves, ML: Mature leaves, FL: Flower, FR; Fruit)
(The significantly different means (at p = 0.05) are indicated by different alphabets within a plant part (A) and within a girth class (B).

The amount of tannins in different plant parts of *B.monosperm*a ranged from 6.48 ± 1.05 to 175.25 ± 9.15 mgg^{-1}, but was absent in fruits. Similar to phenols and flavanoids, tannin content also increased with the increase in girth class with a significant variation among different girth classes (Fig. 3 A). Tannins ranged from 61.20 ± 3.61 to 175.25 ± 9.15 mgg^{-1} in stem bark, from 6.48 ± 1.05 to 24.80 ± 1.23 mgg^{-1} in leaves and from 8.40 ± 1.21 to 12.53 ± 1.67 mgg^{-1} in flowers. Tannins were found to increase from juvenile to young leaves but decreased in mature leaves. Tannin concentration was found to increase from juvenile to young leaves but decreased in mature leaves. Lowest concentration of tannins was found in the youngest girth class (0-30 cm) while maximum in the oldest girth class (>120 cm) of all plant parts. Stem bark possessed highest concentration of tannins in all girth classes (Fig. 3 B). In leaves and fruits tannin concentration varied insignificantly.

DISCUSSION

Plants in nature are exposed to a large number of biotic and abiotic stresses, thus they have evolved multiple defense mechanisms to cope with various stresses [38]. Plants produce a variety of chemical compounds called secondary metabolites to combat these stresses. Phenolic compounds are one of such compounds and by far the most ubiquitous groups of secondary metabolites found throughout the plant kingdom [39-41]. Generally plant phenolics are stored in the sub-epidermal layers of plant tissues exposed to stress and pathogen attack [42,43]. The concentration of phenolic compound with in a plant part depends on season and may also vary at different stages of growth and development [44-46].

Phenols are very important plant constituents because of their scavenging ability on free radicals due to their hydroxyl groups. Therefore, the phenolic content of plants directly contributes to their antioxidant action [47]. Our study revealed that the concentration of phenolic compounds increased with the age of tree. Similar results were obtained by Pandey et al. (2011) they reported the increase in concentration of phenolic compounds in *Saracaasoka* with increase in age of tree. Phenol content of stem bark reported in our study (22.30 to 38.51 mgg^{-1}) is higher than that reported by Kadam et al. [49]. They reported that phenol content in stem bark of *B. monosperma* ranged from 3.92 to 4.13mgg^{-1} in different seasons. Lowman and Box [50] also reported increase in phenolic content of leaves with maturity. Berrocal et al. [51] also reported that the chemical composition of *Pinusradiata* varied significantly with age of tree.

Exposure of plants to increased UV-B light has been demonstrated to increase the synthesis of flavanoids which may be a reason for high flavanoid content in flowers than other plant parts [52]. A direct relationship of tannin and oxalic acid content with age of tree was reported by Pandey and Kori [53]. Fenny [54] studied the seasonal changes in Oak leaf tannins and reported that the concentration of leaf tannins increases as the season progresses. Our results are also in accordance with Remorini et al. [55] and Ghasemi et al. [56]. They reported decrease in phenolic content with maturity of leaves. Stem bark showed highest content of phenols and tannins as compared to leaves, flowers and fruits as these get concentrated in the bark and form a layer against microorganisms [57].

The present studyreports the presence of phenolic compounds (phenols, flavanoids and tannins) in different plant parts of various age group trees of *B. monosperma*. These compounds are responsible for the antioxidant activity as demonstrated by various researchers [56, 58-61]. They revealed a direct correlation of phenolic compound and antioxidant activity in different trees. Thus, the study will be helpful in utilization of different plant parts of *B. monosperma*as potential antioxidant agents.

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