

Nutritional Value and Phytochemical Constituents of some *Plantago* spp. of Ha'il Region, Saudi Arabia

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ABSTRACT

The *Plantago* genus dominates landscapes across the world and comprises about 256 species, which plays an important role as forage for grazing animals and pharmaceutical purposes. The current study was carried out to evaluate the nutritional value and phytochemical contents of four local *Plantago* species (*Plantago ciliata*, *Plantago lanceolata*, *Plantago ovata* and *Plantago cylindrica*), which were collected from different natural parts of Ha'il region, which lies in the middle-north of Saudi Arabia. The results revealed that the values obtained (based on dry weight; DW) of moisture, ash, crude protein, crude fat, crude fiber, and carbohydrates contents were varied from 29.0 to 52.3%, 7.0 to 16.0%, 10.7 to 14.6%, 0.6 to 1.6%, 11.2 to 23.1%, and 11.6 to 24.0%, respectively. The values recorded for acid detergent fiber (ADF %) and total digestible nutrient (TDN %) were 14.0 to 74.0%, 26.0 to 86.0%, respectively. In addition, the values of calcium and phosphorous contents were varied from 0.2 to 0.3 and 0.1 to 0.2 mg kg⁻¹ DW, respectively.

Phytochemical analysis of the aqueous solution of the *Plantago* species showed the presence of varying amounts of protein-xanthoprotein, tannins, cardiac glycosides, flavonoids, saponins, terpenoid, phenols, glycosides and saponins. However, alkaloids were absent only in *Plantago cylindrica*, while cardiac glycosides were absent only in *Plantago lanceolata*. On the other hand, flavonoids were observed only in *Plantago ovata*, while resins were not observed in all species.

Keywords: Nutritional value; Phytochemical content; *Plantago* spp; Forage; Ha'il.

1. INTRODUCTION

Rangelands of Ha'il region at the middle-north of the Kingdom of Saudi Arabia have been severely deteriorated due to the combined effects of animal pressure, human disturbances and predominant aridity (Alghamdi, 2017). Overgrazing, however, was considered the most influencing factor due to the population increase and the demand of red meat and dairy products (Mseddi *et al.*, 2016). Providing enough feed resources for grazing animals in such harsh and arid regions, has led to the development of animal farming systems that integrate the use of foliage with local plant species to produce considerable amounts of high protein biomass and energy (Devendra, 1990). Therefore, laboratory analyses are needed to determine the nutritive value and phytochemical content of local promising forage species which have been well documented in the flora of Ha'il such as members of the family Plantagonaceae (Alghamdi *et al.*, 2018).

Plantago is a genus comprising about 256 species worldwide and belongs to the Plantaginaceae family. It plays an important role in grazing animal feed, pharmaceutical, medical, healthcare and industrial purposes

(Esmaeili *et al.*, 2014). *Plantago* species grow in various types of habitats, including; deserts, sea cliffs, woodlands, disturbed areas and tropical mountains. *Plantago* genus varies greatly in distribution across the world with many species restricted to specific areas while others are more widespread. Also, species of this genus are found to vary from only spring to summer plants as well as from biennials to perennials (Primack, 1976).

There is an increasing attention in the *Plantago* phytochemicals, due to their potential applications in functional food products and medicines. *Plantago* species have numerous phytochemicals in their different organs (e.g., leaves, seeds, and roots). These phytochemicals apparently have medicinal properties and can be used also as taxonomic markers (Samuelsen, 2000). These compounds improve the physiological condition of the grazing animals and reduce the need of antibiotic growth promoters; as well they are good source of protein and minerals (Sano *et al.*, 2002). Therefore, the bioactive compounds with the nutrients contained in the *Plantago* species encourage the use of them as a supplementary diet for the improving of health and production of grazing animals as suggested by Sumon *et al.* (2014). For this purpose, the current study was carried out to evaluate the nutritional value and phytochemical contents of four local species of the genus *Plantago* that have been collected from different natural parts of Ha'il region. The four *Plantago* species submitted to perform the purpose of this study were *Plantago ciliata*, *Plantago lanceolata*, *Plantago ovata* and *Plantago cylindrica*.

2. MATERIALS AND METHODS

2.1 Study Area

The *Plantago* species in the current study were collected from Ha'il region, that lies in the middle-north of the Kingdom of Saudi Arabia between 25° 29'N and 38° 42'E and it extends over an area of 118,322 km². The mean temperature in Ha'il ranges from 10.8°C at Winter to 34.1°C at Summer and the annual rainfall is about 104.4 mm which falls mostly in Winter (El-Ghanim *et al.*, 2010). Therefore, rangeland in Ha'il is classified among the arid-zones with short scattered rainy season and prolonged dry period that lasts most of the year.

2.2 Sample collection

Four *Plantago* species (*Plantago cilata*, *Plantago lanceolata*, *Plantago ovata* and *Plantago cylindrica*) were collected in the 2016 spring season from local natural rangelands of Ha'il region, Saudi Arabia, as shown in Table 1. Fresh grass specimens were uprooted by digging the soil and preserved in polyethylene bags. The samples were then transferred to the laboratory of Department of Biology, Faculty of Science, University, of Ha'il for identification and further analysis. Samples were dried in a vacuum oven at a temperature of 105°C for 24h, and 50 grams of each dried sample were then packed in paper sacks and stored for further analysis.

Table 1: Plant species from natural rangeland of Ha'il, Kingdom of Saudi Arabia, collected in 2016 spring season.

No.	Name	Location	Coordinates
1	<i>Plantago ciliata</i>	Al-Qaed dist. Ha'il	27°44'25" N 41°36'23" E
2	<i>Plantago lanceolata</i>	Al-Qaed dist. Ha'il	27°51'8" N 41°43'32" E
3	<i>Plantago ovata</i>	Salma mountain Ha'il	27°05'30" N 42°07'54" E
4	<i>Plantago cylindrica</i>	Al-Qaed dist. Ha'il	27°44'25" N 41°36'23" E

2.3 Biochemical analysis

The protocol of AOAC, (1984) was applied assess the proximate chemical components of the tested samples. Chemical components assessed include; moisture, ash, crude protein (The total protein in the sample including true protein and non-protein nitrogen), crude fat (Ether extract) (fat is the energy dense nutrient which contains 2.25X to 2.8X the energy found in carbohydrates), crud fiber (the residue of plant materials remained after solvent extraction followed by digestion with dilute acid and alkali), carbohydrates content, Ca and P (mg kg⁻¹ dry weight; DW) content. Acid Detergent Fiber (ADF) and Total Digestible Nutrient (TDN) were calculated based on the protocol of AOAC, (1973). Reported results were expressed as percentage (%) of dry weight (DW).

2.4 Phytochemical analyses

Phytochemical analyses include determination of protein, -xanthoprotein, alkaloids, saponins, tannins, cardiac glycosides, terpenoid, flavonoids, phenols, glycosides and resins in the aqueous solution of the samples were performed based on methods of analyses described by AOAC (1990).

2.5 Statistical Analysis

Results were reported as the average of three independent measurements and were analyzed statistically with SPSS-17 statistical software (SPSS Inc., Chicago, IL, USA).

3. RESULTS

Nutritional value estimation of the *Plantago* samples of the current study was evaluated following proximate analysis protocol as it plays an important role in assessing the suitability of plant species for different grazing animals' requirements (Khan, et al 2014).

3.1 Moisture content

Figure (1) shows that the percentage of moisture content of the tested species was ranged significantly from the highest value found in *Plantago cylindrica* (52.29%,DW) to the lowest in the rest of the samples (37.19%,DW), (34%, DW), (29%,DW) in *Plantago ovata*, *Plantago ciliata* and *Plantago lanceolata*, respectively.

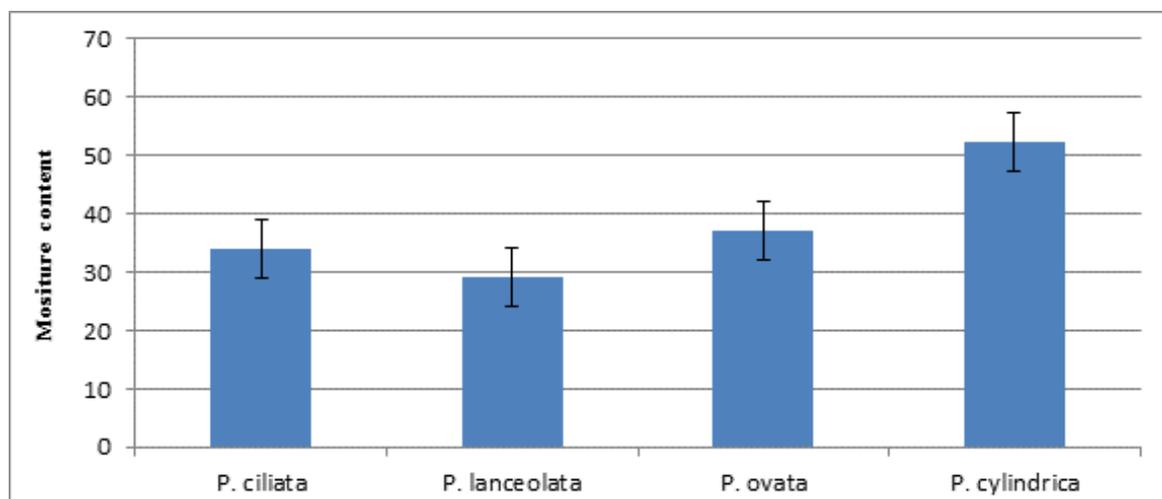


Fig. 1: Percentage of moisture content of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.2 Ash content

As shown in Figure (2) the percentage of moisture content of the species was ranged significantly from the low in *Plantago cylindrica* (7.0%,DW) to the high value in the rest of the samples (16.0%,DW), (15.0%,DW), (12.0%,DW) in *Plantago ovata*, *Plantago lanceolata* and *Plantago ciliata*, respectively.

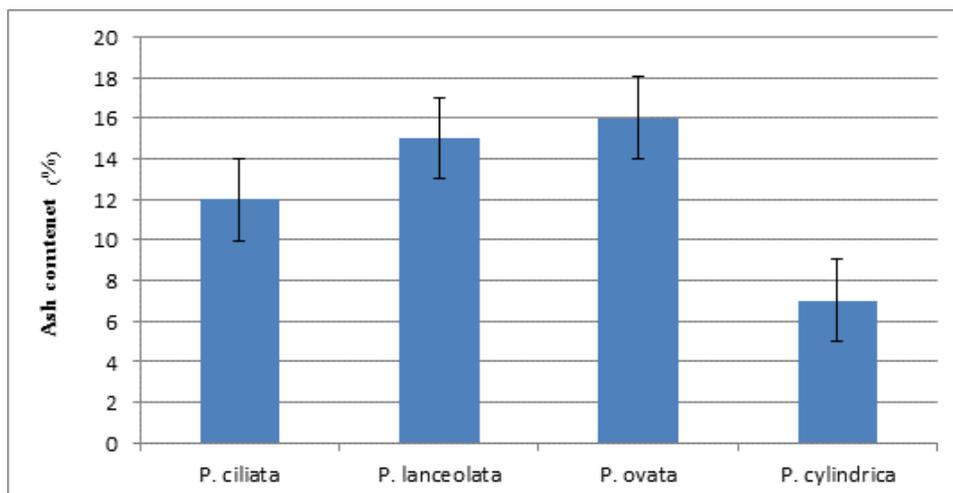


Fig. 2: Percentage of ash content of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.3 Crude protein content

Figure (3) shows the crude protein content of the species was ranged significantly from the lowest in *Plantago ovata* (10.68%,DW) to the highest value in the rest of the samples (14.63%,DW), (14.62 DW %), (14.56%,DW) in *Plantago lanceolata*, *Plantago cylindrica* and *Plantago ciliata*, respectively.

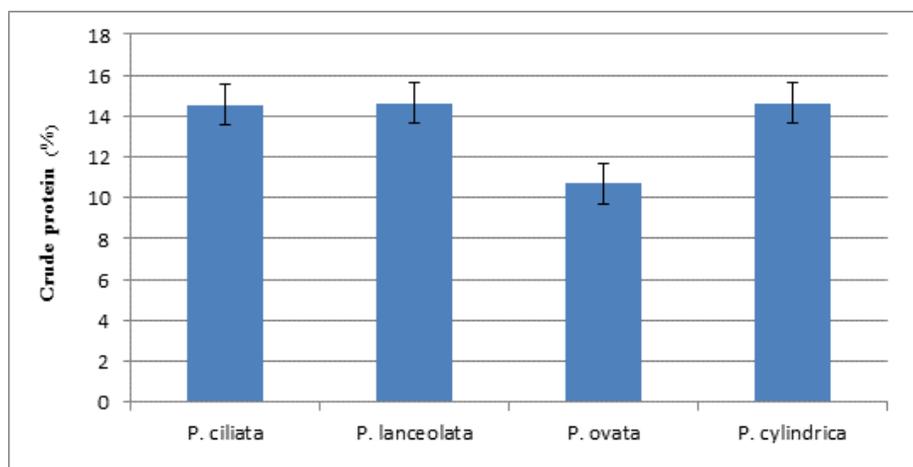


Fig. 3: Percentage of crude protein content of some *Plantago* species of Ha'il/Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.4 Crude fat content

Figure (4) shows the crude fat content of the species was ranged significantly from the highest in *Plantago cylindrica* (1.6%,DW) and *Plantago lanceolata* (1.3%,DW) respectively to the lowest value in the rest of the samples (37.19 DW %), (34 DW %), (29 DW %) in *Plantago ovata* (0.7%,DW) and *Plantago ciliata* (0.6%,DW), respectively.

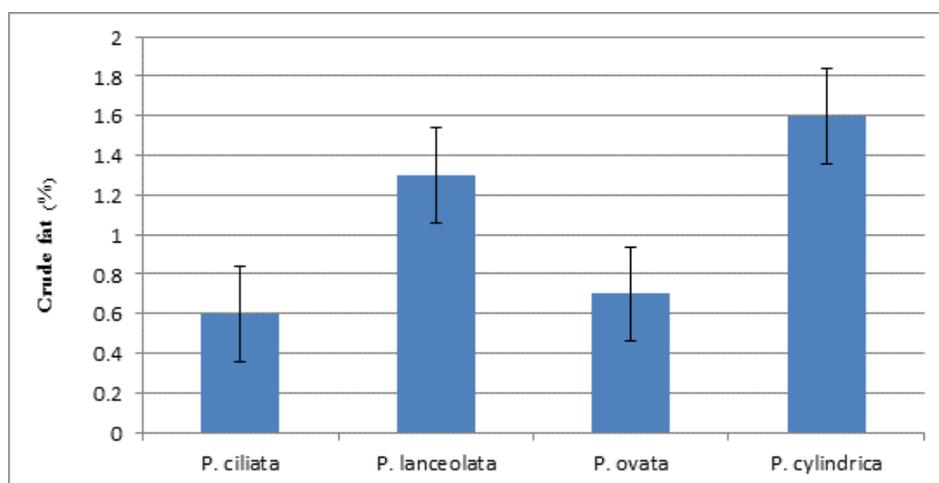


Fig. 4: Percentage of crude fat content of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.5 Crude fiber content

Figure (5) shows that the percentage of crude fiber content of the species was ranged significantly from the highest in *Plantago ciliata* (23.12 %,DW) to the lowest value in the rest of the samples (16.0 %,DW), (12.0%,DW), (11.2 DW %) in *Plantago ovata*, *Plantago lanceolata* and *Plantago cylindrica*, respectively.

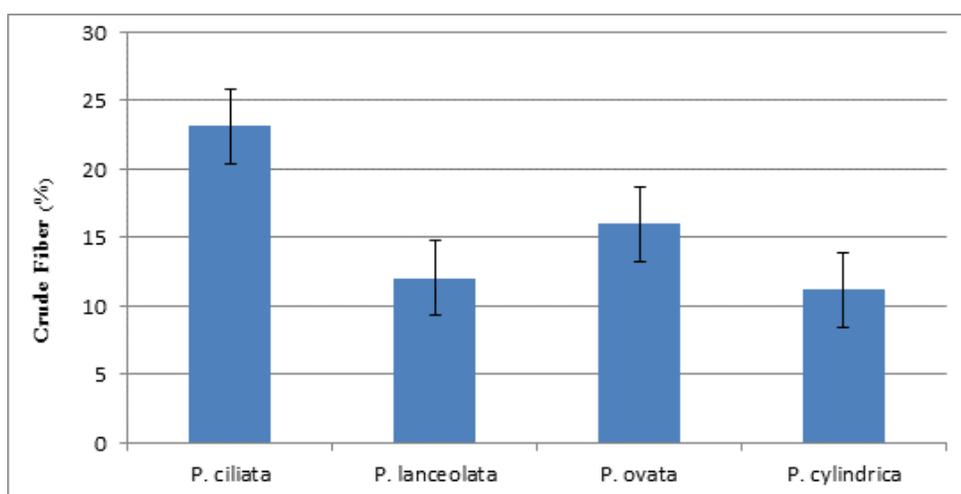


Fig. 5: Percentage of crude fiber content of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.6 Carbohydrates content

Figure (6) shows an insignificant increase in carbohydrates content among the species which was ranged from 11.64 DW % in *Plantago lanceolata* to 24 DW % in *Plantago cylindrica*.

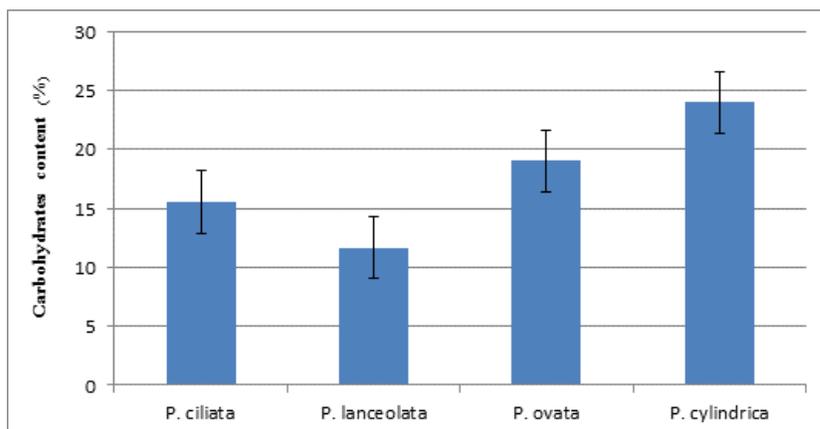


Fig. 6: Percentage of carbohydrates content of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.7 Calcium and phosphorus content

Figure (7) shows that the calcium content of the species was ranged significantly from the lowest in *Plantago lanceolata* (0.2 mg kg^{-1}) to the highest value in the rest of the samples (0.32 mg kg^{-1}), (0.3 mg kg^{-1}), (0.3 mg kg^{-1}) in *Plantago cylindrica*, *Plantago ovata* and *Plantago ciliata*, respectively. In addition, phosphorous content was ranged significantly from the highest value (0.17 mg/kg) in *Plantago cylindrica* to the lowest values in the rest of the species (0.13 mg/kg) (0.12 mg/kg), (0.11 mg/kg) in *Plantago ovata*, *Plantago ciliata* and *Plantago lanceolata*, respectively.

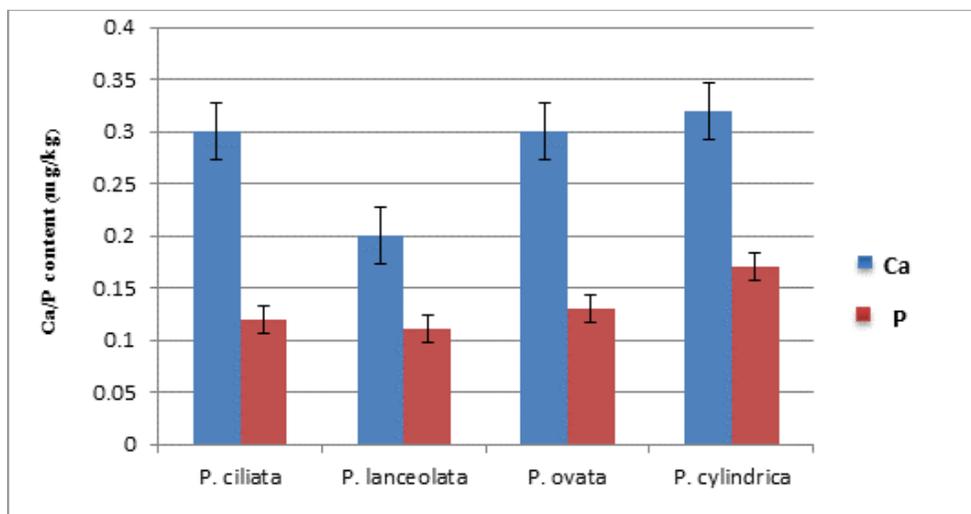


Fig. 7: Contents of calcium (Ca) and phosphorus (P) of some *Plantago* species of Ha'il, Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n = 3$).

3.8 Acid Detergent Fiber (ADF)

Figure (8) shows the crude protein content of the species was ranged significantly from the lowest in *Plantago ciliata* (14%,DW) to the highest value in the rest of the samples (74%,DW), (64%, DW), (54%,DW) in the other species; *Plantago lanceolata*, *Plantago cylindrica* and *Plantago ovata* , respectively.

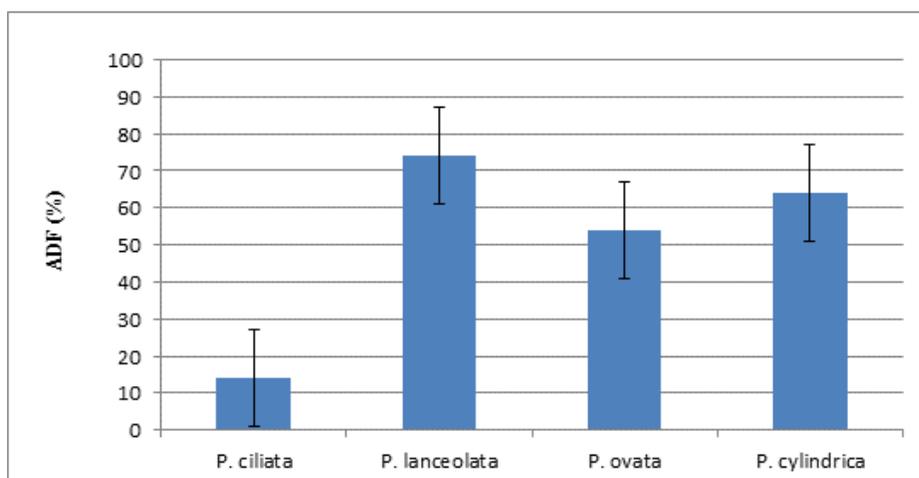


Fig. 8: Percentage of acid detergent fiber (ADF) of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.9 Total Digestible Nutrient (TDN)

Figure (9) shows that the percentage of crude fiber content of the species was ranged significantly from the highest in *Plantago ciliata* (86%,DW) to the lowest value in the rest of the samples (46%,DW), (36%,DW), (26%,DW) in the other species; *Plantago ovata*, *Plantago cylindrica* and *Plantago lanceolata*, respectively.

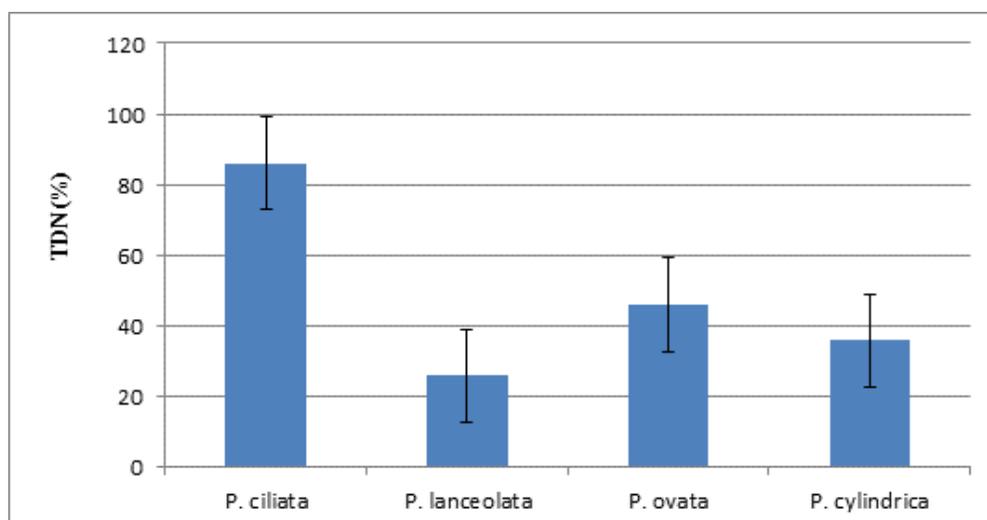


Fig. 9: Percentage of total digestible nutrient (TDN) of some *Plantago* species of Ha'il /Saudi Arabia. Data are expressed as mean \pm SE of replicate determinations ($n=3$).

3.10 Phytochemical content

Phytochemical analysis of the aqueous solutions of *Plantago ciliata*, *Plantago lanceolata*, *Plantago ovata*, and *Plantago cylindrica* were evaluated as shown in Table 2. There are amounts of protein -xanthoprotein, tannins, cardiac glycosides, flavonoids, saponins, terpenoid, phenols, glycosides and saponins at varying degrees. Alkaloid was absent only in *Plantago cylindrica*, while cardiac glycosides were not detected in *Plantago lanceolata*. On the other hand, flavonoids were not observed in all species except for *Plantago ovata*, while in all species resins were not observed.

Table 2. Phytochemical analysis of *Plantago* species of Ha'il /Saudi Arabia.

Phyto-constituents	<i>Plantago ciliata</i>	<i>Plantago lanceolata</i>	<i>Plantago ovata</i>	<i>Plantago cylindrica</i>
Protein -xanthoprotein	+++	++	++	+
Tannins	+	+	+++	+
Alkaloid	++	+	+	-
Saponins	+	+	++	++
Cardiac glycosides	++	-	++	++
Terpenoid	++	+	+	+
Flavonoid	-	-	+	-
Phenols	+	+	+	+
Glycosides	+	+	+++	+
Resins	-	-	-	-

+: present, -: absent

+ (Low in abundance), ++ (Moderate in abundance), +++ (High in abundance)

4. DISCUSSION

As shown in the result section there are significant variations in the nutritional values and mineral content of the *Plantago* plant species, which could be attributed to the effect of many factors, including climate, species, soil type and plant phenology as suggested by Greene *et al.* (1987). Also, Ahmed (2013) attributed such variations due to the degree of maturity of plants.

The moisture content of the *Plantago* plants in the current study varied from 29 to 52.29% (DW) which is relatively high for such plants that live under the arid conditions of Ha'il region. Therefore, such variation in moisture content between different species might be due to their physiological capability to retain water, degree of maturity and to the external environmental conditions such as rainfall seasonality and soil moisture (Rehman and Adnan 2018).

Ash content of the *Plantago* species in this study ranged from 7 to 16% (DW). Such variation could be explained by some factors including; degree of maturity of plants and soil properties that need to be explored further (Alghamdi, 2017).

Crude protein content of the samples varied from 10.68 to 14.63 (DW %), which is a relatively reasonable proportion compared to Alfalfa (16.50%) as mentioned by Ghaley *et al.* (2012). However, such protein is present in the form of non-protein nitrogen, therefore, alternative sources of nitrogen should be supplemented to grazing animals' feed for better utilization and efficiently digestion nitrogen (Attia-Ismail, 2015).

Crude fat content of the current *Plantago* plants varied from 0.6 to 1.6%, (DW). This amount of fat is relatively low; although, it is reasonable as these plants live under dry climate of Ha'il as suggested by Rehman and Adnan (2018) who explained that greater contents of fat exist normally in wet region plants.

Crude fiber content of the current species ranged from 11.2 to 23.12 (DW %), which is relatively high compared to other forages such alfalfa (Ahmed *et al.*, 2013). Such high ratio of fiber might be due to the degree of maturity during sampling, as it has been well documented that when plants became older, the crude fiber tended to increase according to Ahmed *et al.* (2013).

The carbohydrates content of the current species varied from 11.64 to 24 % (DW), which is reasonable for grazing animals as they have microorganisms in their digestive system which are able to digest all the cellulose content of the forages (Hussain and Durrani, 2009).

Mineral content of plants, particularly calcium and phosphorus are important for the proper growth and development of the skeleton in grazing animals. They work closely together, therefore, they must be provided in the right ratio and level. According to Rasby *et al.* (2011) feed dry matter for the grazing animals should contain an adequate ratio of calcium/phosphorous between 1.5:1 to 3:1. Therefore, all *Plantago* species of the current study seemed to be sufficient to provide a good source of calcium and phosphorus for grazing animals.

Acid Detergent Fiber (ADF) (Cellulose and Lignin content) of the *Plantago* species in the current study varied from 14 to 74%(DW) whereas, total digestible nutrients (TDN) ranged from 26 to 86%(DW). This variation could be affected by the maturation of plants as suggested by Andrighetto *et al.* (1993) who argued that the increased ADF in particular is linked to the increase in plant maturity.

Phytochemical results obtained in the current research were consistent with results from literature, for instance; investigations of *P. major* revealed the presence of various chemical constituents such as; flavonoids, caffeoyl phenylethanoid glycosides, iridoid glycosides, polyphenolic compounds (Zubair *et al.*, 2010). The bioactive compounds together with the nutrients detected in the *Plantago* plants species encourage the use of them for improving of health and production of farm animals as suggested by Sumon *et al.* (2014) who have concluded that medicinal plants may be supplemented to the diet to improve the nutritional efficiency of grazing animals. For the past few decades, a growing number of people have been drawn attention to alternative forms of medicine in response to disillusionment with the modern medical system. Many botanical, especially herbal, products have gained popularity for the treatment of ailments and diseases such as the common cold, wounds, hypertension, inflammation, viral infections, depression, insomnia, and even cancer (Blumenthal *et al.*, 2006) due to their good sources of protein and minerals (Sano *et al.*, 2002).

5. CONCLUSION

The author assumes that this is the first study that has examined the nutritional value and phytochemical of four species of the *Plantago* genus that grown naturally in Ha'il region, Kingdom of Saudi Arabia. The findings of the current study showed that these species vary considerably in their nutritional value and phytochemical contents. Also, it revealed that some species have high to reasonable contents of protein, fat, fiber, carbohydrates, minerals and phytochemicals which make them potential local resources to be exploited as alternative forages in such dry-climate region like Ha'il. However, further research is needed in order to investigate the effect of some

important eco-physiological factors such as; plant growth stages, plant seasonal changes, drought and salinity on the suitability of those species as forages.

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