Nutritional Diversity of Dragon Fruit *Hylocereus polyrhizus* (Weber) Britton & Rose from Different Locations of Nepal

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Introduction

- Dragon fruit is a recently introduced tropical and subtropical semi- climbing cactus native to Central America belonging to dicotyledonous family Cactaceae (Caryophyllales) genus *Hylocereu*s. (Paull RE *et al.* 2020).
- The genera Hylocereus include mainly three cultivated species; *Hylocereus undatus* (red skinned & white fleshed), *Hylocereus polyrhizus* (red skinned & red fleshed); and *Hylocereus megalanthus* (yellow skinned & white fleshed).
- This fruit can be cultivate in the region of less rainfall at a altitude of 1500 from M.A.S.L and well grown in average temperature of 20 to 30 ºC with annual rainfall 500-1500 mm
- Floral bud initiation of the Dragon fruit Starts from Chaitra (April) and flowering begins from Baishak, harvesting can be done up to the month Mangshir (November).
- In Nepal only few studies and research has been done in dragon fruit focusing on production locality, market and source of plantlets. This recent fact accelerates not only focus on production but also the chemical properties of the fruits that are cultivated in Nepal.

Objective

To analyse and compare the nutritional characteristics of *Hylocereus polyrhizus* (red skinned and red fleshed), collected from four different altitudinal locations of Nepal.

Materials and Methods

The field experiment was conducted in the different locations of Nepal and the lab based work was carried out in the department of Horticulture, Sikkim University, 6th mile Tadong, East Sikkim during the year 2020-2022. The details of materials and methods are described below:

Experimental material

Dragon fruit *Hylocereus polyrhizus.*

Method of Sample collection

- The fruit samples were collected from four different districts of Nepal viz., Chitwan, Sunsari, Morang and Sankhuwasabha based on the different altitudinal range.
- Mature fruits sample were collected, bagged and tagged separately with the different treatment and replication number (triplicated) during the month of June, 2022.
- Few questions regarding cultivation practices, using a semi-structured questionnaire tested on a small number of local respondents and basic passport information was recorded from farmers of different growing district of Nepal.
- Personal interviews carried out consisted different types of questions related to objectives of the present study.
- Fruits collected from different locations were then taken to the Department of Horticulture, Sikkim University, for further analysis.

Collection area	Climatic Zone	Elevation (MSL)m	Latitude	Longitude
Dibyanagar, Bharatpur metropolitan city, Chitwan	Tropical (Terai region)	177	27º 37' 37''N	84º 18' 20'' E
Tumlingtar, Khadbari Municipality, Sankhuwashaba	Sub-Tropical (Mid hill)	416	27º 20' 43''N	87º 12' 01'' E
Ramdhuni municipality, Sunsari	Tropical	123	26º 42' 56'' N	87º 14' 30'' E
Chokti, Kerabari Rural Municipality, Morang	Tropical (Inner-Terai region)	338	26º 45' 57''N	87º 22' 14''E

Dragon fruit sample collected area and there GPS tracking locations.

Experimental methods

Preparation of sample for estimation of chemical parameters:

The collected fruit samples were peeled and juice of each location fruit samples was extracted separately using Muslin cloth to remove seeds and other traces of pulp. All the beaker containing the sample juice was labelled properly and were subjected for chemical analysis.

Estimation of Physical parameters

i. **Fruit weight(g):** Fruit weight of each treatment was recorded immediately after harvesting by digital weighing balance(Mettler Toledo) and expressed in gram.

ii. **Fruit peel weight (g)**: Peel weight was recorded by removing all outer skin of fruit by using electronic weighing balance(Mettler Toledo).

iii. **Pulp weight (g)**: It was calculated by subtracting peel weight from the fruit weight of each treatment of each replication. Fruit weight-peel weight).

iv. **Fruit length and equatorial diameter(mm)**: Length and diameter of each fruit was measured by using Vernier caliper.

v. **Fruit shape and colour:** Shape and colour of the fruits were visually recorded.

Bio-chemical analysis

a) Moisture and dry matter content:

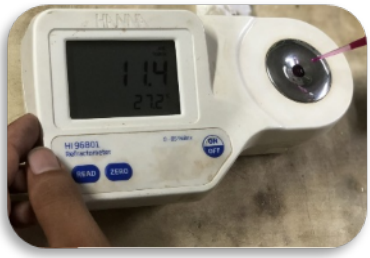
Moisture and Dry matter content were determined by following the method given by AOAC (1999); Fresh weight of each fruit sample was taken and measured by electronic weighing balance, initial data was recorded and sample was placed in aluminium foil and dried in hot air ovan at 65ºC for a week until it becomes soft dry.

$$\text{Moisture (\%)} = \frac{(W1-W2)}{W1} \times 100$$

$$\text{Dry matter (\%)} = \frac{W2}{W1} \times 100$$

Where: W1= weight (g) of sample before drying
W2= weight (g) of sample after drying

b) Total soluble solid (ºBrix): Total soluble solids (TSS) was determined by using digital pocket refractrometer (model: HI96801). A drop of extracted juice from each sample was mounted on prism of dry refractometer and data was recorded in percent.



c) Fruit pH: pH of dragon fruit sample was assessed by using electronic digital pH meter 335. Calibration of pH meter was done with 4.0 and 9.0 buffers.

d) **Titratable acidity (%):** Titratable acidity was determined by titrating juice with 0.1 N NaOH by using phenolphthalein indicator solution and expressed in gram equivalent of malic acid per 100 ml of juice, as per AOAC- Association of Official Analytical Chemists(2026); Ranganna, 2008).

e) **Estimation of ascorbic acid:** The ascorbic acid content was determined by 2, 4- dinitrophenylhydrazine method using Spectrophotometer (Kapur, A *et al.* 2012). The ascorbic acid concentration was expressed in mg/100g**.**

f) **Reducing sugar:**For determination of reducing sugar 2-5, Dinitrosalicylic acid (DNSA) method was applied with slight modification (Phongtongpasuk *et al.* 2016; Miller GL, 1959).

g) **Total Carbohydrate:**Total Carbohydrate was estimated by Anthrone method and absorbance readings were taken at 510nm using Shimadzu UV-Vis spectrophotometer (Model UV-1900i).

Statistical Analysis

One way analysis of variance (ANOVA) was computed for each characteristics in order to identify the variability among the location using CRD the procedures described by Gomez and Gomez (1984). For this, OPSTAT software (Sheran, 1998) was employed for the ANOVA and for the correlations between the variables. Treatment mean separation was made whenever significant differences were noticed at 5% probability level.
Nominally measured descriptors of shape and colour were not used in statistical tests.

Results

Physical characteristics like fruit colour and shape was observed visually and average value of descriptor per individual was taken.

Fruit Colour :

Fruit shape: Rounded in *H. polyrhizus* from all location.

Plate No.1: *H. polyrhizus* (Red peel –red pulp)

Plate No. 2: ***Hylocereus polyrhizus***

Physical observations:

Dragon fruit grown in Nepal exhibits differences in morphological traits between locations (figure no. 1)(table 1). Fruit weight 300g was highest in Sunsari followed by Morang and Sankhuwasabha district both having 270g of fruit weight. Least peel weight was observed in Chitwan district (39.74g). Highest pulp weight 235g was recorded in Sankhuwasabha followed by Sunsari district with 234.6g. There is no significant differences between locations on fruit and pulp weight. Whereas, significantly higher peel weight 71.17g was recorded in Sankhuwasabha district.

Similarly, highest fruit length and diameter, 9.84cm and 8.42cm was measured from Chitwan and Sankhuwasabha district respectively. Fruit shape(length:diameter) of most of the *Hylocereus polyrhizus* observed rounded shape, albeit fruit collected from Sunsari and Morang district showed more rounded shape of 1.01cm and 0.99cm respectively as compare to other location.

Table 1. Morphological traits fruit weight, peel weight, pulp weight, diameter, length and shape of fruits from four different locations of *Hylocereus polyrhizus* (mean of three replicate±standard error).

Treatment	Fruit weight (g)	Peel weight(g)	Pulp weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit shape (cm)
Chitwan	200±22.9	39.74±2.5	160.2±20.3	9.84±0.49	6.28±0.12	1.58±0.11
Sunsari	300±40.4	65.40±3.6	234.6±37.0	7.37±0.26	7.58±0.37	1.01±0.02
Morang	270±27.3	58.77±4.6	211.2±22.6	7.77±0.29	7.79±0.44	0.99±0.01
Sankhuwasabha	270±27.3	71.17±2.1	235.5±3.73	9.58±0.7	8.42±0.36	1.14±0.12
C.D.	N/S	11.28	N/S	1.57	1.16	0.28
SE(m)	30.20	3.40	24.07	0.48	0.35	0.09
SE(d)	42.71	4.81	34.03	0.67	0.50	0.11
C.V.	20.12	10.03	19.81	9.50	8.08	12.32

CD values indicate significant difference (P < 0.05), N/S = Not significant

Chemical Observations:

Bio-chemical traits of *Hylocereus polyrhizus* showed differences in result among four locations observation (figure no. 2). Moisture and Dry matter content was highest 86.81 and 15.32 percent in fruit collected from Sunsari and Chitwan district respectively. Fruit pH was slightly acidic ranging from 4.5 of Sankhuwasabha to 5.47 of Chitwan district. Total soluble solid was highest *Hylocereus polyrhizus* collected from Chitwan and was recorded 14.70 degree Brix. There is no significant different in reducing sugar between location variations, while highest 9.64 mg of reducing sugar was recorded in fruit collected from Morang district.

Table 2. Biochemical traits of fruits from four different locations of *Hylocereus polyrhizus*

Treatment	Moisture%	Dry matter %	pH	Total soluble solid (TSS) (°Brix)	Reducing sugar (mg/100gm)
Chitwan	84.68±1.25	15.32±1.25	5.47±0.2	14.70±0.15	8.98±1.69
Sunsari	86.81±0.79	13.19±0.79	4.98±0.06	14.27±0.06	7.6±0.04
Morang	85.20±0.79	14.80±0.79	4.99±0.03	12.18±0.58	9.64±1.31
Sankhuwasabha	86.44±0.71	13.56±0.71	4.5±0.11	11.70±0.58	4.99±2.01
C.D.	N/S	N/S	0.49	1.40	N/S
SE(m)	0.91	0.91	0.11	0.42	1.57
SE(d)	1.30	1.30	0.17	0.6	2.21
C.V.	1.86	11.17	3.40	5.53	34.71

CD values indicate significant difference (P < 0.05), N/S = Not significant

Carbohydrates content was significantly higher in the fruits collected from Sunsari district (11.36 mg per 100gram) whereas, least amount 5.83mg per 100gram was observed in fruit collected from Sankhuwasabha. Ascorbic acid content was 7.80 mg and 5.32mg in fruit collected from Sankhuwasabha and Chitwan respectively, which were significantly higher. Least titratable acidity was observed in the fruits collected from Sunsari and Morang district with a value of 0.57%

Table 3. Biochemical traits moisture percentage, dry matter percentage, pH, TSS and TA of fruits from four different locations of *Hylocereus polyrhizus* (mean of three replicate±standard error).

Treatment	Total carbohydrates (mg/100gm)	Ascorbic acid (mg/100gm)	Titratable acidity (TA) (%)
Chitwan	10.40±1.2	2.69±0.44	0.79±0.29
Sunsari	11.36±0.01	5.32±1.43	0.57±0.11
Morang	9.92±0.007	1.68±0.5	0.57±0.11
Sankhuwasabha	5.83±0.51	7.80±1.42	0.67±0.19
C.D.	2.18	3.52	N/S
SE(m)	0.66	1.07	0.20
SE(d)	0.92	1.50	0.28
C.V.	12.12	42.14	51.74

CD values indicate significant difference (P < 0.05), N/S = Not significant

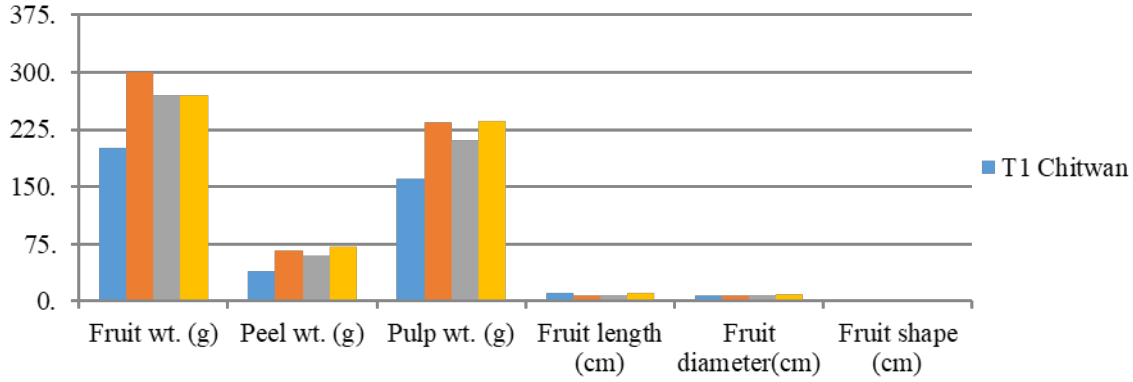


Figure 1. *Comparison of morphological traits among four different locations of Nepal. Significant differences between values was on (P<0.05) level.*

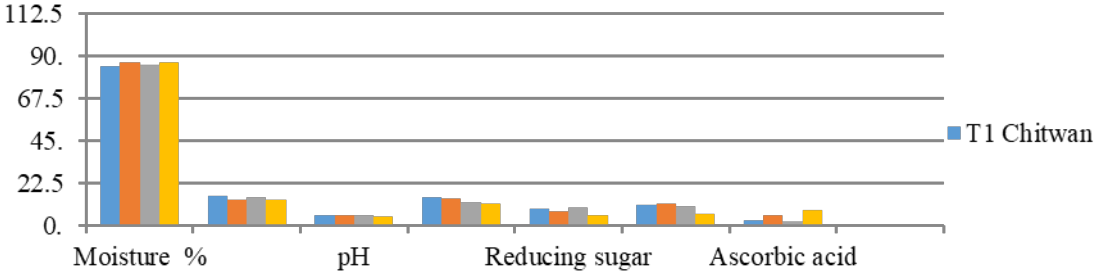


Figure 2. *Comparison of biochemical traits among four different locations of Nepal. Significant differences between values was on (P<0.05) level.*

Farmer's perception on Dragon fruit cultivation

Details on crop production		Response			
		Chitwan	**Sunsari**	**Morang**	**Sankhuwasabha**
i.	Location of cultivation	Bharatpur metropolitan city	Ramdhuni municipality	Kerabari municipality	Khadbari municipality
ii.	Type of soil	Sandy loam	Sandy	Sandy clay	Sandy clay
iii.	Mulching	Plastic mulch	Not done	Not done	Not done
iv.	Distance between pillar	3 × 2 m	2 × 2m	2 × 1.5m	3 × 2m
v.	Irrigation	Yes (perennial)	Yes (perennial)	Yes(perennial)	Yes (perennial)
vi.	Manure and fertilizer	FYM, bone meal, Mustard oil cakes	FYM, Pig & poultry manure	Compost & Mustard oil seed cakes	FYM, Pig and Poultry manure
vii.	Main market of produce	Bharatpur, Kathmandu	Kathmandu, India	Dharan, Itahari, Kathmandu	Khadbari and Kathmandu
viii.	Source of planting materials	India, Vietnam (liza variety)	Malaysia and India	India and Itahari	Kathmandu, Biratchowk, Dharan
ix.	Grading practice	Yes	Yes	No	yes
x.	Total number of pillar	3000	1200	450	250
xi.	Total Plant	12000	4800	1800	920
xii.	Age of Plant	2 and half years	4 years	2years	2 and half years

Summary

Hylocereus polyrhizus do not show significant difference in fruit and pulp weight but peel weight was significantly higher (71.17±2.1 gram) collected from Sankhuwasabha. Highest fruit length and diameter, 9.84cm and 8.42cm was measured from Chitwan and Sankhuwasabha district respectively. Fruit shape (length:diameter) of most of the *Hylocereus polyrhizus was* observed to be round in shape.

- Bio-chemical traits of *Hylocereus polyrhizus* showed differences in result among four locations observation. Moisture and Dry matter content was highest 86.81 and 15.32 percent in fruit collected from Sunsari and Chitwan district respectively.
- Fruit pH was slightly acidic ranging from 4.5 samples from Sankhuwasabha to 5.47 from samples from Chitwan district.

- Total soluble solid was observed highest in *Hylocereus polyrhizus* collected from Chitwan with14.70 degree Brix.
- There is no significant different in reducing sugar between location variations, with highest 9.64 mg^{-100g} of reducing sugar recorded in fruits collected from Morang district.

Conclusion

In the case of Nepal, dragon fruit is a new commodity and every new commodity by its very nature presents both obstacles and opportunities. For the first time detailed morphological and biochemical investigation was conducted *Hylocereus polyrhizus* cultivated in Nepal. The present physico-biochemical characteristics evaluated allows for commercial exploitation in the national as well as international market being able to be commercialized as exotic fruits. This research has carefully analysed the nutritional value of dragon fruits collected from different geographical location of Nepal.

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