Environment and Ecology 41 (4C) : 2853—2858, October—December 2023
Article DOI: https://doi.org/10.60151/envec/JFTT4959
ISSN 0970-0420

Physico-Chemical Characteristics of Dragon Fruit *Hylocereus polyrhizus* (Weber) Britton and Rose from Different Locations of Nepal

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Received 5 June 2023, Accepted 3 October 2023, Published on 15 December 2023

ABSTRACT

The objective of the study were to identify the variation in the physico chemical characteristics of dragon fruit species *Hylocereus polyrhizus* randomly collected from the four districts of Nepal namely., Chitwan, Sunsari, Morang and Sankhuwasabha. Physico - chemical observations were recorded immediately after harvest. Data were collected for fruit pulp, diameter, size, moisture content, dry matter content, pH, soluble solids, reducing sugar, ascorbic acid, titratable acidity and total carbohydrate. The results revealed that the fruit samples collected from Sunsari recorded the highest moisture content (86.81%) which was at par with samples from Sankhuwasabha (86.44%). Dry matter content ranged from 13-15 % among the fruits collected from all the four locations. Average fruit pH was found slightly acidic within the location variation with the highest pH value recorded in the samples collected from Chitwan (5.47). TSS value ranged from 11.7 to 14.70˚ Brix across the different sites. The fruits collected from Sunsari and Morang districts had a significantly trace amount of titratable acidity with an average of 0.57% while the rest of the fruits collected from other locations ranged from 0.6 – 0.7%. Ascorbic acid was found rich in the samples collected from the Sankhuwasabha district (7.80 $mg^{-100g.}$). Reducing sugar was recorded maximum in fruits collected from Morang district (9.64 mg^{-100g}). The highest carbohydrate content was recorded in the samples collected from Sunsari district (11.36 mg^{-100g}). From the present investigation it can be concluded that the physico- chemical characteristics of *Hylocereus polyrhizus* showed differences in the results among the samples collected from the four different location.

Keywords Dragon fruit, Diversity, Ascorbic acid, Biochemical.

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INTRODUCTION

Dragon fruit is a tropical and subtropical semi-epiphytic climbing cactus. It is known as “Dragon fruit” in Asia because of its brilliant red peel and overlapping green fins that cover the fruit. It is now widely cultivated as an export fruit commodity in Southeast

Asia, primarily in Thailand and Vietnam, and is gaining popularity in Nepal (Atreya *et al*. 2020). Among its various species, *Hylocereus polyrhizus* (red dragon fruit or red pitaya) is highly nutritious, containing a variety of bioactive components such as antioxidants, phytonutrients, minerals, and enzymes (Singh *et al.* 2022).

In Nepal only few studies and research has been done in dragon fruit focusing on production locality, market and source of planting material while farmers are establishing orchard more enthusiastically. This recent fact accelerates not only focus on production but also the bio-chemical properties of the fruits that are cultivated in Nepal. While the specific problem handled in this research is that the geographical location may cause variations in the morphological features as well as in the chemical composition of the fruit. The main objective of this research was to identify the potential of this fruit as a nutrition to humans. Despite the fact that the dragon fruit is nutrient rich and offers numerous health advantages, little is known about its exact nutritional and biochemical makeup. The effective inclusion of dragon fruit in a regular diet would benefit from the generation of nutritional and biochemical composition data. It may open the door for the inclusion of dragon fruit as a key component of nutrition campaigns to market it as a cutting-edge tropical super food.

MATERIALS AND METHODS

Location of the study area namely Chitwan, Sunsari, Morang and Sankhuwasabha. was selected based on the altitude variations and availability of established dragon fruit orchards. The chemical analysis of the fruits were recorded in the department of Horticulture, Sikkim University, 6th mile Tadong, East Sikkim, India.

Materials

Mature fruit samples were collected during the month of June 2022 and question regarding cultivation practices were also recorded from progressive farmers of different districts of Nepal to understand their specific cultivation practices.

For analysis of physico-chemical characteristics, fruit samples were randomly collected from each districts and stored in plastic pouch. Fruits samples from different locations were placed separately on different plastic bag. For accuracy of identification fruits were tagged with replication number (triplicated) and weight (gram) and brought to the department for further analysis.

Fruit and peel weight (g): Fruit and peel weight of each treatment of each replication was measured by digital weighing balance. Peel weight was recorded by removing all outer skin of fruit and was measured by using electronic weighing balance (Mettler Toledo) in gram.

Pulp weight(g): It was calculated by subtracting peel weight in fruit weight of each treatment (Fruit weight-peel weight).

Fruit equatorial diameter and length (cm): Diameter and length of each samples was measured by using Vernier calliper in centimetre.

Fruit shape (cm): Fruit shape was measured by ratio of Fruit length: Fruit diameter.

Fruit color: Fruit color was recorded based on visual (optical) appearance.

Moisture and dry matter percentage: Moisture and Dry matter content was determined by following the method given by AOAC (1990).

Preparation of sample for estimation of chemical parameters

The collected fruit samples were peeled and juice of the fruit samples of all the locations 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.

Total soluble solid (^{o}Brix): Total soluble solids (TSS) was determined by using digital pocket refractometer (HI96801).

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.

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 (2000).

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

Reducing sugar: For determination of reducing sugar DNSA method was applied with slight modifications.

Total Carbohydrate: Total Carbohydrates was estimated by using Anthrone method.

Data collection

Methods employed in this study were designed with the purpose of providing baseline information on the use of this species of dragon fruit in local system through surveys and field visits to various areas. Field survey was conducted by collecting information with the help of semi-structured interviews from native knowledgeable people. Personal interviews were carried out using a semi-structured questionnaire on a small number of local people. Interview schedule consisted different types of questions related to objectives of the present study. Information on the age of plant, soil type, mulching, height of post, distance between post, total number of post and total number of plant, source of planting materials, manures and fertilizers, main market, irrigation, grading practices adopted as well as specific issues relating to cultivation of these two species of dragon fruit were also sought as shown in Table1.

One way analysis of variance (ANOVA) was computed for each characteristics in order to identify the variability among the location using the procedures described by Gomez and Gomez (1984). OPSTAT software (Sheoran 1998) was employed for the ANOVA and for the correlations between the variables. The treatments were arranged using completely randomized design with three replication. Treatment mean separation was made whenever significant differences were noticed at 5% probability level.

Table 1. Farmer's response on dragon fruit cultivation.

	Details on crop production	Farmer's 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	2 × 2
v.	Irrigation	Yes (perennial)	Yes (perennial)	Yes (perennial)	Yes (perennial)
vi	Manure and fertilizer	FYM, bone meal, Mustard oil cakes	FYM, Pig manure and poultry manure	Compost & Mustard oil seed cakes	FYM, Pig and Poultry manure
vii.	Main market of produce	Bharatpur, Kathmandu	Kathmandu, India Kathmandu	Dharan, Itahari, Kathmandu	Khadbari and
viii.	Source of planting materials	India, Vietnam (liza variety)	Malaysia and India	India and Itahari	Sunsari
ix.	Grading practice	Yes	Yes	No	No
x.	Total number of pillar	3000	1200	450	230
xi.	Total Plant	12000	4800	1800	920
xii.	Age of Plant	2 and half years	4 years	2years	2 and half years

Table 2. Physical characteristics of fruits from four different locations of *Hylocereus polyrhizus* (mean three replicate±standard error).

Location	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
CD	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
CV	20.12	10.03	19.81	9.50	8.08	12.32

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

RESULTS AND DISCUSSION

Variation in physical characteristics

Dragon fruit species *Hylocereus polyrhizus* cultivated in Nepal exhibits differences in physical traits between locations as shown in Table 2.

Maximum fruit weight of 300g was observed in Sunsari samples followed by Morang and Sankhuwasabha district samples both having 270g of fruit weight. Higher fruit weight could be because of application of extra oil seed cake as manure which serve as Nitrogen to the plant through soil. The fleshy pulp is of a great importance since it is the main part that contains the most important compounds ie., carbohydrates and sugar. Highest pulp weight of 235g was recorded in samples from Sankhu was abha followed by Sunsari district with 234.6 g weight. The result exhibits no significant difference between the samples collected from different locations on fruit and pulp weight. Least peel weight was observed in Chitwan district samples (39.74g) whereas, significantly higher peel weight of 71.17g was recorded in Sankhuwasabha district. Peel content varies with location which means thickness and moisture contains of peel determine weight, it might be because of various factors i.e. cultivation practices, climatic condition and geographic location etc. playing a vital role for peel weight of fruit.These results demonstrate that the loss of peel weight, together with the increase in pulp weight, were counter balanced, which contributed to maintaining the total fruit weight stabilisation. Longest fruit length of 9.84cm was measured from Chitwan samples and maximum fruit diameter was recorded from Sankhuwasabha district samples with 8.42cm respectively. Fruit shape (length:diameter) of most of the *Hylocereus polyrhizus* was observed to be round in shape, albeit fruit collected from Sunsari and Morang district showed more rounded shape of 1.01cm and 0.99 cm respectively as compared to other location. The variance component for all the physical

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

Location	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
Sankhuwasa bha	86.44±0.71	13.56±0.71	4.5±0.11	11.70±0.58	4.99±2.01
CD.	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
CV	1.86	11.17	3.40	5.53	34.71

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

Table 4. Chemical characteristics total carbohydrates, ascorbic acid and TA of fruits from four different locations of *Hylocereus polyrhizus* (mean of three replicate±standard error).

Location	Total arbohydrates (mg/100 gm)	Ascorbic acid (mg/100 gm)	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
CD	2.18	3.52	N/S
SE (m)	0.66	1.07	0.20
SE (d)	0.92	1.50	0.28
CV	12.12	42.14	51.74

characteristics indicated distribution of difference among the samples collected from different locations.

Biochemical Properties

Bio-chemical traits of *Hylocereus polyrhizus* showed differences in result among four locations observation as shown in Table 3-4. Moisture content was observed highest in fruits collected from Sunsari and Sankhuwasabha 86.81 and 86.44%. The moisture content of the samples across the location ranged from 84 -86 %. This corroborates with the research performed by Karunakaran *et al.* (2019) who mentioned that moisture content of dragon fruits ranged from 83.0–88.0 g/100 g. Dry matter content in fruits ranged from 13-15% with the highest dry matter content observed in samples collected from Chitwan district with 15.32% followed by samples from other district without much variation. Fruit pH was slightly acidic ranging from 4.5 of Sankhuwasabha to 5.47 of Chitwan district. Total soluble solid ranged from 11.70-14.70° Brix and highest was observed in Hylocereus polyrhizus collected from Chitwan and was recorded at 14.70 degree Brix. Degree. When evaluating a fruit for consumer acceptance, soluble solids alone won't give the effective picture of the consumer acceptability, but with perceived sweetness, which is determined largely by the relative levels of total soluble solids and acids in the fruits. The total soluble solids are composed of all the soluble solids which are present in the fruits (Karunakaran *et al.* (2019). Different kinds of organic acids and the extent of their concentration play an important role in the flavor of a fruit. Usually high acidity gives better blend and flavor. Thus, presence of considerable quantity of acidity and the presence of total soluble solids in the dragon fruit make them highly acceptable to the consumers. The reducing sugar content ranged from 4.99 to 9.64 among the different location. There was no significant difference in reducing sugar between location variations with the highest amount of 9.64 mg of reducing sugar recorded in fruits collected from Morang district.

It was observed that TSS and pH content of the samples from various location had significant ($P < 0.05$) variations. However the results showed no significant differences between the three sites regarding the moisture content, dry matter content and reducing sugar content.

Total carbohydrate, ascorbic acid and titratable acidity content are compiled in Table 4. Carbohydrates content was significantly higher in the fruits collected from Sunsari district (11.36 mg/100 gram) whereas Sankhuwasabha site possessed significantly lower content (5.83mg/100 gram) of total carbohydrate than the other three sites between which no significant differences were found. Dragon fruit is one of the rich sources of Vitamin C, and the ascorbic acid content ranged between 1.6 to 7.8 mg/100 g. Ascorbic acid content was recorded highest with 7.80 mg in the fruits collected from Sankhuwasabha and Morang recorded the lowest content of 1.68mg/100 g. Vitamin C is one of the most important water-soluble vitamins, naturally present in fruits and vegetables, and it is widely used as a food additive and antioxidant. Humans, unlike most animals, are unable to synthesize vitamin C endogenously, so it is an essential dietary component (Li and Schellhorn 2007). Recommended dietary allowance (RDA) for vitamin C is about 80 mg/day. Hence consumption of 100g fresh dragon fruit provide about atleast 8 % RDA of vitamin C. The fruit was slightly acidic and the titratable acidity varied between 0.57 to 0.79 mg lactic acid equivalents. Organic acids present in the fruits are major constituents responsible for acidity and thus the acidity is the indirect measure of total organic acids in the fruit. Organic acids involves in various function in the human system including growth and maturation. They also highly influence the organoleptic properties such as flavor, color and

aroma as well as fruity taste. They also play a vital role in the post-harvest management of fruits since they increase the shelf life, stability and microbial safety (Al-Farsi *et al.* 2005; Nour *et al.* 2010). Least titratable acidity was recorded from the fruits collected from Sunsari and Morang district with a same value of 0.57%.

The results of analysis of variance showed significant differences between sites regarding both ascorbic acid and total carbohydrate while no differences were indicated for titratable acidity across all locations.

CONCLUSION

From the present investigation it can be concluded that the physico- chemical characteristics of *Hylocereus polyrhizus* showed differences in results among the samples collected from the four different locations. Moisture and Dry matter content was highest with 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 samples to 5.47 of Chitwan district samples. Total soluble solid was recorded highest in Hylocereus polyrhizus collected from Chitwan with 14.70 degree Brix. There was no significant difference in reducing sugar between location variations, with highest 9.64 mg-100g of reducing sugar being recorded in fruits collected from Morang district. In the case of Nepal, dragon fruit is a new commodity, and every new commodity by its very nature presents both obstacles and opportunities. The main objective of this research was to identify the potential of *Hylocereus polyrhizus* fruit for the nutrition of humans and also to investigate the effect of site variations on the composition and physico chemical constituents of the fruits. The present physico-biochemical characteristics evaluated allows for commercial exploitation of *Hylocereus polyrhizus* in the national as well as international market.

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