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VM Parmar
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

KM Karetha
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author
VM Parmar
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Nutritional and organoleptic evaluation of dragon fruit species from different regions of Gujarat

VM Parmar and KM Karetha

Abstract
An investigation was carried out at Department of Horticulture, Junagadh Agricultural University, Junagadh during the year 2019-20. The experiment was laid out in Completely Randomized Design with Factorial concept comprising eight treatment combinations with three replications. The treatments comprised of four level of regions (R) *viz.*, R_1 =West Gujarat Zone, R_2 = North Gujarat Zone, R_3 = Middle Gujarat Zone, R_4 = South Gujarat Zone and two level of species (S) *viz.*, S_1 = *Hylocereus undatus* (White pulp) and S_2 = *Hylocereus polyrhizus* (Red pulp). In case of nutritional evaluation maximum calcium (8.32 mg/100 g) and phosphorus (33.85 mg/100 g) content recorded in species of West Gujarat Zone (R_1) whereas maximum magnesium (40.76 mg/100 g)) and iron (1.47 mg/100 g) content recorded in species of Middle Gujarat Zone (R_3) and South Gujarat Zone (R_4), respectively. In case of species highest calcium (8.63 mg/100 g), magnesium (40.95 mg/100 g), iron (1.40 mg/100 g) and phosphorous (33.21 mg/100 g) content recorded in species *Hylocereus polyrhizus* (S_2) and in treatment combination highest calcium (8.76 mg/100 g) and phosphorus (34.41 mg/100 g) content recorded maximum in R_1S_2 (West Gujarat Zone + *Hylocereus polyrhizus*) whereas highest magnesium (42.30 mg/100 g) and iron (1.64 mg/100 g) content recorded in R_3S_2 (Middle Gujarat Zone + *Hylocereus polyrhizus*) and R_4S_2 (South Gujarat Zone + *Hylocereus polyrhizus*), respectively. In case of organoleptic evaluation highest appearance score was obtained by species S_1 (*Hylocereus undatus*) (8.60) and highest taste score was obtained by species S_2 (*Hylocereus polyrhizus*) (8.53).

Keywords: dragon fruit, species, region, nutritional, organoleptic

Introduction
A pitaya or pitahaya belongs to Cactaceae family. It is known as dragon fruit as its fruit skin covered with bracts or scales. All dragon fruit species has the flesh or dragon fruit pulp filled with lots of tiny black seeds which are edible with the fruit. Dragon fruit is mildly sweet and low in calories (Zainoldin and Baba, 2009) [18]. Dragon fruit is a seasonal fruit. Fruits are mostly available around July to November. Dragon fruit is enjoyed as a fresh fruit or juice but also is valued as a natural food colorant. The fruit's texture is sometimes likened to that of the kiwifruit due to the presence of black, crunchy seeds. In addition to being tasty and refreshing, this fruit contain lot of water and other vital minerals with varied nutritional ingredients. Dragon fruit has a pH ranging between 4.7 and 5.1. (Gunasena *et al.*, 2007) [3].
Dragon fruit can be used to produce industrialized products such as preserve, ice cream, sherbet syrup, candy, pastry, spread, ketch up, fruit juice as well as wine. The flowers can be eaten or steeped as tea. The pulp is firm and crisp with a delicately sweet and lingering taste. The juicy pulp can also be mixed with milk or sugar used in marmalades, jellies, ices and soft drinks. Processed products can be produced from fresh fruit pulp or frozen pulp. The red and pink pulp of dragon fruit can be used as a food colouring agent and as a raw material for the food colouring industries (Wybraniec and Mizrahi, 2002) [16]. The flower buds of dragon fruit are used to make soups or mixed in salads and also eaten as a vegetable. The peels can be dried to extract pectin and antioxidants. The use of red pitaya as a raw material significantly improves the appearance of the food products and also enhances the nutritional quality of the end products.
Dragon fruit is rich in minerals and fibre which are good for health compared to other fruits (Suryono, 2006) [12]. Dragon fruit has obtained attention during last few years among the people in society due to its colour, nutritional value and other features (Hoa *et al.*, 2006; Harivaindaran *et al.*, 2008) [5, 4]. It represents a significant source of antioxidants which is a value added characteristic to any food crop (Rebecca *et al.*, 2010) [10]. Mechanisms of dragon fruit is to secure water requirement for developing aerial roots from the sides of the stem to

collect water from the surroundings (Nobel and de la Barrera, 2002) [8].

Dragon fruit has high economic value and is useful for treating various types of diseases. It is believed to able lower cholesterol concentration, balance blood sugar concentration, prevent colon cancer, strengthen kidney function and bone, strengthen the brain workings, increasing the sharpness of the eyes as well as cosmetic ingredients (Suryono, 2006) [12]. In addition, it has the ability to promote the growth of probiotics in the intestinal tract (Zainoldin and Baba, 2009) [18]. The dragon fruit helps in the digestive process, neutralize toxic substances such as heavy metal and when it will consume regularly the dragon fruit can help against asthma and cough. These effects may be attributed by the active components present in the pitaya fruit such as antioxidant, polyphenolics, thiols and their antioxidative activity from the beta-cyanin contents (Wybraniec and Mizrahi, 2002) [16].

No detailed study concerning nutritional and organoleptic properties of dragon fruit have been performed. The aim of this study was to determine nutritional and organoleptic properties of two species widely grown in four different regions of Gujarat.

Material & Methods

The present investigation was carried out at Department of Horticulture, Junagadh Agricultural University, Junagadh during the year 2019-20. The experiment was laid out in Completely Randomized Design (CRD) with Factorial concept comprising eight treatment combinations with three replications. The treatments comprised of four level of regions (R) *viz*., R_1 =West Gujarat Zone, R_2 = North Gujarat Zone, R_3 = Middle Gujarat Zone, R_4 = South Gujarat Zone and two level of species (S) *viz*., S_1 = *Hylocereus undatus* (White pulp) and S_2 = *Hylocereus polyrhizus* (Red pulp). Three fruit from each treatment and each repetition were selected for mineral and organoleptic evaluation.

Minerals (Ca, Mg, Fe, P) mg/100 g

Measurements of elements (Ca, Mg, Fe) were performed using an Analytic Jena Plasma Quant PQ 9000 inductively coupled plasma optical emission spectrometer. The phosphorus content was determined by spectrometry at 400 nm using a Helios Alpha UV-VIS apparatus according to A.O.A.C.

Organoleptic test (By scoring method)

Three fruit from each treatment and each repetition were selected and sensory evaluation for characteristics *viz*., appearance, taste, flavour and texture was carried out by "Hedonic rating test". Each attribute was given a separate score of 10 points. Evaluation panel consisted of 10 panelists from the Department of Horticulture. The panelists evaluated the samples as per hedonic scale procedure.

Various characters under study were statistically analysed by using analysis of variance technique for Completely Randomized Design (CRD) with Factorial concept as described by Panse and Sukhatme (1985) [9].

Results & Discussion

Minerals

Calcium (mg/100 g)

Among regions maximum calcium (8.32 mg/100 g) was noted in R_1 (West Gujarat Zone) which was at par with R_2 (North Gujarat Zone) (8.17 mg/100 g). Minimum calcium (8.10 mg/100 g) was noted in R_4 (South Gujarat Zone). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Taghavi *et al.* (2019) [13] in strawberry.

Among species highest calcium (8.63 mg/100 g) was noted in S_2 (*Hylocereus polyrhizus*) as compared to S_1 (*Hylocereus undatus*) (7.73 mg/100 g). The similar kind of findings were recorded by Bellec *et al.* (2006) [2] in dragon fruit and Joshi (2016) [6] in guava and Topuz *et al.* (2005) [14] in orange.

Among interaction effect maximum calcium (8.76 mg/100 g) was noted in R_1S_2 (West Gujarat Zone + *Hylocereus polyrhizus*) which was at par with R_2S_2 (North Gujarat Zone + *Hylocereus polyrhizus*) (8.72 mg/100 g). Minimum calcium (7.63 mg/100 g) was noted in R_2S_1 (North Gujarat Zone + *Hylocereus undatus*). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Saaed *et al.* (2010) [11]; Zafar and Sindhu (2017) [17] in mango.

Magnesium (mg/100 g)

Among regions maximum magnesium (40.76 mg/100 g) was noted in R_3 (Middle Gujarat Zone) which was at par with R_2 (North Gujarat Zone) (39.60 mg/100 g). Minimum magnesium (38.81 mg/100 g) was noted in R_1 (West Gujarat Zone). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Taghavi *et al.* (2019) [13] in strawberry.

Among species highest magnesium (40.95 mg/100 g) was noted in S_2 (*Hylocereus polyrhizus*) as compared to S_1 (*Hylocereus undatus*) (38.31 mg/100 g). The similar kind of findings were recorded by Bellec *et al.* (2006) [2] in dragon fruit and Joshi (2016) [6] in guava and Topuz *et al.* (2005) [14] in orange.

Among interaction effect maximum magnesium (42.30 mg/100 g) was noted in R_3S_2 (Middle Gujarat Zone + *Hylocereus polyrhizus*) which was at par with R_4S_2 (South Gujarat Zone + *Hylocereus polyrhizus*) (41.35 mg/100 g). Minimum magnesium (36.40 mg/100 g) was noted in R_3S_1 (Middle Gujarat Zone + *Hylocereus undatus*). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Saaed *et al.* (2010) [11]; Zafar and Sindhu (2017) [17] in mango.

Iron (mg/100 g)

Among regions maximum iron (1.47 mg/100 g) was noted in R_4 (South Gujarat Zone) which was at par with R_2 (North Gujarat Zone) (1.38 mg/100 g). Minimum iron (1.07 mg/100 g) was noted in R_3 (Middle Gujarat Zone). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc.* The similar kind of findings were recorded by Taghavi *et al.* (2019) [13] in strawberry.

Among species highest iron (1.40 mg/100 g) was noted in S_2 (*Hylocereus polyrhizus*) as compared to S_1 (*Hylocereus undatus*) (1.22 mg/100 g). The similar kind of findings were recorded by Bellec *et al.* (2006) [2] in dragon fruit and Joshi (2016) [6] in guava and Topuz *et al.* (2005) [14] in orange.

Among interaction effect maximum iron (1.64 mg/100 g) was noted in R_4S_2 (South Gujarat Zone + *Hylocereus polyrhizus*) which was at par with R_2S_2 (North Gujarat Zone + *Hylocereus polyrhizus*) (1.54 mg/100 g). Minimum iron (1.06 mg/100 g) was noted in R_3S_1 (Middle Gujarat Zone + *Hylocereus undatus*). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The

similar kind of findings were recorded by Saaed *et al.* (2010) [11]; Zafar and Sindhu (2017) [17] in mango.

Phosphorus (mg/100 g)

Among regions maximum phosphorus (33.85 mg/100 g) was noted in R_1 (West Gujarat Zone) which was at par with R_2 (North Gujarat Zone) (32.80 mg/100 g). Minimum phosphorus (31.13 mg/100 g) was noted in R_3 (Middle Gujarat Zone). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Taghavi *et al.* (2019) [13] in strawberry.

Among species highest phosphorus (32.21 mg/100 g) was noted in S_2 (*Hylocereus polyrhizus*) as compared to S_1 (*Hylocereus undatus*) (31.98 mg/100 g). The similar kind of findings were recorded by Bellec *et al.* (2006) [2] in dragon fruit and Joshi (2016) [6] in guava and Topuz *et al.* (2005) [14] in orange.

Among interaction effect maximum phosphorus (34.41 mg/100 g) was noted in R_1S_2 (West Gujarat Zone + *Hylocereus polyrhizus*) which was at par with R_2S_2 (North Gujarat Zone + *Hylocereus polyrhizus*) (34.24 mg/100 g). Minimum phosphorus (30.52 mg/100 g) was noted in R_3S_1 (Middle Gujarat Zone + *Hylocereus undatus*). This might be due to environmental factor such as light intensity, light quality, temperature, humidity, *etc*. The similar kind of findings were recorded by Saaed *et al.* (2010) [11]; Zafar and Sindhu (2017) [17] in mango.

Organoleptic test

Appearance

Significant differences found between dragon fruit species Highest appearance score was obtained by species S_1 (*Hylocereus undatus*) (8.60) as compared to species S_2 (*Hylocereus polyrhizus*) (8.37). Fruit appearance is an important quality parameter because it attracts the consumer visually and thus influences the market price. The appearance of the whole white pulp dragon fruit was similar to the red pulp dragon fruit. Both white pulp and red pulp species are ovary fruit with brilliantly red peel. They have reddish scales (special leaves) with greenish at the end of the scales, whereas the scales of red pulp dragon fruit were obviously shorter than the white pulp dragon fruit. This unique appearance gives the fruits an interestingly exotic and oriental looks. The numerous edible small black seeds contribute with white pulp for white pulp dragon fruit and with red pulp for red pulp dragon fruit were clearly observed. The average length, diameter and weight of the white pulp dragon fruit were significantly higher than that of the red pulp dragon fruit. The study was supported by Wichienchot *et al.* (2010) [15]; Mohd (2010) [7] in dragon fruit.

No significance difference found in case of regions and interaction effect on appearance of dragon fruit.

Taste

Significant differences found between dragon fruit species Highest taste score was obtained by species S_2 (*Hylocereus polyrhizus*) (8.53) as compared to species S_1 (*Hylocereus undatus*) (8.33). The well-ripe fruit of *Hylocereus undatus* is soft and sweet, whereas the pulp of *Hylocereus polyrhizus* is usually very sweet and mild acidic. The study was supported by Gunasena *et al.* (2007) [3]; Le Bellec *et al.* (2006) [2] in dragon fruit.

No significance difference found in case of regions and interaction effect on taste of dragon fruit.

Flavour

No significant difference found among different regions, species and their interaction effect on flavour of dragon fruit.

Texture

No significant difference found among different regions, species and their interaction effect on texture of dragon fruit.

Table 1: Effect of different regions and species on mineral content of dragon fruit

Sr. No.	Treatment	Ca (mg/100 g)	Mg (mg/100 g)	Fe (mg/100 g)	P (mg/100 g)
Regions (R)					
R_1	West Gujarat Zone	8.32	38.81	1.32	33.85
R_2	North Gujarat Zone	8.17	39.60	1.38	32.80
R_3	Middle Gujarat Zone	8.14	40.76	1.07	31.13
R_4	South Gujarat Zone	8.10	39.35	1.47	32.61
	S.Em.±	0.039	0.454	0.025	0.419
	C.D. at 5%	0.12	1.36	0.07	1.26
Crop Species (S)					
S_1	*Hylocereus undatus*	7.73	38.31	1.22	31.98
S_2	*Hylocereus polyrhizus*	8.63	40.95	1.40	33.21
	S.Em.±	0.027	0.321	0.018	0.296
	C.D. at 5%	0.08	0.96	0.05	0.89
Interaction (R x S)					
T_1	R_1S_1	7.88	37.57	1.29	33.29
T_2	R_1S_2	8.76	40.06	1.34	34.41
T_3	R_2S_1	7.63	39.11	1.22	31.36
T_4	R_2S_2	8.72	40.09	1.54	34.24
T_5	R_3S_1	7.78	36.40	1.06	30.52
T_6	R_3S_2	8.50	42.30	1.07	31.75
T_7	R_4S_1	7.65	40.16	1.30	33.56
T_8	R_4S_2	8.55	41.35	1.64	31.66
	S.Em.±	0.055	0.642	0.035	0.593
	C.D. at 5%	0.16	1.92	0.11	1.78
	C.V.%	1.16	2.81	4.68	3.15

Table 2: Effect of different regions and species on organoleptic evaluation of dragon fruit

Sr. No.	Treatment	Appearance	Taste	Flavour	Texture
Regions (R)					
R_1	West Gujarat Zone	8.49	8.37	8.37	8.70
R_2	North Gujarat Zone	8.51	8.50	8.50	8.85
R_3	Middle Gujarat Zone	8.45	8.39	8.39	8.55
R_4	South Gujarat Zone	8.48	8.47	8.47	8.48
	S.Em.±	0.107	0.096	0.104	0.092
	C.D. at 5%	NS	NS	NS	NS
Crop Species (S)					
S_1	*Hylocereus undatus*	8.60	8.33	8.42	8.63
S_2	*Hylocereus polyrhizus*	8.37	8.53	8.44	8.67
	S.Em.±	0.076	0.068	0.073	0.065
	C.D. at 5%	0.23	0.20	NS	NS
Interaction (R x S)					
	S.Em.±	0.151	0.136	0.146	0.131
	C.D. at 5%	NS	NS	NS	NS
	C.V.%	3.09	2.80	3.01	2.62

Conclusion

On the basis of results obtained from the present investigation, it can be concluded that among two dragon fruit species *Hylocereus polyrhizus* recorded maximum Ca and P content in West Gujarat Zone while, Mg and Fe content in fruit was maximum in Middle Gujarat Zone and South Gujarat Zone, respectively and highest appearance score was obtained by species *Hylocereus undatus* while, highest taste score was obtained by species *Hylocereus polyrhizus.*

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