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Evaluation of Nutritive and Mineral value in Ripe Fruits of Indian Hog Plum (*Spondias pinnata* Linn.) from Four Different Location of Northern Parts of West Bengal

Dey K[1]*, Ghosh A[1], Dey AN[2], Bhowmick N[1] and Bauri FK[3]

Abstract

Indian hog plum (*Spondias pinnata* Linn.) is a drupaceous fruit, popular in the food and nutraceutical industries for its taste and health benefits. This study reports on the physico-chemical constituents at the stages of maturity of Indian hog plum fruits collected from four different sources. This experiment was carried out using CRD with four treatments and five replications. Parameters like fruit weight (35.69 g), specific gravity (1.27), peel/pulp ratio (0.65), seed weight (13.53 g), TSS (8.12°brix), titrable acidity (0.49%), total sugar (6.56%), reducing sugar (4.42%), non-reducing sugar (2.14%), ascorbic acid (22.10 mg/100g pulp), total phenolics (29.19 mg/100g pulp), moisture (78.55%), ash (4.79%), crude fibre (4.09%), food energy value (168.76 kcal/g), calcium (0.84%), iron (1.87%), potassium (1.78%) and sodium (1.51%) etc. were recorded highest in fruits collected from Jalpaiguri source.

Keywords

Indian hog plum; Minor fruit; Physico-chemical composition; Source variation

Introduction

In spite of having nutritional and medicinal values of Indian Hog plum (*Spondias pinnata* Linn.), the crop has not been properly utilized. Though in the present day world, people residing away from the urban societies are dependent on the indigenous plants for food security and everyday products from medicines to fibers [1]. The underutilized crops could also have an important role to play as new promising crops due to their consistent use in lesser common farming situations and subsistence agriculture practiced by poor farming households [2]. Some of these plants are rich in nutrients, and their consumption helps to maintain a balanced diet among the rural population [3]. Most of these species have wide adaptability as well as high degree of tolerance and hence can thrive even under most adverse situations [4]. Therefore, their adoption on a commercial scale, with crop improvement, standardization of cultural practices and popularization in adverse farming systems are warranted to achieve stability in farm production and food security [4]. Indian Hog-plum or Amra [5], belongs to the family Anacardiaceae, is a minor fruit in West Bengal. It is native to tropical Asia, and grows in the Western Peninsula, Andaman and the sub-Himalayan tract, and is also widely grown in many tropical climates [6-9]. Fruit is a drupe with a large stone, ellipsoid to elliptic-ovoid, yellowish orange at maturity, 3.5-5 × 2.5-3.5 cm. It is a unique, fleshy, drupe fruit with mango flavour, characterized by thin, leathery pericarp, fleshy mesocarp and hard endocarp with a single seed [10]. Inner part of endocarp is woody and grooved, outer part is fibrous [11,12]. The unripe fruits are acidic, thermogenic, appetizer and aphrodisiac, while ripe ones are sweet–sour with a hard stone. The fruit is aromatic and astringent and is eaten raw and can be used for preparation of pickles, jam and other processed food and also used as a vegetable and flavouring in curry. It is used in treatment of rheumatic articular, muscular pain and sore throat [13-16] Two novel bioactive compounds (spondiol and glycospondin) in the fruit showed high anti-oxidant activity and inhibited platelet-aggregation [16]. Munmun [17] stated that dried products of hog-plum contained substantially higher nutrient content than fresh one with the exception of vitamin C which was almost half of that present in fresh one. It was found that hog-plum contains various nutrients, vitamins and minerals such as protein, carbohydrate, calcium, iron, carotene, vitamin B_1, B_2, C etc. [17-19]. It is rich source of vitamin C (22.63 mg/100 g) or ascorbic acid [10,13]. However, very little information is available for this area on the physico-chemical composition of Indian Hog-plum for their use as a valuable source of functional food and thereby to exploit these for the benefit of the growers. The aim of the present study was to determine physico-chemical constituents of raw fruits of *Spondiaspinnata* Linn. in northern parts of West Bengal.

Materials and Method

Collection of fruits

Indian hog-plum fruits of the uniform size and maturity were collected from different homestead garden of four different districts i.e. Cooch Behar (26°23'86" N latitude and 89°25'53" E longitude), Jalpaiguri (26°58' N latitude and 89°00'69" E longitude), North Dinajpur (26°27' N latitude and 88°20' E longitude) and Alipurduar (26°50' N latitude and 89°52' E longitude) during the year 2014. After collection of fruits, they were immediately brought to the laboratory of the Department of Pomology and Post-harvest Technology, Faculty of Horticulture, at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar. The fruits after washing in running tap water dried in the shade for few minutes.

Treatments

Four source variations were treated as four different treatments. T_1-Cooch Behar hog-plum, T_2-Jalpaiguri hog-plum, T_3-North Dinajpur hog-plum and T_4-Alipurduar hog-plum.

Observation recorded

Physical parameters: Fruit weight, Peel weight, Pulp weight and Seed weight was measured with the help of electronic (digital) balance [Mettler Toledo PB153-L] and expressed in gram (g). The fruit colour was recorded with the help of Royal Horticulture Society Colour

***Corresponding author:** Dey K, Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252, India, E-mail: koyelfruits@gmail.com

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Chart (fifth edition). Fruit length and breadth was measured with the help of digital slide caliper in millimeters (mm). Specific gravity was calculated following the water displacement method. Peel/pulp ratio was calculated by dividing peel weight to pulp weight.

$$Peel / Pulp\ ratio = Peel\ weight / Pulp\ weight$$

Bio-chemical properties: TSS, Total sugar, Reducing sugar and Non-reducing sugar content of the fruit was recorded with the help of hand Refractometer [20]. Titratable acidity was estimated by following the method of Rangana [21]. Ascorbic acid was measured colorimetrically by UV/Vis spectrometer expressed as mg per 100g fruit pulp [21]. Total phenolics was estimated at 650 nm colorimetrically by UV/Vis spectrometer and expressed as mg per 100 g fruit pulp [9]. Moisture in food samples was calculated as follows: % Moisture = (Loss in weight/Weight of sample) × 100. Ash content of fruits was estimated using muffle furnace following the method of AOAC [5]. Crude fibre was determined by method of Sadasivam and Manikam [22]. Fat content was estimated by Soxhlet apparatus (Pelican Socsplus-SCS 04 R) using thimble size 25 mm × 80 mm [23]. Protein was measured colorimetrically at 660 nm [24] using UV/Vis spectrometer. Total carbohydrate was determined colorimetrically at 630 nm [22] using UV/Vis spectrometer (Perkin Elmer, Lambda 25). Food energy value was calculated by using the formula i.e. kcal/g = (3.36 × % protein fresh weight) + (3.60 × % total carbohydrate fresh weight) + (8.37×% fat fresh weight) [25].

Mineral content: Calcium and Sodium content of fruits was estimated using Flame photometer (Systronics Model No. 128) following the method of [26]. Iron was measured using Atomic absorption spectrometer (Perkin Elmer AA analyst 200) following the method of Piper [26]. Copper content of fruits was determined using Atomic absorption spectrometer (Perkin Elmer AA analyst 200) following the method of Jackson [27]. Carbon, Nitrogen, Sulphur and Hydrogen was estimated using the dried grind fruit sample in CHNSO Elementer (Model no. Vario EL III). Phosphorus content of fruits was measured by following the colorimetrical method of Fiske and Row [28] using UV/Vis spectrometer at 660 nm. Potassium was estimated using Flame photometer (Systronics Model No. 128) following the method of Jackson [27].

Experimental design and statistical analysis

The experiment had completely randomized design with 4 treatments and 5 replications. Analysis of variance (one way classified data) for each parameter was performed using ProcGlm of Statistical Analysis System (SAS) software (version 9.3). Mean separation for different treatment under different parameter were performed using Least Significant Different (LSD) test ($P \leq 0.05$). Normality of residuals under the assumption of ANOVA was tested using Kolmogrov-Smirnov, Shapiro-Wilk, Cramer-Von Mises and Anderson Darling procedure using Proc-Univariate procedure of SAS, (version 9.3).

Results and Discussion

Physical parameters

Fruit weight: Result (Table 1) showed that fruit weight was ranged from 28.92 g to 35.69 g. Highest fruit weight (35.69 g) was obtained in T_2 (Indian hog plum of Jalpaiguri district) followed by T_1 (Indian hog plum of Cooch Behar district) (31.06 g) and least weight (28.92 g) was obtained in T_3 (Indian hog plum of North Dinajpur district). The data were statistically significant under all the treatments. Variation in fruit weight of different location might be due to different agro-climatic condition.

Colour: Table 1 indicated that fruit colour was varied from light yellowish green to deep yellowish green. Light yellowish green (YGG144A) was obtained in T_2 and deep yellowish green (YGG144B) was obtained in T_3 and T_4. Variation in fruit colour of different locations might be due to different agro-climatic condition.

Fruit ength: The data presented in Table 1 on fruit length revealed that fruit length was ranged from 39.78 mm to 48.82 mm. Highest fruit length (48.82 mm) was obtained in T_2 followed by T_1 (44.67 mm). Lowest fruit length (39.78 mm) was obtained in T_3. The data pertaining on fruit length were statistically significant under all the treatments except T_3 and T_4 which were statistically at per. Variation in fruit length of different locations might be due to different agro-climatic condition.

Fruit breadth: Results (Table 1) showed that fruit breadth was differed from 31.56 mm to 39.74 mm. Highest fruit breadth (39.74 mm) was obtained in T_2 and minimum breadth (31.56 mm) was obtained in T_3. The data were statistically significant under all the treatments. Variation in fruit breadth of different locations might be due to different agro-climatic condition.

Specific gravity: Table 1 represented that specific gravity was ranged from 1.06 to 1.27. Highest specific gravity (1.27) was obtained in T_2 followed by T_1 (1.15). Lowest specific gravity (1.06) was obtained in T_3. The data were statistically significant under all the treatments except T_3 and T_4 where they were statistically at ratio (0.56) was obtained in T_1. The data were statistically at per under all the treatments. Variation in peel/pulp ratio of different location was recorded might be due to different agro-climatic condition.

Seed weight: Results (Table 1) represented that seed weight was ranged from 10.65 g to 13.53 g. Highest seed weight (13.53 g) was obtained in T_2 (Indian hog plum of Jalpaiguri district) followed by T_4 (Indian hog plum of Alipurduar district) (13.42 g). Minimum seed weight (10.65 g) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data pertaining on fruit length were statistically significant under all the treatments except T_2, T_3 and T_4 where the data were statistically at per. Variation in seed weight of different locations might be due to different agro-climatic condition.

Table 1: Effect of source variation on physical parameters of Indian Hog-Plum fruits.

Treatments	Fruit Weight (g)	Colour	Length (mm)	Breadth (mm)	Specific gravity	Peel weight (g)	Pulp weight (g)	Peel/pulp ratio	Seed weight (g.)
T_1 (Cooch Behar)	31.06b	YGG144A	44.67b	34.52b	1.15b	7.29ab	13.12a	0.56a	10.65b
T_2 (Jalpaiguri)	35.69a	YGG144A	48.82a	39.74a	1.27a	8.75a	13.52a	0.65a	13.53a
T_3 (North Dinajpur)	28.92c	YGG144A	39.78c	31.56d	1.06c	5.93b	10.02b	0.59a	12.97a
T_4 (Alipurduar)	30.04bc	YGG144A	41.50c	33.11c	1.08c	6.13b	10.38b	0.59a	13.42a
SEm (±)	**0.92**	**-**	**1.15**	**0.71**	**0.04**	**1.09**	**1.20**	**0.09**	**0.97**
LSD (P ≤ 0.05)	**1.52**	**-**	**1.89**	**1.16**	**0.07**	**1.79**	**1.97**	**NS**	**1.59**

Note: **Means with the same letter are not significantly different.

Biochemical parameters

TSS (Total soluble solids): Results (Table 2) showed that TSS content was ranged from 6.60° brixto 8.12° brix. Highest TSS (8.12° brix) was obtained in T_2 (Indian hog plum of Jalpaiguri district) followed by T_3 (Indian hog plum of North Dinajpur district) (7.40° brix). Lowest TSS (6.60° brix) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data were per. Variation in specific gravity of different locations might be due to different agro-climatic condition.

Peel weight: Results (Table 1) indicated that peel weight was varied from 5.93 g to 8.75 g. Highest peel weight (8.75 g) was obtained in T_2 and lowest fruit weight (5.93 g) was obtained in T_3. The data were statistically significant under all the treatments except T_3 and T_4 which were statistically at per. Variation in peel weight of different locations might be due to different agro-climatic condition.

Pulp weight: The data presented in Table 1 showed that pulp weight was ranged from 10.02 g to 13.52 g. Highest pulp weight (13.52 g) was obtained in T_2 followed by T_1 (13.12 g). Minimum fruit weight (10.02 g) was obtained in T_3. The data pertaining on pulp weight were statistically significant under all the treatments. Variation in pulp weight of different location was recorded might be due to different agro-climatic condition.

Peel/pulp ratio: Results (Table 1) showed that peel/pulp ratio was differed from 0.59 to 0.65. Highest peel/pulp ratio (0.65) was obtained in T_2 and lowest peel/pulp statistically significant under all the treatments. Variation in TSS of different locations might be due to different agro-climatic condition. Akther et al. [13] reported that differences in physico-chemical composition for Barishal and Mymensingh hog-plum might be due to the variation of soil, growing condition, harvesting period, maturity stage, climate etc. TSS content is in line with the findings reported by Sivaprasad et al. [8] Munmun [17] and Sivaprasad et al. [10].

Titrable acidity: Table 2 declared that titrable acidity was varied from 0.42% to 0.49%. Highest titrable acidity (0.49%) was obtained in T_2 and lowest titrable acidity (0.42%) was obtained in T_1. The data pertaining on titrable acidity were statistically at per under all the treatments. Variation in titrable acidity of different locations might be due to different agro-climatic condition. Akther et al. [13] reported that differences in physico-chemical composition for Barishal and Mymensingh hog-plum might be due to the variation of soil, growing condition, harvesting period, maturity stage, climate etc. Titrable acidity content is in line with the findings reported by Sivaprasad et al. [10].

Total sugar: It is evident from the data presented in Table 2 that total sugar content was ranged from 5.42% to 6.56%. Highest total sugar (6.56%) was obtained in T_2 followed by T_3 (6.03%). Lowest total sugarcontent (5.42%) was obtained in T_1. The data pertaining on total sugar were statistically significant under all the treatments. Variation in total sugar content of different locations might be due to different agro-climatic condition [8,10,13].

Reducing sugar: Results (Table 2) indicated that reducing sugar content was varied from 3.85% to 4.42%. Highest reducing sugar content (4.42%) was obtained in T_2 followed by T_1 (4.02%) and least content (3.85%) was obtained in T_4. The data pertaining on reducing sugar were statistically significant under all the treatments except T_1, T_3 and T_4 where the data were statistically at per.

Variation in reducing sugar content of different locations might be due to different agro-climatic condition. Akther et al. [13] reported that differences in physico-chemical composition for Barishal and Mymensingh hog-plum might be due to the variation of soil, growing condition, harvesting period, maturity stage, climate etc. Reducing sugar content is in line with the findings reported by Sivaprasad et al. [10] and Sivaprasad et al. [8].

Non-reducing sugar: Results (Table 2) showed that non-reducing sugar content was differed from 1.40% to 2.14%. Highest non-reducing sugar (2.14%) was given in T_2 and minimum content (1.40%) was obtained in T_1. The data on non-reducing sugar were statistically significant under all the treatments except T_2, T_3 and T_4 where the data were statistically at per. Variation in non-reducing sugar content of different locations might be due to different agro-climatic condition. These findings are in agreement with the findings of Akther et al. [13].

Ascorbic acid: The data presented in Table 2 on ascorbic acid represented that ascorbic acid content was ranged from 20.53 mg/100 g pulp to 22.10 mg/100 g pulp. Highest ascorbic acid content (22.10 mg/100 g pulp) was recorded in T_2 followed by T_3 (21.17 mg/100 g pulp). Least content (20.53 mg/100 g pulp) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data were statistically significant under all the treatments except T_1 and T_4 which were statistically at per.

Variation in ascorbic acid content of different location was recorded might be due to different agro-climatic condition. Akther et al. [13] reported that differences in physico-chemical composition for Barishal and Mymensingh hog-plum might be due to the variation of soil, growing condition, harvesting period, maturity stage, climate etc. Ascorbic acid content is in line with the findings reported by Munmun [17], Islam [18], Sivaprasad et al. [10], Sivaprasad et al. [8], Koziol and Macia [5] Annon. [29] and Satpathy et al. [25].

Total phenolics: Table 2 showed that total phenolics content was varied from 24.76 mg/100 g pulp to 29.19 mg/100 g pulp. Highest total phenolics content (29.19 mg/100 g pulp) was obtained in T_2 followed by T_3 (26.93 mg/100 g pulp). Minimum content (24.76 mg/100 g pulp) was obtained in T_1. The data pertaining on total phenolics content

Table 2: Effect of source variation on biochemical properties of Indian Hog-Plum fruits.

Treatments	TSS (° brix)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100g pulp)	Total phenols (mg/100g pulp)	Moisture (%)	Ash (%)	Crude fibre (%)	Fat (%)	Protein (%)	Total carbohydrate (%)	Food energy value (kcal/g)
T_1 (Cooch Behar)	6.60c	0.42a	5.42c	4.02b	1.40b	20.53c	24.76d	77.21d	4.48b	3.51c	12.42b	0.78a	14.54a	158.92c
T_2 (Jalpaiguri)	8.12a	0.49a	6.56a	4.42a	2.14a	22.10a	29.19a	78.55a	4.79a	4.09a	13.46a	0.86a	14.79a	168.76a
T_3 (North Dinajpur)	7.40b	0.44a	6.03ab	3.89b	2.14a	21.17b	26.93b	78.10b	4.67ab	3.93b	13.36a	0.82a	14.77a	167.58ab
T_4 (Alipurduar)	7.08bc	0.44a	5.78bc	3.85b	1.93a	20.76c	25.86c	77.64c	4.76ab	3.82b	12.64b	0.84a	14.78a	161.90bc
SEm (±)	**0.44**	**0.05**	**0.36**	**0.20**	**0.28**	**0.21**	**0.31**	**0.14**	**0.17**	**0.09**	**0.24**	**0.07**	**1.24**	**4.18**
LSD(P ≤ 0.05)	**0.72**	**NS**	**0.58**	**0.33**	**0.47**	**0.35**	**0.50**	**0.24**	**0.28**	**0.14**	**0.40**	**NS**	**NS**	**6.86**

Note: **Means with the same letter are not significantly different.

were statistically significant under all the treatments. Variation in total phenolics content of different location was recorded might be due to different agro-climatic condition [13]. Total phenolics content is in line with the findings reported by Sivaprasad et al. [8,10].

Moisture: Results (Table 2) declared that moisture content was differed from 77.21% to 78.55%. Highest moisture content (78.55%) was recorded in T_2 (Indian hog plum of Jalpaiguri district) followed by T_3 (Indian hog plum of North Dinajpur district) (78.10%). Lowest moisture content (77.21%) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data pertaining on moisture content were statistically significant under all the treatments. Variation in moisture content of different locations might be due to different agro-climatic condition. Akther et al. [13], reported that differences in physico-chemical composition for Barishal and Mymensingh hog-plum might be due to the variation of soil, growing condition, harvesting period, maturity stage, climate etc. Similar results were also reported by Ali et al. [18], Andola and Purohit [11], Annon [29], Munmun [17], Islam [19], Koziol and Macia [5] and Satpathy et al. [25].

Ash: Results (Table 2) showed that ash content was differed from 4.48% to 4.79%. Highest ash content (4.79%) was obtained in $T_2$and least ash content (4.48%) was obtained in T_1. The data pertaining were statistically significant under all the treatments except T_3 and T_4 where they were statistically at per. Variation in ash content of different locations might be due to different agro-climatic condition [13]. Similar results were also reported by Ali et al. [18], Andola and Purohit [11], Munmun [17], Islam [19], Koziol and Macia [5] and Satpathy et al. [25].

Crude fibre: Results (Table 2) indicated that crude fibre content was ranged from 3.51% to 4.09%. Highest crude fibre content (4.09%) was obtained in T_2 followed by T_3 (3.93%). However, it is minimum (3.51%) in T_1. The data were statistically significant under all the treatments except T_3 and T_4 where the data were statistically at per. Variation in crude fibre content of different locations might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Similar crude fibre content was reported by Koziol and Macia [5] and Satpathy et al. [25].

Fat: The data presented in Table 2 on fat content revealed that fat content was varied from 12.42% to 13.46%. Highest fat content (13.46%) was obtained in T_2 and lowest content (12.42%) was obtained in T_1. The data on fat content were statistically significant under all the treatments.

Variation in fat content of different locations might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Fat content is in line with the findings reported by Annon [29], Koziol and Macia [5] and Satpathy et al. [25].

Protein: Results (Table 2) showed that protein content was ranged from 0.78% to 0.86%. Highest protein content (0.86%) was obtained in $T_2$and least content (0.78%) was obtained in T_1. The data were statistically at per under all the treatments. Variation in protein content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. protein content is in line with the findings reported by Annon. [29], Sivaprasad et al. [8,10], Koziol and Macia [5] and Satpathy et al. [25].

Total carbohydrate: Results (Table 2) indicated that total carbohydrate content was varied from 14.54% to 14.79%. Highest total carbohydrate content (14.79%) was obtained in T_2 followed by T_3 (14.77%). Minimum content (14.54%) was obtained in T_1. The data were statistically at per under all the treatments. Variation in total carbohydrate content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Total carbohydrate content is in line with the findings reported by Annon [29], Koziol and Macia [5] and Satpathy et al. [25].

Food energy value: The data presented in Table 2 represented that food energy value was ranged from 158.92 kcal/g to 168.76 kcal/g. Highest food energy value (168.76 kcal/g) was obtained in T_2 and lowest food value (158.92 kcal/g) was obtained in T_1. The datas pertaining on food energy value were statistically significant under all the treatments. Variation in food energy value of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Food energy value is in line with the findings reported by Koziol and Macia [5] and Satpathy et al. [25].

Mineral content

Calcium: Results (Table 3) showed that calcium content was varied from 0.76% to 0.84%. Highest calcium content (0.84%) was obtained in T_2 (Indian hog plum of Jalpaiguri district) followed by T_4 (Indian hog plum of Alipurduar district) (0.82%). Lowest calcium content (0.76%) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data pertaining on calcium content were statistically at per under all the treatments. Variation in calcium content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Calcium content is in line with the

Table 3: Effect of source variation on mineral properties of Indian Hog-Plum fruits.

Treatments	Calcium (%)	Iron (%)	Copper (%)	Sulphur (%)	Hydrogen (%)	Carbon (%)	Nitrogen (%)	C/N ratio	Phosphorus (%)	Potassium (%)	Sodium (%)
T_1 (Cooch Behar)	0.76a	1.67b	1.43a	0.04ab	11.46b	40.56b	0.73b	56.01a	0.78a	1.70a	1.38a
T_2 (Jalpaiguri)	0.84a	1.87a	1.54a	0.05a	12.13a	40.49b	0.87b	48.72a	0.81a	1.78a	1.51a
T_3 (North Dinajpur)	0.79a	1.74ab	1.49a	0.02bc	12.05a	41.21a	0.94b	51.70a	0.79a	1.73a	1.43a
T_4 (Alipurduar)	0.82a	1.80ab	1.54a	0.02c	11.79ab	41.07a	1.53a	26.92b	0.80a	1.78a	1.47a
SEm (±)	**0.12**	**0.12**	**0.09**	**0.01**	**0.26**	**0.24**	**0.24**	**8.75**	**0.02**	**0.08**	**0.12**
LSD(P ≤ 0.05)	**NS**	**0.19**	**NS**	**0.02**	**0.43**	**0.40**	**0.39**	**14.38**	**NS**	**NS**	**NS**
Note: **Means with the same letter are not significantly different.											

findings reported by Annon. [29], Koziol and Macia [5] and Satpathy et al. [25].

Iron: Results (Table 3) declared that iron content was differed from 1.67% to 1.87%. Highest iron content (1.87%) was obtained in T_2 and lowest content (1.67%) was obtained in T_1. The data were statistically significant under all the treatments except T_3 and T_4 where they were statistically at per. Variation in iron content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Iron content is in line with the findings reported by Annon [29], Koziol and Macia [5] and Satpathy et al. [25].

Copper: It is clear from the data presented in Table 3 that copper content was ranged from 1.43% to 1.54%. Highest copper content (1.54%) was obtained in $T_2$and minimum copper content (1.43%) was obtained in T_1. The data pertaining on copper content were statistically at per under all the treatments. Variation in copper content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Copper content is in line with the findings reported by Satpathy et al. [25].

Sulphur: Table 3 reflected that sulphur content was varied from 0.02% to 0.05%. Highest sulphur content (0.05%) was obtained in T_2 followed by T_1 (0.04%) and lowest sulphur content (0.02%) was obtained in T_4. The data were statistically significant under all the treatments. Variation in sulphur content of different location was recorded might be due to different agro-climatic condition.

Hydrogen: The data presented in Table 3 represented that hydrogen content was ranged from 11.46% to 12.13%. Highest hydrogen content (12.13%) was obtained in T_2 followed by T_3 (12.05%). Lowest content (11.46%) was obtained in T_1. The data on hydrogen content were statistically significant under all the treatments except T_2 and T_3 which were statistically at per. Variation in hydrogen content of different location was recorded might be due to different agro-climatic condition.

Carbon: Results (Table 3) showed that carbon content was differed from 40.49% to 41.21%. Highest carbon content (41.21%) was obtained in $T_3$and minimum content (40.49%) was obtained in T_2.

The data were statistically significant under all the treatments. Variation in carbon content of different location was recorded might be due to different agro-climatic condition.

Nitrogen: It is evident from Table 3 that nitrogen content was ranged from 0.73% to 1.53%. Highest nitrogen content (1.53%) was obtained in T_4 (Indian hog plum of Alipurduar district) followed by T_3 (Indian hog plum of North Dinajpur district) (0.94%). Lowest nitrogen content (0.73%) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data pertaining on nitrogen content were statistically significant under all the treatments except T_1, T_2 and T_3 where the data were statistically at per. Variation in nitrogen content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc.

C/N ratio: Results (Table 3) revealed that C/N ratio was varied from 26.92 to 56.01. Highest C/N ratio (56.01) was obtained in T_1 and lowest C/N ratio (26.92) was obtained in T_4. The data were statistically significant under all the treatments except T_1, T_2 and T_3 where they were statistically at per. Variation in C/N ratio content of different location was recorded might be due to different agro-climatic condition.

Phosphorus: The data presented in Table 3 on phosphorus content declared that phosphorus content was differed from 0.78% to 0.81%. Highest phosphorus content (0.81%) was obtained in T_2 followed by T_4 (0.80%). Lowest phosphorus content (0.78%) was obtained in T_1. The data on phosphorus content were statistically at per under all the treatments. Variation in phosphorus content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Phosphorus content is in line with the findings reported by Annon [29], Koziol and Macia [5] and Satpathy et al. [25].

Potassium: Results showed that potassium content was ranged from 1.70% to 1.78%. Highest potassium content (1.78%) was obtained in T_2 followed by T_4 (1.78%) and lowest content (1.70%) was obtained in T_1. The data were statistically at per under all the treatments. Variation in potassium content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit 1111] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Potassium content is in line with the findings reported by Koziol and Macia [5] and Satpathy et al. [25].

Sodium: Results (Table 3) indicated that sodium content was ranged from 1.38% to 1.51%. Highest sodium content (1.51%) was obtained in T_2 (Indian hog plum of Jalpaiguri district) followed by T_4 (Indian hog plum of Alipurduar district) (1.47%). Minimum sodium content (1.38%) was obtained in T_1 (Indian hog plum of Cooch Behar district). The data were statistically at per under all the treatments. Variation in sodium content of different location was recorded might be due to different agro-climatic condition. Andola and Purohit [11] reported that differences in physico-chemical composition for hog-plum of Chauki and Maletha of Western Himalaya might be due to the variation of soil and environmental factors etc. Sodium content is in line with the findings reported by Koziol and Macia [5] and Satpathy et al. [25].

Conclusion

This study provides an overview of the physico–chemical properties of Indian hog plum fruits. It is a unique fruit with some potential in dietary regimes [30]. It is a good source of antioxidants (Ascorbic acid and Total phenolic) and minerals. This study provides useful information in terms of composition and nutritive content at maturity [31,32]. The composition and nutritive contents are useful considerations when evaluating its uses and potential for value adding. This aspect might have commercial applications during the preparation of a new generation of nutraceutical products.

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Author Affiliations

Top

[1]*Department of Pomology and Post-harvest Technology, India Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, Pin- 736165, India*

[2]*Department of Forestry, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, India*

[3]*Department of Fruits and Orchard Management, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252*