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Characterization of ambarella (*Spondias dulcis*) genotypes based on morphological and physio-biochemical quality attributes

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Ambarella (*Spondias dulcis* Forst.) belongs to the Anacardiaceae family and known by different common name like otaheite apple, golden apple, polynesian plum, caja-manga, jew plum, june plum, pomme cythere and kedongdong. Ambarella is native to Melanesia and through Polynesia it flourishes well in humid tropical and subtropical regions of the world (Mohammed *et al.* 2011). The tree of ambarella is fast growing semi-evergreen, perennial deciduous tree and fruit bear in cluster. Ambarella fruit is known for its nutritional and medicinal value. It has a good source of vitamin C, potassium and folic acid. The fruit has emerged as an interesting addition to the table fruits as well as suitable for pickles, jams, jellies, juices, stew and soup. It is well known for its potential source of natural polyphenols, antimicrobial, cytotoxic and thrombolytic, and antioxidant activities (Minh and Oanh 2018). The peel of the unripe fruit is a good source of pectin (9.76%). The fruit is used to treat anaemia, regulate blood glucose levels, and to cure digestive problems as ambarella contains high amount of dietary fibre (Jayarathna *et al.* 2020). It also has an important role to play as new promising crops due to its consistent use in lesser common farming situations and subsistence agriculture practiced by poor farming households (Dey *et al.* 2016). The tree of ambarella has a wider adaptability as well as thrives efficiently in condition of Manipur with less incident of diseases and pests. However, no specific recommended variety is available, although a wide variability exists throughout valley region of Manipur showing wide variation in fruit quality (sweet and sour), shape, sizes and yield. Hence, there is a great potential for characterization and evaluation of ambarella for identification of potential elite genotypes for effective crop improvement programme in the future. The present experiment was conducted to survey and characterized 21 genotypes of ambarella on the basis of morphological and physio-biochemical characters.

An experiment was conducted during 2022–23 at Central Agricultural University, Imphal, Manipur. A total of 21 genotypes were selected from 7 different locations, viz. Kakching Mayai Leikai, Kakching Turel Wangma, Kakching Chumnang (Kakching district), Khurai Lairikyengbam Leikai (Imphal East District), Yairipok (Thoubal District), Uripok and Singjamei (Imphal West District). The survey and characterization were specially carried out in the valley region of Manipur (24°29'N - 24°49'N and 93°3'E- 93°58'E with an altitude of 776–845 meter amsl)

The observations on fruit and its related parts were recorded at fully ripening stage. The fruit length, fruit width, stone length and stone width were measured using vernier calliper and expressed in cm. The fruit weight was measured by analytical weighing balance and expressed in gram. The qualitative character like fruit bearing intensity, fruit shape, skin colour of ripe fruit, fruit skin surface texture and stone shape were classified base on IPGRI descriptor of mango since it belongs to Anacardiaceae family. Total soluble solids (TSS) content was determined by using digital refractometer. Titratable acidity of the fruit was determined by titrating the fruit juice against 0.1 N NaOH solution using phenolphthalein as an indicator (light pink end point) and expressed as percentage in terms of citric acid. Reducing sugar was estimated by spectrophotometric method described by Somogyi (1952). Total sugar was determined by Lane and Eynon method (Ranganna 1986). Ascorbic acid content was determined by titratation method (Ranganna 1986). Vitamin A content was estimated by calorimetric method (Bayfield and Cole 1980). Yield of the plant was recorded by multiplying the number of fruits counted per tree into the average weight of the fruit. The experiment was laid out in randomized block design (RBD) and data were analysed by using analysis of variance (ANOVA) and differences among the means were determined for significance at $P<0.05$ (Gomez and Gomez 1984).

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Fruit morphological characters: Ambarella genotypes showed significant variations for different characters under studied (Table 1). All the 21 genotypes showed fruiting duration ranges from 236 to 244 days with fruit bearing intensity ranges from medium to high. This finding was in accordance with Geurts *et al.* (1986) who reported 6 to 7 months' duration in fruit ripening. All the genotypes under studied showed golden yellow colour in ripe fruit except P4 showed yellow colour and P10 and P16 also observed pale golden yellow colour. This was conformity with findings of Jayarathna *et al.* (2020). The genotypes under studied showed two morphological fruit shape, viz. oblong and roundish. Hayati *et al.* (2022) also recorded two type of fruit shape oblong type and globose type, while Jayarathna *et al.* (2020) observed oval shape fruit. Similarly, Muralidhara *et al.* (2023) also recorded 8 different fruit shapes in avocado germplasm. Among the selected genotypes under studied, genotypes P19, P8, P3 and P15 showed superior characters in term of fruit weight and size (Table 2). The longest fruit length was observed in P19 (7.09 cm) while minimum in P14 (4.93 cm). The fruit width among the genotypes ranges from 4.49 to 6.65 cm. This was in accordance with findings of Souza *et al.* (2021) and Jayarathna *et al.* (2020) in *S. cytherea* belong to Anacardiaceae family. The maximum fruit weight was found in genotype P19 (158.50 g) while minimum in genotype P14 (64.99 g) and average fruit weight of all genotypes was 110.16 g. These results were in conformity with the findings of Souza *et al.* (2021) and Franquin *et al.* (2005) whose reported average fruit weight of 108.29 g and 116.4 g respectively. The selected genotypes showed significant difference in stone length, stone width and stone weight. The stone weight ranged from 9.75 to 18.50 g. This was in accordance with findings of Souza *et al.* (2021). However, fruit from Tropical Andaman and Nicobar Islands have lesser endocarp weight of 5.93 g which may be due to variation in the genotype and agro-climatic conditions as reported by Bohra and Waman (2017). The maximum stone length and width was observed in P19 (3.65 cm) and (3.62 cm) and minimum in P14 with stone length of 2.20 cm and width of 2.19 cm. In this regard Souza *et al.* (2021) also found that the average length and width of *S. dulcis* endocarp or stone was 26.81 and 24.53 mm respectively . According to Pereira *et al.* (2021) *S. tuberosa* where it belongs to same genus with *S. cytherea.* was also observed to have endocarp length in a range between 19.8 to 20.8 mm and endocarp width ranges from 13.3 to 15.5 mm.

Yield character: The observed data on average yield per plant showed significant variation among the genotypes of 7 locations (Table 2). The maximum yield of 147.10 kg/tree was recorded in genotype P7 followed by P19 (133.44 kg/tree) and P1 (131.47 kg/tree). The minimum yield of 53 kg/tree was observed in genotype P13. However, according to Geurts *et al.* (1986) 800–900 fruits yield per tree with an average weight of 270–450 kg.

Table 1 Fruiting characteristics of ambarella genotypes

Genotype	Number of years to first fruiting	Fruiting duration (day)	Fruit bearing intensity	Fruit shape	Skin colour of ripe fruit	Skin surface texture	Stone shape
P1	4	237	High	Oblong	Golden yellow	Smooth	Roundish
P2	3	237	High	Oblong	Golden yellow	Smooth	Roundish
P3	5	239	High	Oblong	Golden yellow	Smooth	Roundish
P4	3	239	High	Roundish	Yellow	Smooth	Roundish
P5	4	239	High	Roundish	Golden yellow	Smooth	Roundish
P6	3	236	High	Oblong	Golden yellow	Smooth	Ovoid
P7	3	238	High	Roundish	Golden yellow	Smooth	Roundish
P8	3	239	High	Oblong	Golden yellow	Smooth	Roundish
P9	4	237	High	Oblong	Golden yellow	Rough	Roundish
P10	5	237	High	Roundish	Pale golden yellow	Rough	Roundish
P11	3	238	Medium	Oblong	Golden yellow	Smooth	Roundish
P12	4	237	High	Oblong	Golden yellow	Smooth	Ovoid
P13	3	242	Medium	Oblong	Golden yellow	Rough	Roundish
P14	4	241	High	Oblong	Golden yellow	Smooth	Roundish
P15	3	244	Medium	Roundish	Golden yellow	Smooth	Roundish
P16	4	240	Medium	Roundish	Pale golden yellow	Rough	Roundish
P17	3	241	High	Roundish	Golden yellow	Smooth	Roundish
P18	3	240	High	Oblong	Golden yellow	Smooth	Roundish
P19	3	238	High	Roundish	Golden yellow	Smooth	Roundish
P20	4	236	High	Oblong	Golden yellow	Smooth	Ovoid
P21	3	236	High	Roundish	Golden yellow	Smooth	Roundish

Table 2 Observation on yield and physical characters of ambarella genotypes

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Stone weight (cm)	Stone length (cm)	Stone width (cm)	Yield per plant (kg/tree)
P1	5.88	5.11	94.39	12.18	2.73	2.90	131.47
P2	6.24	5.19	105.04	13.06	2.80	2.94	90.71
P3	6.65	5.85	140.05	14.99	3.24	3.08	123.05
P4	6.33	6.26	133.43	14.79	3.49	3.22	103.19
P5	5.79	5.39	96.81	10.75	2.72	2.55	88.65
P6	6.28	5.14	100.57	11.51	3.03	2.97	109.56
P7	5.93	5.32	95.75	10.67	2.51	2.78	147.1
P8	6.75	6.44	149.28	17.22	3.51	3.31	98.63
P9	6.38	6.11	139.45	13.38	3.24	3.14	115.6
P10	5.04	5.18	77.20	9.75	2.27	2.73	67.12
P11	5.65	5.27	88.03	10.82	2.31	2.69	62.15
P12	6.06	5.64	103.22	13.08	2.81	2.75	87.73
P13	6.12	5.14	101.56	12.14	2.85	2.76	53.00
P14	4.93	4.49	64.99	9.58	2.20	2.19	58.8
P15	6.62	6.24	142.15	16.07	3.35	3.43	79.04
P16	5.90	5.49	102.69	11.73	3.05	2.85	57.89
P17	6.06	5.71	104.44	12.56	2.83	3.20	121.2
P18	5.76	5.29	88.06	10.99	2.87	3.13	77.44
P19	7.09	6.65	158.50	18.50	3.65	3.62	133.44
P20	6.14	5.20	99.04	13.25	2.80	2.96	99.03
P21	6.34	5.45	128.79	14.39	3.09	2.80	129.37
Mean	6.09	5.55	110.16	12.92	2.92	2.95	96.87
SEm±	0.07	0.04	1.54	0.32	0.05	0.05	-
CD (P=0.05)	0.21	0.12	4.41	0.92	0.13	0.13	-

Biochemical characters: Wide ranges of variability were observed among the ambarella genotypes under studied with respect to fruit biochemical characters (Table 3). The TSS content among the genotypes ranges from 10.93°Brix recorded to 17°Brix. The maximum TSS content was recorded in genotype P17 (17°Brix) followed by P11 (16.30°Brix) while minimum in P13 (10.93°Brix). In this regard, Souza *et al.* (2022), and Jayarathna *et al.* (2020) evaluated lesser content of TSS (7.5 to 11.48◦ Brix) owing to variation in genotypes or physiological factors. The amount of titratable acidity content was observed maximum in genotype P13 (2.05%) followed by P5 (1.78%) and minimum in P12 (0.51%). Similarly, Jayarathna *et al.* (2020) reported titratable acidity content of 1.08% in fully ripe fruit and Angami *et al.* (2020) also observed titratable acidity of 2.44%. A considerable amount of variation was observed in respect to sugar content among different genotypes. The range of variations in total sugar was 5.60 to 6.84% and reducing sugar was 2.89 to 3.54%. This finding of total sugar and reducing sugar were in accordance with Angami *et al.* (2020). The vitamin C content among the genotypes ranged between 16.67 mg/100 g to 40.81 mg/100 g in which highest content was recorded in genotype P7 (40.81 mg/100 g) and lowest in P6 (16.67 mg/100 g). Similarly, significant variation in vitamin C content among the genotypes was reported by Souza *et al.* (2022). The findings of Franquin *et al.* (2005), Jayarathna *et al.* (2020) and Imen *et al.* (2023) also come in conformity with the present investigation. Vitamin A content of ambarella was maximum in genotype P19 (0.62 mg/100 g) followed by P3 (0.58 mg/100 g) and minimum in P11 (0.46 mg/100 g). However, Mattietto *et al.* (2011) reported Vitamin A of 223.0 (RE.100/g) in *S. mombin* where they belong to same genus.

Based on the findings obtained from the present investigation, it can be concluded that, the genotypes of ambarella exhibited noticeable variation among them. The genotype P19 found superior in terms of fruit weight and size. Genotype P7 showed desirable yield character and genotype P17 showed excelled character in terms of TSS and sugar content. Thus, genetic diversity was observed from this exploration of germplasm in valley region of Manipur of this important underutilized fruit crop of ambarella which can be used for crop improvement programmed in the future .

SUMMARY

Survey and characterization of ambarella found in valley region of Manipur was conducted during 2022–23 to identified superior genotypes for yield and various physio-

Table 3 Observation on biochemical parameters of ambarella genotypes

Treatment	TSS (°Brix)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Vitamin C (mg/100 g)	Vitamin A (mg/100 g)
P1	15.07	1.16	6.42	3.31	25.00	0.54
P2	13.67	1.02	6.17	3.16	28.42	0.50
P3	13.93	0.96	6.25	3.26	25.00	0.58
P4	13.00	1.68	5.89	3.10	24.18	0.53
P5	14.23	1.78	6.19	3.23	25.00	0.49
P6	12.60	1.90	5.97	3.06	16.67	0.53
P7	14.17	0.87	6.33	3.22	40.81	0.52
P8	15.13	0.65	6.37	3.30	35.42	0.57
P9	14.83	0.94	6.39	3.31	36.25	0.51
P10	14.20	0.96	6.27	3.26	37.50	0.49
P11	16.30	0.60	6.66	3.46	29.17	0.46
P12	15.40	0.51	6.38	3.31	31.25	0.56
P13	10.93	2.05	5.60	2.89	31.94	0.49
P14	12.00	1.06	5.79	2.98	24.18	0.53
P15	15.77	0.85	6.32	3.28	22.31	0.56
P16	13.93	1.15	6.23	3.22	31.39	0.48
P17	17.00	0.89	6.84	3.54	22.10	0.51
P18	14.20	1.00	6.27	3.23	26.39	0.51
P19	15.47	0.94	6.56	3.36	29.86	0.62
P20	14.00	0.86	6.25	3.19	20.14	0.56
P21	16.17	1.07	6.59	3.43	31.94	0.51
Mean	14.38	1.09	6.27	3.24	28.33	0.53
SEm±	0.17	0.02	0.02	0.02	0.96	0.01
CD (P=0.05)	0.48	0.05	0.06	0.05	2.74	0.03

biochemical characters having sweeter taste and high yield traits. Genotype P7 gave maximum yield (147.10 kg/tree) and P19 has maximum fruit weight (158.50 g), length (7.09 cm) and width (6.65 cm). However, genotypes P17 has highest TSS (17^0Brix), total sugar (6.84%), P7 highest vitamin C (40.81 mg/100 g) and P19 gave highest vitamin A content (0.62 mg/100 g). Hence, genetic diversity of ambarella was observed among the selected genotypes in valley region of Manipur for screening elite genotypes for the future.

REFERENCES

Angami T, Wangchu L, Debnath P, Sarma P, Singh B, Singh A K, Singh S, Hazarika B N, Singh M C and Chhetri A. 2020. Determination of nutritional content of *Spondias* species from the eastern Himalaya. *International Research Journal of Pure and Applied Chemistry* **21**(7): 12–17.

Bayfield R F and Cole E R. 1980. Colorimetric estimation of vitamin a with trichloroacetic acid. *Methods in Enzymology* **67**: 180–95.

Bohra P and Waman A A. 2017. *Spondias dulcis* L.: An important acidulant species in Bay Islands. *International Journal of Forest Usufructs Management* **18**(1): 25–29.

Dey K, Ghosh A, Dey A N, Bhowmick N and Bauriv F K. 2016. 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. *Vegetos* **29**(4).

Franquin S, Marcelin O, Aurore G, Reynes M and Brillouet J M. 2005. Physicochemical characterisation of the mature-green Golden apple (*Spondias cytherea* Sonnerat). *Fruits* **60**(3): 203–10.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*, 2nd edn. John Wiley and Sons, New York.

Geurts F, Blaak G and El-Baradj T. 1986. Anacardiaceae– *Spondias cytherea* (Ambarella). *Genetic Resources of Tropical and Subtropical Fruits and Nuts* (excluding *Musa)*, pp. 18–19. International Board for Plant Genetic Resources Rome, Italy.

Hayati I, Hartana A, Djuita N R and Ariyanti N S. 2022. Morphological variation of kedondong (*Spondias dulcis* Parkinson) in central part of Sumatra. *Floribunda* **6**(8): 315–23.

Imen H, Anissa R, Imen T and Chafik H. 2023. Determination of healthy natural antioxidants in selected muskmelon (*Cucumis melo*) cultivars. *The Indian Journal of Agricultural Sciences* **93**(3): 279–83.

Jayarathna P L, Jayawardena J A E C and Vanniarachchy M P G. 2020. Identification of physical, chemical properties and flavour profile of *Spondias dulcis* in three maturity stages. *International Research Journal of Advanced Engineering and*

Science **5**(1): 208–11.

Mattietto R A and Matta V M. 2011. Caja (*Spondias mombin* L.). *Postharvest Biology and Technology of Tropical and Subtropical Fruits,* pp. 330–53. Woodhead Publishing.

Muralidhara B M, Sakthivel T, Karunakaran G, Venugopalan R, Venkataravanappa V, Savadi S, Nayaka V S, Shivashankara K S and Honnabyraiah M K. 2023. Survey, collection and characterization of Indian avocado (*Persea americana*) germplasm for morphological characters. *The Indian Journal of Agricultural Sciences* **93**(2): 139–44. https://doi.org/10.56093/ijas.v93i2.132039

Minh N P and Oanh T T K. 2018. Fermentation of ambarella (*Spondias dulcis*) wine. *International Journal of Applied Engineering Research* **13**(2): 132–27.

Mohammed M, Ahmad S H, Bakar R A and Abdullah T L. 2011. Golden apple (*Spondias dulcis* Forst. syn. *Spondiascytherea* Sonn.). *Postharvest Biology and Technology of Tropical and Subtropical Fruits,* pp. 159–79. Woodhead Publishing.

Pereira F R A, Pereira W E, Pessoa A M D S and Vasconcelos E S A G D. 2021. Biometry in Umbu fruits from the semi-arid region of Paraiba. *Revista Brasileira de Fruticultura* **43**(6): 1–11.

Ranganna S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*, 2nd edn. Tata MeGraw-Hill Publ. Co. New Delhi, India.

Somogyi M. 1952. Estimation of sugar by calorimetric method. *Journal of Biochemical Chemistry*, pp. 200–45.

Souza P H M D, Gomes F R, Silva G Z D, Rocha D I, Cruz S C S and Silva D F P D. 2021. Morphological characterization of fruits, endocarp, seed and seedlings of caja-manga (*Spondias dulcis*). *Revista Ceres, Vicosa* **68**(3): 239–44.

Souza P H M D, Monteiro V A, Rodrigues C D M, Gomes F R, Oliveira J A A and Silva D F P D. 2022. Fruit quality and genetic diversity of *Spondias dulcis* accessions. *Revista Ceres, Viçosa* **69**(2): 180–86.