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Standardization of Technology for Development, Physico-chemical properties, Organoleptic acceptability and Storage of Value Added Kiwi Fruit Squash (*Actinidia deliciosa*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A present study was conducted for the development of kiwi fruit squash *(Actinidia deliciosa).* The study was constituted to evaluate the effect of different treatments on the physico-chemical and organoleptic properties and prolonged storage life of kiwi fruit squash. The experiment was carried

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out in the Post Harvest Laboratory, Learning Integrated Livelihood Forestry, Agronomy & Rural Management, Ministry of Uttarakhand Dehradun, during the year 2022-24. The experiment was laid out in 2x2 Factorial Randomized Block Design with 3 replications. Based on the statistical analysis, the experiment shows that Bruno variety (V_3) performed best in terms of physico-chemical properties *viz.,* TSS, acidity, moisture, vitamin C, and reducing sugar, followed by the Abbott variety (V_2). The study indicated that Abbott variety (V_2) was most acceptable in terms of organoleptic properties *viz.,* colour & appearance, taste & flavour, texture and overall acceptability, followed by the Hayward variety (V_1). On the other hand microbial analysis of the squash shows the stored life which is up to 60 days without any microbial contamination. The squash maintained acceptability for up to 2 months when diluted with water, making it suitable as a refreshing beverage for all age groups.

Keywords: Kiwi; organoleptic properties; physico-chemical properties; storage; squash.

1. INTRODUCTION

Kiwi fruit belongs to the family of Actinidiaceae and genus Actinidia. The other names of kiwi fruit are Macaque peach, Mihoutau, and Chinese gooseberry. It is nearly 3 inches long and has a brown hairy peel containing green flesh and white pulp in the center with many minute black edible seeds [1]. It is one of the newest fruit crops to gain international commercial importance [2]. 56.5% of the total produce (i.e., 8.5 thousand tons) of kiwi fruit in India comes from Arunachal Pradesh followed by Nagaland. The plant grows best in either full sun or light shade and generally needs slightly acidic soil that has a pH between 6.0 and 6.5. Kiwi is mostly eaten as fresh, while some are also processed into juices, purees, candies, fortified drinks, dehydrated, frozen and lyophilized products, leather, spirits, and syrups [3].

It contains ample amount of nutrients that provide health benefits to the one's consuming it by improving the digestive, immune, and metabolic health of an individual. It is a potent source of vitamins such as vitamins A, B, C, E, and K and notably appreciable levels of dietary fiber, folate, potassium, and other minerals [4]. It consists of various phytochemicals such as carotenoids, flavonoids, anthocyanins, and lutein. It possesses various pharmacological properties such as anti- cancerous, anti- diabetic, antifertility, hepatoprotective, antiulcer, prevention of cataracts, and macular degeneration [5].

The fruit has high nutritive and medicinal value. It is a rich source of vitamin B & C and minerals like phosphorus, potassium & calcium. Fruits are consumed fresh or combined with other fruits in salads and desserts. It is also used for preparation of squash and wine. Recent studies also have confirmed the health benefits associated with its consumption [6]. Antioxidants contained in kiwifruit reduce oxidative stress and support the cardiovascular system [7].

The use of kiwi fruit as a suitable option for preparation of squash because kiwis are high in Vitamin C and dietary fiber and provide a variety of health benefits. This tart fruit can support heart health, digestive health, and immunity. The kiwi is a healthy choice of fruit and is rich with vitamins and antioxidants. Its tart flavor, pleasing texture, and low calorie count make it a delicious and healthy option for snacking, sides, or a unique dessert. Therefore, in the present study preparation of kiwi fruit squash will attempted for the formulation of a unique delightful and delicious beverage with improved organoleptic and nutritive value.

2. MATERIALS AND METHODS

The present investigation was carried out in the Post Harvest Laboratory, Learning Integrated Livelihood Forestry, Agronomy & Rural Management, Ministry of Uttarakhand Dehradun during 2022-2024. The experiment was laid out in the 2x2 Factorial Randomized Block Design (FRBD) which comprises of three replications. The treatments were T_0:V_1 (Hayward + Sugar), T_0:V_2 (Abbott + Sugar), T_0:V_3 (Bruno + Sugar), T_1:V_1 (Hayward + Sugar + Ginger + Mint), T_1:V_2 (Abbott + Sugar+ Ginger + Mint), T_1:V_3 (Bruno + Sugar + Ginger + Mint), T_2:V_1 (Hayward + Honey + Ginger + Mint), T_2:V_2 (Abbott + Honey + Ginger + Mint), T_2:V_3 (Bruno + Honey + Ginger + Mint), T_3:V_1 (Hayward + Jaggery + Ginger + Mint), T_3:V_2 (Abbott + Jaggery + Ginger + Mint), T_3:V_3 (Bruno + Jaggery + Ginger + Mint). Three

varieties of kiwi *viz.,* hayward, abbott and bruno, were selected for the preparation of squash. The kiwi fruits used to produce the kiwi squash were sourced from the ICAR- Central Institute of Temperate Horticulture, Mukteshwar, Uttarakhand, while the remaining ingredients were procured from the local market in Dehradun.

2.1 Preparation and Storage of Kiwi Squash

The process of making kiwi squash began with selecting and washing fresh, ripe kiwifruits to remove any dirt and contaminants. After trimming away damaged or bruised portions, the kiwis were cut or grated for juice extraction. The grated or chopped kiwis were processed through a pulper and the extracted juice was strained through a muslin cloth for clarity. The volume of the juice was measured, and a syrup was prepared by dissolving different sweeteners *viz.,* sugar, jaggery and honey, with citric acid. The syrup was heated gently to dissolve the sweeteners completely and then strained. The kiwi juice was then mixed with the prepared syrup, and sodium benzoate was added as a preservative. The mixture was bottled in sterilized glass bottles with appropriate headspace, sealed airtight and stored in a cool, dry place away from direct sunlight to ensure optimal quality and shelf life.

2.2 Evaluation of Physico-chemical Properties of Kiwi Squash

The kiwi squash was evaluated for various physico-chemical properties *viz.,* TSS, acidity, moisture, vitamin C and reducing sugar. TSS content was analyzed using a hand refractometer, while the acidity content was analyzed by titration method. The moisture content was analyzed using the oven dry method. The vitamin C content was analyzed by 2, 6-dicholorophenol-inndophenol visual titration method. The total sugar content was analyzed by lane and eynon method.

2.3 Evaluation of Organoleptic Properties of Kiwi Squash

The kiwi squash was evaluated by a panel of five judges to determine colour & appearance, flavour & taste, texture and overall acceptability. Each sample was evaluated and given a score by the panelists on the scale of 1-9 using hedonic rating method.

3. RESULTS AND DISCUSSION

3.1 Physico-chemical Properties of Kiwi Squash

The prepared squash samples were stored for a period of 60 days and analyzed at five different intervals: 1 day, 15 days, 30 days, 45 days and 60 days, to assess changes in various physico-chemical properties *viz.,* TSS, acidity, moisture, vitamin C and reducing sugar over prolonged storage. The data recorded on the effect of different treatments on physico-chemical properties of kiwi squash over prolonged storage is presented in Tables 1 and 2.

Based on the physico-chemical analysis, it was observed that after 60 days of storage, the maximum TSS of 46.67 °Brix was recorded in treatment T_3:V_3 (Bruno + Jaggery + Ginger + Mint), followed by 44.67 °Brix in T_3:V_1 (Hayward + Jaggery + Ginger + Mint). In contrast, the minimum TSS of 33.00 °Brix was recorded in treatment T_0:V_1 (Hayward + Sugar). The decreasing trend of TSS was observed during stoarge. This might be due to increase in moisture content and conversion of polysaccharides to monosaccharides. Similar results were reported by Shivaswamy et al., [8] in guava squash incorporated with peanut milk.

Based on the physico-chemical analysis, it was observed that after 60 days of storage, the maximum acidity of 0.86% was recorded in treatments T_3:V_1 (Hayward + Jaggery + Ginger + Mint) and T_3:V_2 (Abbott + Jaggery + Ginger + Mint), followed by 0.82% in T_1:V_3 (Bruno + Sugar + Ginger + Mint). The minimum acidity of 0.35% was recorded in treatment T_0:V_1 (Hayward + Sugar). The increase in acidity during storage was noted. The decrease in pH during storage may be attributed to increase in acids due to formation of organic acids by the degradation of ascorbic acid. Similar results were reported by Tiwari, [9] in chinese orange squash.

Based on the physico-chemical analysis, it was observed that after 60 days of storage, the maximum moisture content of 60.90% was recorded in treatment T_0:V_1 (Hayward + Sugar), followed by 56.19% in T_3:V_3 (Bruno + Jaggery +

Ginger + Mint). In contrast, the minimum moisture content of 46.76% was recorded in treatment T_1:V_3 (Bruno + Sugar + Ginger + Mint). Increase in moisture content was observed during storage of squash. This might be due to fermentation of sugar into alcohol, carbohydrates and water. Similar results were reported by Shivaswamy et al., [8] in guava squash incorporated with peanut milk.

Based on the physico-chemical analysis, it was observed that after 60 days of storage, the maximum vitamin C content of 8.62 mg/100g was recorded in treatment T_3:V_2 (Abbott + Jaggery + Ginger + Mint), followed by 7.85 mg/100g in T_0:V_2 (Abbott + Sugar). In contrast, the minimum vitamin C content of 1.90 mg/100g was recorded in treatment T_0:V_1 (Hayward + Sugar). The decrease in ascorbic acid content during storage was observed. This might be due to oxygen cause oxidation of ascorbic acid and degrades it into dehydroascorbic acid, which might be the reason for its decrease in squash during storage. Similar results were reported by Zulfkar et al., [10] in seabuckthorn squash.

Based on the physico-chemical analysis, it was observed that after 60 days of storage, the highest reducing sugar content of 20.35% was observed in treatment T_1:V_2 (Abbott + Sugar + Ginger + Mint), followed by 18.44% in T_0:V_3 (Bruno + Sugar). Conversely, the lowest reducing sugar content of 5.11% was recorded in treatment T_0:V_1 (Hayward + Sugar). The decreasing trend in reducing sugars was noted with increasing storage duration, aligning with the findings reported by Bhardwaj and Mukherjee [11].

3.2 Organoleptic Properties of Kiwi Squash

The prepared squash samples were stored for a period of 60 days and analyzed at five different intervals: 1 day, 15 days, 30 days, 45 days and 60 days, to assess changes in various organoleptic properties *viz.,* colour & appearance, taste & flavour, texture and overall acceptability over prolonged storage. The data recorded on the effect of different treatments on organoleptic properties of kiwi squash over prolonged storage is presented in Tables 3 and 4.

The sensory evaluation showed a slightly decreasing trend in the organoleptic properties after 60 days of storage. The maximum score for colour and appearance was 8.75, recorded in treatment T_3:V_2 (Abbott + Jaggery + Ginger + Mint), followed by 8.72 in treatment T_3:V_1 (Hayward + Jaggery + Ginger + Mint). In contrast, the minimum score for colour and appearance was 6.83, recorded in treatment T_2:V_1 (Hayward + Honey + Ginger + Mint). Similar results were reported by Muslim et al., [12] in mango squash & Din et al., [12] in mango and guava blended squash. The data also revealed that the maximum score for flavour and taste was 8.68, observed in treatment T_3:V_2 (Abbott + Jaggery + Ginger + Mint), followed by 8.63 in treatment T_3:V_1 (Hayward + Jaggery + Ginger + Mint). However, the minimum score for flavour and taste was 7.17, recorded in treatment T_0:V_2 (Abbott + Sugar). Similar results were reported by Din et al., [13] in mango and guava blended squash. Furthermore, the maximum score for texture was 8.59, recorded in treatment T_1:V_2 (Abbott + Sugar + Ginger + Mint), followed by 8.35 in treatment T_3:V_1 (Hayward + Jaggery + Ginger + Mint). Conversely, the minimum score for texture was 6.70, observed in treatment T_2:V_1 (Hayward + Honey + Ginger + Mint). Similar results were reported by Relekar et al., [14] in sapota squash during storage. Regarding the overall acceptability, the maximum score was 8.59, recorded in treatment T_3:V_1 (Hayward + Jaggery + Ginger + Mint), followed by 8.56 in treatment T_3:V_2 (Abbott + Jaggery + Ginger + Mint). However, the minimum score for overall acceptability was 7.06, observed in treatment T_0:V_3 (Bruno + Sugar). Similar results were reported by Din et al., [13] in mango and guava blended squash.

3.3 Microbial Analysis of Kiwi Squash

The microbial analysis indicated that no coliform bacteria were detected in any of the samples during prolonged storage days. After 60 days of storage, the maximum yeast and mold counts of 2.33 (×100 cfu/ml) were recorded in treatments T_1:V_2 (Abbott + Sugar + Ginger + Mint) and T_3:V_2 (Abbott + Jaggery + Ginger + Mint), followed by 2.00 (×100 cfu/ml) in treatments T_0:V_1 (Hayward + Sugar), T_0:V_3 (Bruno + Sugar), and T_2:V_3 (Bruno + Honey + Ginger + Mint). In contrast, the minimum yeast and mold counts of 1.00 (×100 cfu/ml) were recorded in treatments T_1:V_1 (Hayward + Sugar + Ginger + Mint), T_1:V_3 (Bruno + Sugar + Ginger + Mint), and T_2:V_2 (Abbott + Honey + Ginger + Mint). Furthermore, the

Table 1. Effect of different treatments on total soluble solids, acidity and moisture content of kiwi squash over prolonged storage

Treatments	TSS (ºBrix)					Acidity (%)					Moisture (%)				
	0 Days	15 Days	30 Days	45 Days	60 Days	0 Days	15 Days	30 Days	45 Days	60 Days	0 Days	15 Days	30 Days	45 Days	60 Days
T_0:V_1	44.33	43.00	34.33	33.00	33.00	1.49	0.96	0.67	0.21	0.35	57.47	58.26	59.04	61.29	60.90
T_0:V_2	44.67	42.67	39.67	38.00	36.67	1.48	1.29	1.32	0.63	0.60	50.63	51.78	52.18	52.53	52.66
T_0:V_3	45.00	42.67	41.67	41.00	40.33	1.35	1.29	1.11	0.63	0.59	50.34	51.39	51.80	52.67	53.48
T_1:V_1	44.00	42.33	39.00	37.33	36.33	1.29	1.17	0.87	0.77	0.53	51.26	51.37	51.73	52.16	52.59
T_1:V_2	44.33	42.67	40.33	38.67	38.33	1.33	1.30	1.25	0.75	0.64	50.53	51.09	51.38	51.51	51.94
T_1:V_3	45.00	43.33	42.33	42.00	40.67	1.38	1.52	0.95	0.71	0.82	44.62	45.98	46.20	46.40	46.76
T_2:V_1	44.33	42.67	41.67	40.33	39.67	1.77	1.49	1.07	0.83	0.76	50.89	51.80	52.91	54.63	55.05
T_2:V_2	43.67	42.67	39.67	38.00	38.67	1.86	1.29	1.24	0.86	0.71	51.51	51.91	52.56	53.86	54.35
T_2:V_3	44.67	42.67	39.67	38.67	38.00	1.94	1.73	1.30	0.89	0.74	51.13	52.38	53.03	54.74	56.17
T_3:V_1	47.33	47.00	45.67	45.00	44.67	2.56	1.90	1.60	1.09	0.86	51.59	52.28	53.63	54.82	55.98
T_3:V_2	46.67	44.67	41.33	40.00	39.67	2.05	1.88	1.52	1.17	0.86	50.51	51.68	52.72	54.26	54.20
T_3:V_3	49.00	48.67	47.67	47.00	46.67	1.49	1.36	0.96	0.79	0.65	50.56	51.57	53.08	54.37	56.19
Mean	45.25	43.75	41.08	36.58	39.39	1.66	1.43	1.24	0.77	0.67	50.92	51.79	52.52	53.54	54.18
C.V	1.55	1.7	1.81	1.03	1.07	11.24	10.5	10.74	11.17	15.21	1.11	1.37	1.34	1.46	0.83
F-test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
C.D 5%	1.19	1.25	1.25	0.7	0.71	0.319	0.252	0.21	0.147	0.174	0.957	1.147	1.2	1.329	0.766

Table 2. Effect of different treatments on vitamin C and reducing sugar content of kiwi squash over prolonged storage

Treatments	Vitamin C (mg/100g)					Reducing Sugar (%)				
	0 Days	15 Days	30Days	45 Days	60 Days	0 Days	15 Days	30 Days	45 Days	60 Days
$T_0:V_1$	10.34	9.93	8.30	5.87	1.90	8.30	6.21	5.59	5.35	5.11
$T_0:V_2$	13.72	10.80	11.51	9.78	7.85	20.85	15.76	12.73	11.17	10.00
$T_0:V_3$	13.83	11.95	10.43	8.55	4.66	26.66	25.29	21.63	20.52	18.44
$T_1:V_1$	14.64	9.99	8.51	4.81	3.68	14.96	13.54	10.17	10.11	9.77
$T_1:V_2$	14.77	11.01	8.20	6.85	3.68	25.57	24.48	23.76	22.18	20.35
$T_1:V_3$	17.85	13.83	11.72	9.65	6.15	16.71	15.56	14.62	13.68	13.24
$T_2:V_1$	14.02	11.06	8.12	5.90	3.36	18.67	18.41	17.47	17.09	16.29
$T_2:V_2$	16.05	10.92	10.41	8.43	4.58	14.51	13.70	13.30	12.62	12.38
$T_2:V_3$	14.94	12.73	10.31	7.49	4.59	18.75	17.47	17.13	16.26	15.56
$T_3:V_1$	16.04	13.69	12.29	10.05	7.27	10.51	8.69	7.83	7.33	7.12
$T_3:V_2$	18.81	14.55	13.75	10.96	8.62	10.62	8.71	8.29	7.57	7.36
$T_3:V_3$	18.26	15.79	12.95	11.21	7.72	9.44	9.28	8.69	8.21	8.11
Mean	15.27	12.18	10.54	8.36	5.33	16.29	14.75	13.43	12.67	11.97
C.V	12.1	10.64	12.99	17.18	22.41	2.32	1.9	3.59	3.21	2.59
F-test	S	S	S	S	S	S	S	S	S	S
C.D 5%	3.13	2.19	2.32	2.41	2.02	0.642	0.476	0.817	0.691	0.527

Table 3. Effect of different treatments on colour and appearance, taste and flavour of kiwi squash over prolonged storage

Treatments	Colour and appearance					Flavour and taste				
	0 Days	15 Days	30 Days	45 Days	60 Days	0 Days	15 Days	30 Days	45 Days	60 Days
T_0:V_1	8.80	8.77	8.67	8.62	8.56	8.81	8.74	8.61	8.57	8.49
T_0:V_2	7.60	7.57	7.45	7.38	7.18	7.62	7.53	7.39	7.28	7.17
T_0:V_3	7.70	7.51	7.39	7.26	7.22	7.74	7.46	7.35	7.24	7.19
T_1:V_1	8.16	8.04	7.95	7.90	7.82	8.19	8.04	7.90	7.83	7.78
T_1:V_2	9.00	8.95	8.89	8.77	8.68	9.00	8.90	8.56	8.43	8.31
T_1:V_3	8.67	8.62	8.55	8.43	8.39	8.64	8.59	8.47	8.39	8.25
T_2:V_1	7.17	7.13	6.98	6.89	6.83	9.00	8.93	8.82	8.74	8.54
T_2:V_2	8.63	8.53	8.47	8.43	8.39	8.70	8.50	8.40	8.34	8.27
T_2:V_3	7.80	8.01	7.93	7.89	7.82	7.85	7.75	7.63	7.56	7.46
T_3:V_1	8.95	8.90	8.87	8.83	8.72	8.93	8.89	8.78	8.70	8.63
T_3:V_2	9.00	8.95	8.88	8.82	8.75	9.00	8.95	8.88	8.80	8.68
T_3:V_3	8.93	8.83	8.78	8.73	8.67	8.90	8.82	8.73	8.68	8.57
Mean	8.37	8.32	8.23	8.16	8.09	8.53	8.42	8.29	8.21	8.11
C.V	2.63	0.63	0.42	0.45	0.87	2.44	0.62	0.63	0.35	0.94
F-test	S	S	S	S	S	S	S	S	S	S
C.D 5%	0.37	0.09	0.06	0.06	0.12	0.35	0.09	0.09	0.05	0.13

Table 4. Effect of different treatments on texture and overall acceptability of kiwi squash over prolonged storage

Treatments	Texture					Overall acceptability				
	0 Days	15 Days	30 Days	45 Days	60 Days	0 Days	15 Days	30 Days	45 Days	60 Days
$T_0:V_1$	8.83	8.74	8.63	8.58	8.33	8.81	8.75	8.64	8.59	8.46
$T_0:V_2$	7.77	7.53	7.41	7.37	6.98	7.66	7.54	7.42	7.34	7.11
$T_0:V_3$	7.73	7.46	7.37	7.24	6.78	7.72	7.48	7.37	7.25	7.06
$T_1:V_1$	8.20	8.04	7.90	7.82	7.46	8.18	8.04	7.92	7.85	7.69
$T_1:V_2$	8.96	8.88	8.82	8.77	8.59	8.99	8.91	8.76	8.66	8.53
$T_1:V_3$	8.60	8.55	8.51	8.29	8.12	8.64	8.59	8.51	8.37	8.25
$T_2:V_1$	7.27	7.03	6.92	6.89	6.70	7.81	7.70	7.57	7.51	7.36
$T_2:V_2$	8.69	8.49	8.46	8.36	8.25	8.67	8.51	8.44	8.38	8.30
$T_2:V_3$	7.88	7.54	7.37	7.24	6.95	7.84	7.77	7.64	7.56	7.41
$T_3:V_1$	8.92	8.79	8.54	8.41	8.35	8.93	8.86	8.73	8.65	8.57
$T_3:V_2$	8.94	8.79	8.59	8.42	8.26	8.98	8.90	8.78	8.68	8.56
$T_3:V_3$	8.90	8.11	7.84	7.88	7.58	8.91	8.59	8.45	8.43	8.27
Mean	8.39	8.16	8.03	7.94	7.7	8.43	8.3	8.19	8.11	7.96
C.V	2.34	2.27	0.76	0.66	0.75	3.55	4.09	4.49	4.54	5
F-test	S	S	S	S	S	S	S	S	S	S
C.D 5%	0.33	0.31	0.1	0.09	0.1	0.5	0.57	0.62	0.62	0.67

maximum total plate count (TPC) of 9.00 was observed in treatment T_2:V_3 (Bruno + Honey + Ginger + Mint) after 60 days of storage, followed by 8.00 in treatment T_3:V_2 (Abbott + Jaggery + Ginger + Mint). However, the minimum TPC of 2.67 was recorded in treatment T_0:V_1 (Hayward + Sugar).

4. CONCLUSION

It is concluded that, the Bruno variety (V_3) performed best in terms of physico-chemical properties *viz.,* TSS, acidity, moisture, vitamin C and reducing sugar, followed by Abbott variety (V_2). The sensory evaluation revealed that Abbott variety (V_2) was most acceptable in terms of colour & appearance, taste & flavour, texture and overall acceptability, followed by the Hayward variety (V_1). The microbial analysis indicated that the kiwi fruit squash could be stored for up to 60 days without any microbial contamination.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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