Standarization of Technology for Development, Physico chemical properties, Organpleptic acceptability and Storage of Value added Kiwi fruit Squash (*Actinidia deliciosa)*

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 propertiesand prolonged storage life of kiwi fruit squash. The experiment was carried 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 2x2Factorial 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 handmicrobial 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

Kiwifruit *(Actinidia deliciosa)* is well known as a nutritious fruit due to its high contents of ascorbic acid (vitamin C), potassium, folic acid and antioxidants (e.g. polyphenols, carotenoids). Kiwifruit is perhapes the best known nutritious fruit amongst the other soft fruits. As its name indicates, the plant is of chinese origin where the vigorous woody vine. The kiwifruit is rusty brown with hairy surface, oblong in shape look like a sapota fruit. The brown hairs disappear by rubbing in muslin cloth/gunny bag after harvesting. A ripe fruit is refreshing, delicate flavour with pleasing aroma and high nutritive value. The nutritive value and flavour are retained when the fruit is processed to squash, jam, jelly or preserves.The most consumed are the Green kiwifruit *(Actinidia deliciosa),* the Sungold*(A. chinensis)***(Lopez-Sobaler*et al.*, 2016)** and the mini kiwifruit (*A. arguta*), a variant of the first one.

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 **(Sobaler*et al.*, 2016; Baranowska and Szwajgier 2019).** Antioxidants contained in kiwifruit reduce oxidative stress and support the cardiovascular system **(Leontowicz*et al.*, 2016).**

Kiwi fruit is also meant for major health benefits in human being. Maintaining a low sodium intake is essential to lowering blood pressure, however increasing potassium intake may be just as important because of its vasodilation effects. According to the National Health and Nutrition Examination Survey, fewer than 2% of US adults meet the daily 4700 mg recommendation. Reduces chances of asthma to 34%. Good source of vitamin C, Kiwi can help combat the formation of free radicals known to cause cancer. Since oxidative DNA damage is strongly linked to colon cancer, regular kiwi consumption could lower your risk of colon cancer, too. The fiber, potassium, vitamin C and B6 content in kiwi all support heart health. Kiwi's have plenty of fiber, which is already good for digestion. They also contain a proteolytic enzyme called actinides that can help break down protein.

Use of kiwifruit as a suitable option for preparation of squash because Kiwi's 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 2x2Factorial 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). The kiwi fruits used to produce the kiwi squash were sourced from the CITH, Research Centre,Mukteshwar, Uttarakhand, while the remaining ingredients were procured from the local market in Dehradun.

2.1 Extraction of Juice from kiwifruit

The process began with the selection of fresh, ripe kiwi fruits, which were thoroughly washed to remove any dirt, pesticide residues, or other contaminants, followed by trimming to remove any damaged or bruised portions. Next, the prepared fruits were cut or grated to facilitate the extraction of juice. The grated or chopped kiwi was then subjected to juice extraction using appropriate equipment, such as a pulper or juicer. The extracted juice was then strained through a muslin cloth or a fine mesh sieve to remove any pulp or sediment, ensuring a clear and smooth juice.

2.2 Preparation and Storage of Kiwi Squash

The volume of the extracted juice was measured to determine the quantity of other ingredients required for the preparation of the squash. A sugar syrup was prepared by dissolving sugar in water, with the addition of an acid, such as citric acid or lime juice, to enhance the flavor. The syrup was heated just enough to dissolve the sugar completely, and then strained to remove any impurities. The strained sugar syrup was then mixed with the

measured kiwi juice. As a preservative, either 0.6 g of potassium metabisulfite (KMS) or 10 g of sodium benzoate per litre of squash was added to the mixture. This preservative helped to extend the shelf life of the squash by inhibiting the growth of microorganisms and preventing spoilage. The prepared squash was then bottled in sterilized containers, leaving appropriate headspace to allow for expansion. The bottles were then sealed airtight to prevent contamination and maintain the quality of the squash. Finally, the bottled squash was stored in a cool, dry place, away from direct sunlight, to ensure optimal quality and shelf life.

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 Table 1 & 2.

Based on the statistical 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 decrease in TSS of the squash was likely due to the conversion of sugars to acids, as reported in previous studies on mango pudina beverage and mango whey beverages.

Based on the statistical 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).

Based on the statistical 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). The increase in moisture content was likely due to the dehydration phenomenon. Similar results were obtained by **Ferdous and Alim (2018)**, and a decreasing trend of moisture with storage was reported by **Tomkins (1979).**

Based on the statistical 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 likely due to degradation, as reported in previous studies on papaya squash, lemon juice, and bael beverages. The oxidation or irreversible conversion of L-ascorbic acid into dihydroascorbic acid, catalyzed by enzymes like ascorbinase, as well as the presence of air in the storage containers, may have contributed to the decline in vitamin C levels.

Based on the statistical 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). Furthermore, a decreasing trend in reducing sugars was noted with increasing storage duration, aligning with the findings reported by **Bhardwaj and Mukherjee (2011)**.

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, textureand 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 Table 3 & 4.

The sensory evaluation showed a slightly decreasing trend in the scores 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). 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).

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). 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). The sensory evaluation revealed a gradual decrease in overall acceptabilityduring storage due to the increasing time, temperature and enzymes activity at room temperature. This finding was conformity with **Priyanka *et al.*, (2012)** in aonla beverages.

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 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).

Table 1: Effect of different treatments on physico-chemical properties *viz.*, total soluble solids, acidity and moistureover prolonged storage

Treatments	TSS (^{0}Brix)					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 physico-chemical properties *viz.*, total soluble solids, acidity and moistureover 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 organoleptic properties *viz.*, colour and appearance, taste and flavour 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 organoleptic properties *viz.*, texture and overall acceptability 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**

CONCLUSION

From the Present study 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).Wheras the evaluation 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). The Microbial analysis shows the Kiwi fruit squash could be stored for up to 60 days without any microbial contamination.

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