International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 4, Issue 8, 2025
DOI: https://doi.org/10.38124/ijsrmt.v4i8.713

Development of a Carrot-Based Functional Drink Supplemented with Cucumber Peel Extract

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Publication Date 2025/08/30

Abstract

The increasing demand for functional beverages has led to innovative approaches to enhance nutritional and bioactive properties while reducing food waste. This study explores the incorporation of cucumber peel extract into carrot juice to improve its antioxidant content, sensory appeal, and overall functionality. Four formulations were developed: T_0 (100% carrot juice), T_1 (5% cucumber peel extract in 95% carrot juice), T_2 (10% cucumber peel extract in 90% carrot juice), and T_3 (15% cucumber peel extract in 85% carrot juice). Sodium benzoate was added for microbial stability, and samples were stored at 4°C for 15 days. Physicochemical analyses revealed a pH decline from 6.05 to 5.62 and an increase in titratable acidity from 0.54% to 0.68%. Total soluble solids ranged from 8.96 to 7.65 °Brix. The 10% cucumber peel extract formulation T_2 exhibited the best color stability. Sensory evaluation indicated initial preference for T_2 due to its balanced taste and enhanced functionality, with all formulations remaining acceptable for up to 15 days. These findings highlight the potential of cucumber peel extract as a sustainable ingredient in functional beverages, promoting bioactive enrichment and food waste reduction.

Keywords: *Carrot Juice, Cucumber Peel Extract, Functional Drink, Shelf Life, Bioactive Properties, Physicochemical Properties, Organoleptic Attributes, Waste Reduction.*

I. INTRODUCTION

Rising health-consciousness about fresh natural foods created an escalating need for functional and value-added food products. Today's consumers prefer nutritious food products which provide additional health advantages to their nutritional requirements (Shakeel *et al.,* 2015). The developing market interest in nutritious food products has prompted food researchers and industry stakeholders to investigate new processing methods and natural ingredients for enhancing traditional foods (Yang *et al.,* 2024).

Carrots (Daucus carota L.) stand as one of the world's most popular vegetable crops belonging to the Apiaceous family (Polat and Izli, 2019). The high levels of β-carotene found in carrots serve vital functions in maintaining sight and immune health and overall cell wellness. The flexible characteristics of these fruits enable consumption as fresh foods as well as processing for a wide variety of valuable products spanning from beverages to preserves to sweets and dry powders (Choi et al., 2024). The bioactive compounds found in carrots include β-carotene along with phenolic compounds and vitamins (A, C, and K) due to their rich orange appearance. The antioxidants together with anti-inflammatory and anticancer properties of these compounds have been documented by Duru et al. (2017).

Cucumis sativus (cucumber) belongs to the Cucurbitaceous family while maintaining 95% water content in its composition (Kaur *et al.,* 2022). The peel contains valuable amounts of vitamins A, B6, C and K while containing minerals K, Mg, P along with bioactive compounds including flavonoids, triterpenes, and lignin's. Cucumber peel that people typically discard contains abundant antioxidants alongside phytochemicals that show promise for boosting food product nutrition and functionality. The combination of high lactic acid content and cytoprotective and antioxidant properties makes cucumber peel extract a valuable natural food fortification ingredient (Aljobair, 2024).

People enjoy drinking carrot juice because it offers both nutritious content and pleasant.

II. MATERIALS AND METHODS

Fresh carrots (*Daucus carota* L.) and cucumbers (*Cucumis sativus*) were sourced directly from local agricultural fields in refreshment. The processing techniques and storage environment affect both shelf stability and sensory experiences of this product. Cucumber peel extract fortifies carrot juice through innovative technology to enhance both its functional properties and organoleptic characteristics and its storage life expectancy (Jp, 2023). The combined bioactive compounds of carrots and cucumbers improve the functional properties of juice thereby making it more attractive to health-focused consumers (Gouma *et al.*, 2020).

The research investigates whether adding cucumber peel extract to carrot juice can enhance its physical characteristics and sensory qualities as well as extend its storage stability. This research study aims to establish the best concentration of cucumber peel extract that creates preferred sensory experiences and sustains nutritional value and product freshness in time. A collaborative approach between research scientists uses underutilized cucumber peel waste to develop sustainable food processing and waste management practices.

Bahawalpur. The selected vegetables were carefully picked based on uniform size, color, and absence of physical defects. These raw materials were transported under hygienic conditions to the laboratory for processing.

➢ *Sorting, Washing, and Preliminary Preparation*

The carrots and cucumbers underwent a meticulous sorting process to ensure that any damaged, bruised, or substandard pieces were removed, maintaining only the highest quality produce. Following this, both vegetables were carefully washed under a continuous stream of clean tap water to effectively eliminate any surface impurities, dirt, or residual soil.

This rigorous cleaning process helps preserve their freshness, enhances food safety, and ensures they are ready for further processing or consumption.

➢ *Preparation of Carrot Juice*

The carrots were peeled manually using a stainless steel knife to ensure the removal of undesired surface components. Subsequently, the peeled carrots were diced into uniform 1 cm pieces to facilitate juice extraction. Using a domestic juicer, the juice was extracted and filtered through a double-layered muslin cloth to obtain a clear carrot juice. Residual carrot pomace was collected, blanched, sun- dried, and ground into powder for potential utilization as broiler feed.

➢ *Extraction of Cucumber Peel Juice*

Cucumbers were peeled using a stainless steel knife. The peels were then processed in a domestic juicer to extract cucumber peel juice, which was filtered through muslin cloth to remove any remaining solid particles.

➢ *Juice for Tification with Cucumber Peel Extract*

Carrot juice was fortified with cucumber peel extract in varying proportions. Four formulations were prepared as follows:

T_0: 100% carrot juice (control)

- T_1: 95% carrot juice + 5% cucumber peel extract
- T_2: 90% carrot juice + 10% cucumber peel extract
- T_3: 85% carrot juice + 15% cucumber peel extract

Sodium benzoate (0.1%) was added to each formulation to enhance microbial stability. Each mixture was homogenized and pasteurized at 65–70°C for 10–15 minutes, then cooled to ambient temperature.

➢ *Packaging and Storage*

The juice formulations were packaged in plastic bottles containing equal volumes, and the lids were securely tightened to prevent contamination. The samples were stored at 4°C for 15 days, with quality assessments conducted at intervals of 0, 5, 10, and 15 days.

➢ *Physicochemical Analysis*

- *pH Measurement*

The pH of the juice samples was determined using a calibrated digital pH meter (InoLab pH 7110, Germany). Calibration was performed using standard buffer solutions at pH 4.01, 6.86, and 9.18. Measurements were taken within 50 minutes of juice extraction at a depth of 1.8 cm (Pingen *et al.*, 2016).

- *Total Soluble Solids (°Brix)*

A density meter (DMA 35, Anton Paar, Austria) was used to measure total soluble solids (TSS). A 5 mL sample was drawn into a syringe and injected into the density meter to obtain °Brix readings (Hashem *et al.*, 2014).

- *Titratable Acidity*

The titratable acidity (TA) was determined by titration. A 15 mL juice sample was diluted to 100 mL with distilled water and titrated against 0.1 N NaOH to an endpoint of pH 8.2. Results were expressed as citric acid equivalents (Umair *et al.*, 2019).

- *Instrumental Color Analysis*

The color parameters of the juice samples (L*, a*, b*) were assessed using a digital color analysis application (Color Grab, Loom Tix) (Ye et al., 2015).

Calculations for chroma (C^*), hue angle ($h°$), whiteness (W^*), and color difference (ΔE) were performed using the following equations:

$h° = \text{ATAN}\,(b^*/a^*)$ $C^* = \sqrt{a^{*2} + b^{*2}}$ $W^* = L^* - 3b^*$
$\Delta E = \sqrt{(L1^*-L2^*)^2 + (a1^*-a2^*)^2+(b1^*-b2^*)^2}$

- *Sensory Evaluation*

The sensory attributes of color, taste, odor, and overall acceptability were evaluated by a panel of 15 semi-trained participants comprising faculty and students. A 9-point hedonic scale was used, where 1 indicated extreme dislike and 9 indicated extreme liking. The average scores of sensory parameters were recorded for statistical analysis.

- *Statistical Analysis*

Data were analyzed using a factorial design ANOVA at a 95% confidence level ($p < 0.05$) with Statistic 8.1 software. Results were expressed as Means ± Standard Deviation (SD), and significant differences among treatments were determined using the Least Significant Difference (LSD) test (Badejo *et al.*, 2014).

III. RESULTS AND DISCUSSION

➢ *Physicochemical Analysis of Carrot Juice with Cucumber Peel Extract*

The integration of cucumber peel extract (CPE) into value-added carrot juice (VCJ) significantly altered its physicochemical properties, namely pH, °Brix, and titratable acidity (TA). These changes were meticulously evaluated across various treatments and storage durations to understand the impact of CPE addition on the quality and stability of carrot juice.

- *Effect of the Treatments and Storage on the pH Value of Value-added Carrot Juice:*

The pH of VCJ exhibited significant variation across different treatments ($p < 0.05$). Treatment T0, which served as the control without CPE, recorded the highest pH value, significantly higher than treatments T1, T2, and T3. Specifically, the addition of CPE resulted in a notable decrease in pH, with T1 showing a significantly lower pH than T0, and T3 exhibiting the lowest pH among all samples. The observed pH values ranged from 5.62 ± 0.08 to 6.05 ± 0.04, aligning closely with the pH range of 5.20 to 5.90 reported by Aderinola & Abaire (2019) for carrot juice. The reduction in pH in VCJ can be attributed to the inherently lower pH of CPE, measured at 4.7, which is consistent with the 4.97 pH reported by Chantaro *et al.* (2008). During storage, pH levels in VCJ showed a significant decline over time, although the interaction between treatment and storage days was non-significant. Specifically, pH remained relatively stable at D 0 and D 5 but decreased significantly at D 10 and D 15.

This trend is supported by El- zainy *et al.* (2017), who observed a similar pH reduction in strawberry juice with the addition of cucumber extract, although the extent of pH change varied due to differences in fruit types and extract concentrations. Additionally, the observed decrease in pH over storage aligns with findings by Embaby & Mokhtar (2019) and Hashem *et al.* (2014), who reported pH declines in juice blends due to ongoing chemical reactions.

- *Effect of the Treatments and Storage on the TSS Value of Value-added Carrot Juice:*

The Brix values of VCJ were significantly influenced by the addition of CPE ($p < 0.05$), while storage duration did not have a significant effect. Treatment T0 exhibited the highest °Brix values, which were significantly greater than those of T1, T2, and T3, indicating a clear decreasing trend in sugar content with increasing CPE concentrations. Specifically, T1 showed a significant reduction in °Brix compared to T0, followed by T2 and T3, which had the lowest °Brix values among all treatments. The °Brix values ranged from 7.65 ± 0.07 to 8.96 ± 0.01, slightly higher than the 7.4 °Brix reported by Aderinola & Abaire (2019) for pure carrot juice, but lower than the 8.5 °Brix observed by Xu *et al.* (2020). This decrease is likely due to the lower sugar content in CPE, as evidenced by Okwori *et al.* (2017), who reported a °Brix of 3.0 for CPE. Throughout the storage period, °Brix values remained largely unaffected, with T0 consistently maintaining the highest °Brix at all-time points (D 0, D 5, D 10, and D 15), while T3 consistently showed the lowest values. Notably, the °Brix of T1 at D 15 was significantly higher than at D 0, suggesting minor fluctuations over time. These findings ensure that the °Brix of VCJ remained above the European fruit juice code's minimum requirement of 7.0, even with the addition of CPE.

- *Effect of the Treatments and Storage on the Titratable Acidity Value of Value-added Carrot Juice:*

The addition of CPE significantly enhanced the TA of VCJ ($p < 0.05$). Treatment T0 recorded the lowest TA, which was significantly lower than T1, T2, and T3. Among the treatments, T3 exhibited the highest TA, indicating an increasing trend in acidity with higher concentrations of CPE.The TA values of VCJ ranged from 0.54 ± 0.01 to 0.68 ± 0.01, comparable to the 0.55 reported by Gereffi *et al.* (2011) for pure carrot juice. The elevated TA in VCJ can be attributed to the higher acidity of CPE (0.67), as reported by Vanajakshi *et al.* (2015), and potential enzymatic reactions during storage, as suggested by Ahmad *et al.* (2005). During storage, TA values of VCJ showed a significant increase over time, although the interaction between treatment and storage days was non-significant. Specifically, TA was lowest at D 0 and D 5, increasing significantly at D 10 and reaching the highest levels at D 15. This trend is consistent with the findings of El-zainy *et al.* (2017) and Omoba & Onyekwere (2016), who observed similar increases in TA with the addition of cucumber extracts and other fruit juices. The increase in TA over storage is likely due to ongoing biochemical processes that generate organic acids, thereby enhancing the overall acidity of the juice.

The physicochemical analysis of carrot juice fortified with cucumber peel extract revealed significant modifications in pH, °Brix, and titratable acidity. The addition of CPE led to a decrease in pH and °Brix, while simultaneously increasing the TA of the juice. These changes are primarily driven by the inherent acidity and lower sugar content ofCPE, as well as biochemical reactions occurring during storage. The findings underscore the potential of CPE as a functional additive to enhance the nutritional profile of carrot juice, although the impact on sensory attributes such as taste and sweetness should be considered in future studies.

Table 1 Effect of Treatments and Storage on pH, TSS and TA% of the Value-Added Carrot Juice

Quality Attributes	Treatments	0	torage Days 5	10	15
	T0	6.05±0.04^{a}	6.02±0.22^{a}	5.79±0.04^{bcde}	5.74±0.23^{abcd}
pH	T1	5.82±0.06^{bcd}	5.75±0.03^{bcdef}	5.69±0.03^{def}	5.69±0.08^{def}
	T2	5.77±0.02^{bcdef}	5.87±0.03^{b}	5.84±0.02^{bc}	5.67±0.08^{ef}
	T3	5.71±0.02^{cdef}	5.7±0.02^{cdef}	5.69±0.03^{def}	5.62±0.08^{f}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	8.96±0.01^{a}	8.93±0.03^{a}	8.91±0.04^{a}	8.86±0.05^{a}
TSS (°Brix)	T1	8.25±0.09^{cde}	8.31±0.1^{bcd}	8.39±0.11^{bc}	8.43±0.14^{b}
	T2	8.26±0.07^{cde}	8.18±0.09^{de}	8.17±0.12^{de}	8.15±0.15^{e}
	T3	7.65±0.07^{f}	7.76±0.08^{f}	7.76±0.1^{f}	7.79±0.11^{f}
Storage			*		
Treatments			NS		
Storage*treatment			NS		
	T0	0.54±0.01^{h}	0.55±0.01^{gh}	0.58±0^{ef}	0.62±0.01^{bc}
TA%	T1	0.57±0.03^{fg}	0.59±0.01^{ef}	0.63±0.01^{b}	0.63±0.01^{b}
	T2	0.6±0.01^{de}	0.6±0.02^{cde}	0.6±0.01^{cde}	0.63±0.02^{abc}
	T3	0.62±0.01^{bcd}	0.6±0.01^{de}	0.68±0.01^{a}	0.66±0.02^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		

Data represents means ± SD. Data were analyzed by ANOVA; means were separated with the LSD test ($p <$ 0:05). Mean values carrying different letters are significantly different from one another.

$*$ = $p \leq$ 0:05; $**$ = $p \leq$ 0:01; ns = $p >$ 0:05. $**$ = highly significant; $*$ = significant; ns = non- significant.

- *Instrumental Colors of Value- Added Carrot Juice*

The incorporation of cucumber peel extract (CPE) significantly influenced the color properties of carrot juice (VCJ) across various parameters, including lightness (L*), redness (a*), yellowness (b*), Chroma (c*), hue angle (h°), color difference (ΔE), and whiteness (W*). A significant (p<0.05) effect of treatments and storage days was observed for most color attributes, while the interaction between treatments and days remained non- significant.

The L* value, indicative of lightness, showed a notable increase with the addition of CPE, with T3 exhibiting the highest L* value among all treatments. This trend persisted throughout the 15-days storage period at chilling temperatures, reflecting the light- enhancing properties of CPE.

The observed L* values (19.94 ± 0.04 to 32.41 ± 0.4) were consistent with the findings of Hashemi and Qashqari (2018) but varied from other studies, likely due to differences in carotenoid content, processing, or storage conditions. The redness (a*) values of VCJ followed a similar increasing trend, with T3 achieving the highest a* values across all storage intervals. This enhancement can be attributed to the synergistic interaction of carotenoids and anthocyanins present in the carrot juice and CPE. The observed a* values (11.7 ± 0.07 to 14.82 ± 0.29) were lower than those reported by Zou (2016) but aligned with findings where plant extracts increased redness in juice blends.

Yellowness (b*) values also significantly increased with higher CPE concentrations, reflecting the influence of carotenoids on VCJ color. The b* values ranged from 16.35 ± 0.09 to 19.74 ± 0.21, which were lower than those observed in studies with different carrot varieties or processing conditions. The increasing b* values emphasize the role of carotenoids and other pigments in enhancing the visual appeal of VCJ. Chroma (c*) values, representing color intensity, also demonstrated a significant increase with CPE addition, with T3 consistently showing the highest c* values.

The c* values (20.1 ± 0.09 to 24.68 ± 0.33) in this study exceeded those of pure carrot juice reported in earlier research, indicating a higher saturation and vibrancy due to CPE incorporation. The hue angle (h°), indicative of color direction, showed a significant increase with CPE addition, suggesting a shift toward a more orange hue. The h° values (0.93 ± 0.001 to 0.949 ± 0.002) were consistent with the findings of Marszałek *et al.* (2017), reflecting the color stability and quality of VCJ during storage. The overall color difference (ΔE)

Values highlighted significant treatment effects, with T3 exhibiting the highest ΔE values, reflecting the cumulative impact of CPE on VCJ color attributes. The ΔE values ranged from 28.33 ± 0.08 to 40.73 ± 0.45, aligning with prior studies on juice blends with plant extracts. Whiteness (*W**) values increased significantly with CPE addition, with T3 again achieving the highest values. The observed range (17.45 ± 0.02 to 28.04 ± 0.34) was similar to findings from studies on pure carrot juice, underscoring the influence of carotenoids and chlorophylls in defining juice color. The addition of CPE enhanced the visual quality of VCJ, with improvements in lightness, redness, yellowness, Chroma, and overall color intensity. These changes reflect the interplay of carotenoids and chlorophyll pigments, highlighting the potential of CPE as a functional ingredient to improve the aesthetic and nutritional value of carrot juice.

Table 2 Effect of Treatments and Storage on *L**, *A**, *B**, *C**, *H*°, ΔE and *W** of the Value-Added Carrot Juice

Quality Attributes	**Treatments**	**0**	**Storage Days 5**	**10**	**15**
	T0	19.94±0.04^{f}	20.07±0.08^{ef}	20.26±0.14^{df}	20.47±0.29^{d}
*L**	T1	24.21±0.05^{c}	24.28±0.07^{c}	24.37±0.14^{c}	24.5±0.31^{c}
	T2	27.68±0.06^{b}	27.74±0.08^{b}	27.8±0.15^{b}	27.8±0.32^{b}
	T3	32.19±0.08^{a}	32.25±0.12^{a}	32.32±0.18^{a}	32.41±0.4^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	11.72±0.03^{d}	11.7±0.07^{d}	11.75±0.12^{d}	11.83±0.19^{d}
*a**	T1	12.32±0.06^{c}	12.39±0.11^{c}	12.48±0.18^{c}	12.58±0.27^{c}
	T2	13.46±0.04^{b}	13.47±0.14^{b}	13.56±0.16^{b}	13.66±0.31^{b}
	T3	14.56±0.07^{a}	14.58±0.08^{a}	14.69±0.19^{a}	14.82±0.29^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	16.36±0.08^{g}	16.35±0.09^{g}	16.4±0.15^{g}	16.48±0.24^{g}
*b**	T1	17.23±0.06^{f}	17.29±0.11^{f}	17.42±0.18^{ef}	17.56±0.21^{e}
	T2	18.43±0.11^{d}	18.4±0.08^{cd}	18.49±0.12^{cd}	18.63±0.18^{c}
	T3	19.51±0.13^{b}	19.57±0.13^{ab}	19.68±0.21^{ab}	19.74±0.21^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	20.13±0.08^{e}	20.1±0.09^{e}	20.18±0.18^{e}	20.28±0.25^{e}
*c**	T1	21.18±0.07^{d}	21.27±0.15^{cd}	21.42±0.25^{cd}	21.6±0.31^{c}
	T2	22.82±0.07^{b}	22.81±0.15^{b}	22.93±0.19^{b}	23.1±0.33^{b}
	T3	24.35±0.14^{a}	24.4±0.13^{a}	24.56±0.28^{a}	24.68±0.33^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	0.949±0.002^{a}	0.949±0.003^{a}	0.949±0.003^{a}	0.948±0.009^{a}
h°	T1	0.95±0.002^{a}	0.949±0.001^{a}	0.949±0.003^{a}	0.949±0.006^{a}
	T2	0.94±0.004^{b}	0.939±0.003^{b}	0.938±0.003^{b}	0.938±0.006^{b}
	T3	0.93±0.002^{c}	0.93±0.004^{c}	0.93±0.001^{c}	0.927±0.005^{c}
Storage			*		
Treatments			NS		
Storage*treatment			NS		
	T0	28.33±0.08^{g}	28.41±0.08^{g}	28.6±0.08^{fg}	28.82±0.38^{f}
ΔE	T1	32.17±0.07^{e}	32.28±0.12^{e}	32.45±0.06^{de}	32.66±0.18^{d}
	T2	35.87±0.09^{c}	35.91±0.16^{c}	36.03±0.14^{c}	36.14±0.36^{c}
	T3	40.36±0.12^{b}	40.44±0.17^{ab}	40.59±0.28^{ab}	40.73±0.45^{a}
Storage			*		
Treatments			*		
Storage*treatment			NS		
	T0	17.45±0.02^{e}	17.58±0.09^{e}	17.75±0.18^{de}	17.92±0.22^{d}
*W**	T1	21.31±0.04^{c}	21.35±0.06^{c}	21.39±0.21^{c}	21.47±0.36^{c}
	T2	24.16±0.03^{b}	24.22±0.04^{b}	24.24±0.17^{b}	24.19±0.3^{b}

	T3	27.95±0.07[a]	27.99±0.08[a]	28±0.14[a]	28.04±0.34[a]
Storage			*		
Treatments			NS		
Storage*treatment			NS		

Data represents means ± SD. Data were analyzed by ANOVA; means were separated with the LSD test ($p < 0{:}05$). Mean values carrying different letters are significantly different from one another.

$* = p \leq 0{:}05$; $** = p \leq 0{:}01$; ns = $p > 0{:}05$. $**$ = highly significant; $*$ = significant; ns = non- significant. Sensory Evaluation of Value- Added Carrot Juice

The sensory attributes of value-added carrot juice (VCJ) enriched with cucumber peel extract (CPE) were evaluated for color, taste, odor, and overall acceptability during 15 days of storage at chilling temperature. A significant (p<0.05) effect of treatments and storage days was observed for all sensory parameters, while the interaction of treatments and days (VCJ*Days) was non-significant except for odor. The incorporation of CPE significantly enhanced sensory attributes compared to the untreated control (T0).

- *Color Value:*

The incorporation of CPE positively influenced the color score of VCJ, with T3 (highest concentration of CPE) achieving significantly higher scores than other treatments. Storage analysis revealed. That color values remained stable from D 0 to D 5 but declined significantly from D 10 to D15. The observed color scores ranged from 6.88 ± 0.23 to 7.44 ± 0.18, aligning with the findings of Aderinola & Abaire (2019), who reported a score of 7.60 ± 1.89 for 100% carrot juice. The improved color in T3 was attributed to the dark green hue of CPE, which enhanced the brightness of carrot juice's natural red coloration. The results highlight the role of carotenoids and chlorophylls in enhancing consumer appeal, consistent with previous findings by Puranik *et al.* (2013).

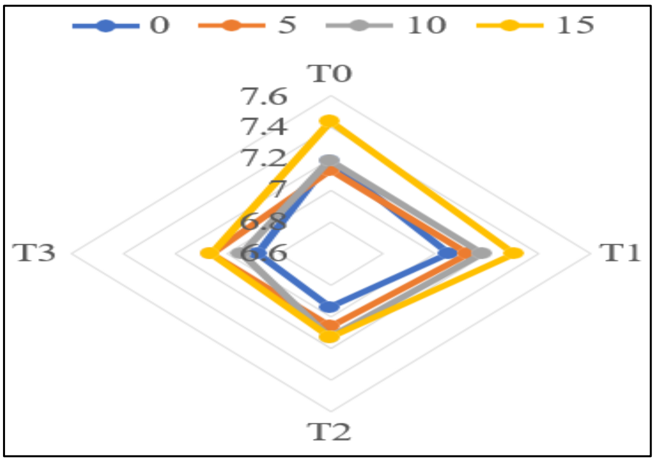

Fig 1 Color Value of Value-Added Carrot Juice

- *Taste Value:*

The taste evaluation demonstrated a significant improvement with T2 the addition of CPE, particularly in T3, which recorded the highest scores among all treatments. The taste scores of VCJ ranged from 6.13 ± 0.23 to 7.38 ± 0.23, consistent with previous studies (Aderinola & Abaire, 2019). A decline in taste was observed during storage, with Day 0 exhibiting the highest scores and D 15 the lowest. The superior taste of T3 was attributed to the synergistic effect of CPE and the natural sweetness of carrot juice. These findings underscore the importance of sugar content and flavor compounds, as highlighted by Breslin (2013).

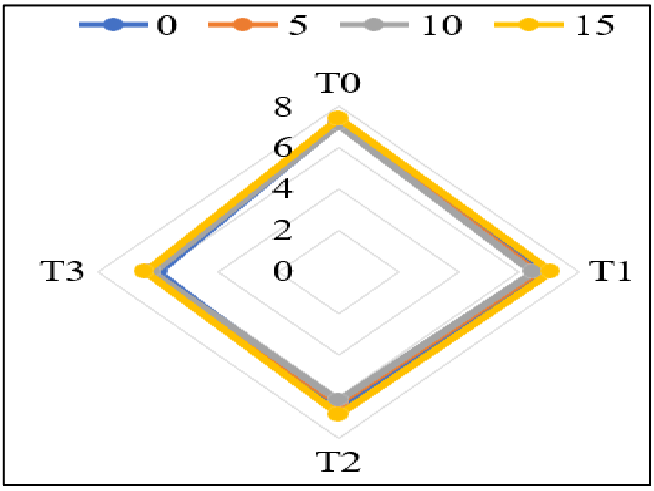

Fig 2 Taste Value of Value-Added Carrot Juice

- *Odor Value*:

The odor scores of VCJ were significantly affected by both treatments and storage duration. T3 exhibited the highest odor scores across all treatments, with a range of 5.63 ± 0.23 to 7.69 ± 0.26, comparable to the results of Aderinola & Abaire (2019). A decreasing trend was observed during storage, attributed to potential chemical changes in the juice (Singh *et al.*, 2010). The enhanced odor in T3 indicates the effectiveness of CPE in preserving the sensory integrity of VCJ, demonstrating its potential for improving aromatic appeal.

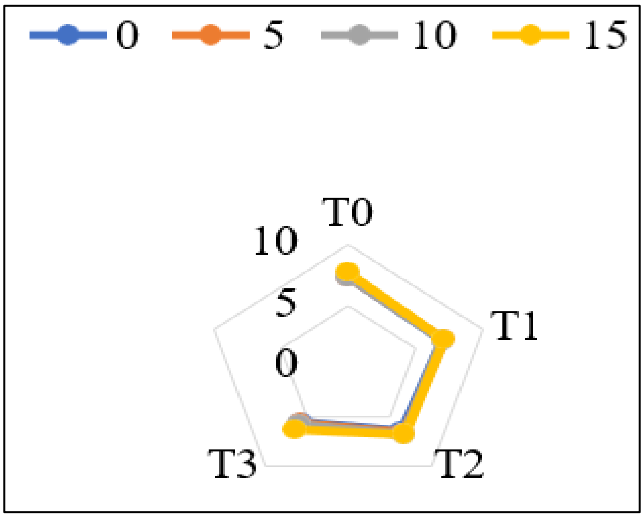

Fig 3 Odor Value of Value-Added Carrot Juice

- *Overall Acceptability*:

The overall acceptability (OA) of VCJ was significantly enhanced by CPE addition, with T3 showing the highest scores across treatments. OA scores ranged from 6.21 ± 0.12 to 7.65 ± 0.13, consistent with Aderinola & Abaire (2019) and Zellner (2008), who reported improved acceptability of carrot juice upon incorporation of fruit pomace. Storage-wise, OA declined over 15 days, but treatment- wise, T3 consistently outperformed the control, emphasizing the sensory benefits of CPE addition.

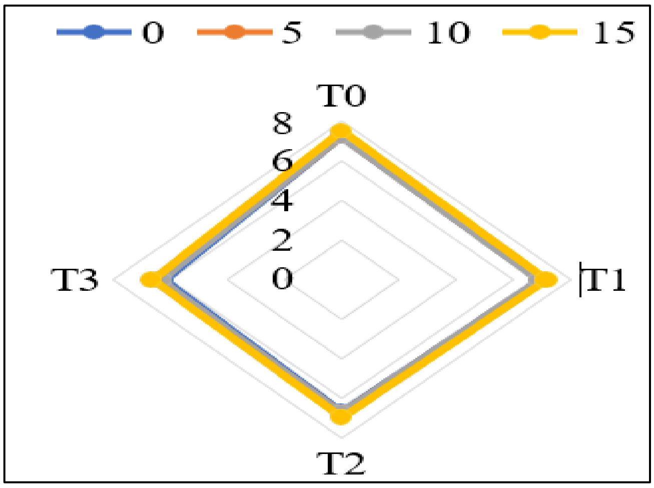

Fig 4 Overall Acceptability of Value- Added Carrot Juice

This study demonstrates that incorporating CPE into carrot juice significantly improves sensory attributes, particularly color, taste, odor, and overall acceptability. The findings support the use of natural additives like CPE to enhance sensory appeal and consumer preference for functional beverages. While storage time negatively impacted sensory scores, treatment T3 emerged as the most acceptable formulation, maintaining high- quality attributes over the storage period. These results open avenues for the development of novel, value-added beverages with improved sensory and functional properties.

IV. CONCLUSION

This study successfully developed a value- added carrot juice (VCJ) fortified with cucumber peel extract (CPE), highlighting its potential as a functional beverage. The incorporation of CPE enhanced the sensory attributes, including color, taste, odor, and overall acceptability, with T3 emerging as the

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[2]. Ahmad B, Hassan S, Bakhsh K. (2005). Factors affecting yield and profitability of most preferred formulation. The fortification also contributed to nutritional benefits, such as antimicrobial, antioxidant, and anti- inflammatory properties, while promoting immunity and skin health. Physicochemical properties like pH, °brix, and TA were significantly influenced by CPE addition, indicating its functional role. The enhanced L^*, a^*, and b^* values, along with increased hue angle and whiteness, demonstrated improved visual appeal. The synchronization of colors created by CPE was particularly attractive. Although sensory attributes declined slightly during storage, the fortified VCJ retained acceptable quality. This research emphasizes the effective utilization of cucumber peels, a natural byproduct, for waste valorization and offers a sustainable, health-promoting beverage option. Further studies may explore extended shelf life and consumer acceptance at a larger scale. carrot in two districts of Punjab. International Journal of Agriculture and Biology. 7:794- 798.

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