International Journal of
Food Science
(IJF)

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CARI Journals

International Journal of Food Sciences
ISSN: 2789-3383 (Online)
Vol. 7, Issue No.2, pp 64 - 82, 2025
www.carijournals.org

Comparative Assessment of Consumer Preferences and Sensory Attributes of GAP and Non-GAP Greenhouse Tomatoes among Urban Consumers in Mogadishu, Somalia

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Accepted:30th November, 2025, Received in Revised Form: 12th December, 2025, Published: 17th December, 2025

Abstract

Purpose: In Mogadishu, Somalia, the cultivation of tomatoes in greenhouses is rapidly gaining popularity as farmers strive to improve both yield and quality. Despite this trend, there is limited understanding of consumer perceptions regarding tomatoes grown using Good Agricultural Practices (GAP) compared to those produced through traditional, non-GAP methods. This study assessed the sensory qualities and consumer preferences for tomatoes from both farming techniques.

Methodology: This study evaluated the sensory attributes and consumer acceptability of tomatoes from both production systems. A Completely Randomized Design (CRD) with two treatments (GAP vs. non-GAP) was applied. Thirty untrained panelists rated appearance, aroma, flavor, texture, and overall acceptability on a five-point hedonic scale (1 = dislike a lot - 5 = like a lot). Data were analyzed using Minitab v.19. Paired t-tests and Wilcoxon Signed-Rank tests were applied to ensure robustness of the findings.

Findings: The findings revealed that tomatoes grown with GAP received higher scores than non-GAP tomatoes in terms of appearance (4.27 ± 0.86 versus 4.01 ± 0.94), aroma (4.06 ± 0.96 compared to 3.76 ± 1.02), flavor (4.04 ± 1.04 against 3.68 ± 1.12), and overall acceptability (4.21 ± 0.94 as opposed to 3.96 ± 1.12) (all $p < 0.001$). No notable difference in texture was observed between the two types. The Pearson correlation showed strong positive associations among the sensory attributes, especially between flavor and overall acceptability ($r = 0.647$). Panelists were also more willing to pay a higher price for GAP tomatoes, with an average price difference of 0.84 USD ($p < 0.001$), suggesting a perception of superior quality.

Unique Contribution Theory, Policy and Practice: Overall, the results indicate that implementing GAP enhances key sensory attributes and increases consumer satisfaction. The study recommends that tomato growers in Mogadishu adopt GAP to improve product quality and competitiveness. Additionally, policymakers and extension services should support GAP training and awareness programs to promote sustainable, market-oriented tomato production in Somalia.

Keywords: *Solanum lycopersicum L., GAP, Greenhouse, Consumer Preference, WTP, Mogadishu*

1. INTRODUCTION

Tomatoes (Solanum lycopersicum L.) rank among the most widely cultivated and consumed vegetables globally (Campestrini et al., 2019; Li et al., 2021). They are the second most important vegetable crop worldwide, following potatoes (Solanum tuberosum L.), with an annual production of approximately 186.11 million tons across 4.92 million hectares (FAOSTAT, 2025). Tomatoes are a vital source of nutraceutical compounds and essential nutrients in human diets (Salehi et al., 2019). China is the leading producer of tomatoes, but production levels vary significantly around the world. In 2022, yields ranged from over 423 tons per hectare in the Netherlands to less than 1.45 tons per hectare in Somalia (FAOSTAT, 2025). Tomatoes are the fifth most cultivated vegetable worldwide, playing a significant role in the global food system (Baldi et al., 2021; Šugrova et al., 2020). Both fresh and processed tomatoes are favored for their rich nutrient content (Baldi et al., 2021; Formoso et al., 2020; Rezitis & Pachis, 2016; Rocha et al., 2013; Šugrova et al., 2020). Somalia's agriculture has significant potential, and tomatoes are among the promising crops for the country. Tomatoes are a vital part of Somali cuisine and could bolster the local economy, as there is high demand for both fresh and processed tomatoes. The increasing urban population and changing eating habits increase the need for tomatoes (MoA, 2025), and the production is highly constrained by recurrent droughts and poor water management practices, resulting in reduced yields (See Figure 1), crop failures, and income losses for smallholder farmers (Ahmed, 2023). Beyond production constraints, farmers face substantial post-harvest losses along the supply chain, which are mainly attributed to poor infrastructure, prolonged transportation times due to inspection delays, and inconsistent market access, all of which accelerate fruit decay and reduce overall quality (Nuur Ismaan et al., 2022). These combined constraints have encouraged local farmers to seek more controlled production systems, leading to a rise in greenhouse tomato production in Mogadishu. The quality of fresh tomatoes is determined by various traits, including external factors like appearance and texture, as well as internal factors such as flavor, texture, and nutritional value. These quality attributes are complex, being polygenic and influenced by the tomato's genotype, environmental conditions, farming practices, and the maturity stage at harvest (Baldwin et al., 2015; Grandillo & Cammareri, 2016; Zhao et al., 2019).

As global food systems face increasing pressure from population growth, efficient and resilient production methods are essential (Olabisi & Nofiu, 2022; Orakwue & S. Otonye, 2022).

Greenhouse cultivation offers a viable solution by enabling controlled, year-round production and improving fruit quality consistency (Olabisi & Nofiu, 2022). Good Agricultural Practices (GAP) have been widely promoted to improve food safety, environmental sustainability, and market competitiveness (Vijayakumar et al., 2021). Within such systems, GAP adoption can improve fruit appearance, reduce contamination levels, and enhance post-harvest losses.

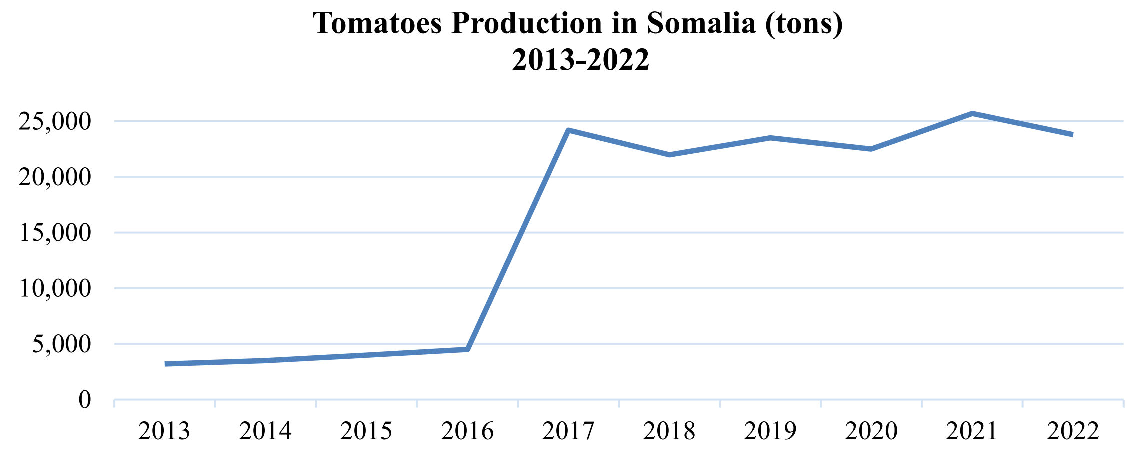

Figure 1: Tomatoes Production in Somalia (tons) 2013-2022 (Source: MOAI-2025)

In consumer decision-making, extrinsic quality cues, such as appearance, strongly influence consumers' initial selection decisions (Oltman et al., 2014). In contrast, intrinsic factors, including eating quality characteristics, are the dominant determinants of subsequent purchasing behavior (Maul et al., 1997). Preference-mapping studies of fresh market tomatoes consistently identified flavor and texture as the principal sensory attributes that drive and differentiate consumer preferences (Causse et al., 2003, 2010; Piombino et al., 2013; Sinesio et al., 2010). Flavor arises from the integration of tastes and retronasal olfaction, and is influenced by a broad range of physiological, biochemical, and perceptual factors involving multiple sensory systems (Goff & Klee, 2006). The distinctive sweet–acid balance and overall flavor intensity typical of tomatoes are governed by a complex interplay of primary and secondary metabolites, primarily encompassing reducing sugars (glucose and fructose), organic acids (citrate, malate, and glutamate), mineral constituents, and an array of key volatile compounds (Baldwin et al., 2000; Goff & Klee, 2006; Tieman et al., 2017). Similarly, texture encompasses mechanical properties such as firmness, juiciness, and structural integrity (Aurand et al., 2012), which contribute to both the overall sensory profile and consumer acceptability (Baldwin et al., 2000; Goff & Klee, 2006).

Sustainable agriculture ensures profitability, environmental health, and social and economic equality. GAP implementation contributes to these objectives and supports progress towards Sustainable Agriculture 2030 (UNEP, 2021). Protecting consumers from foodborne illness depends on food safety and is an essential dimension of security, which requires regular access to safe and nutritious food that meets dietary needs (APEC, 2021). As a result, consumer behavior regarding food is changing over time due to its direct relationship with changes in the macro-environmental context (Latino et al., 2023). For example, (Baldi et al., 2021; Meyerding et al., 2019), found that Italian consumers were willing to pay a premium for fresh, sustainably produced tomatoes from Southern Europe, which require minimal water. Consequently, the country-of-origin attribute was found to be closely linked to sustainability considerations. Moreover, (Meyerding et al., 2019) reported that German consumers prioritized products that were economical, safe, and healthy, and only subsequently considered social and climate-related attributes in their purchase decisions.

The increased sensitivity of people to their own well-being, health, safety, and environmental issues has stimulated the agri-food system to develop products with healthy, safe, and environmentally friendly attributes (Ballen et al., 2022; Hatanaka, 2020; Panzone et al., 2016). In particular, the connection between food and health is increasingly capturing the attention of modern consumers, as it elevates the role of food beyond merely providing energy to serve as a means for disease prevention and management (Cornil et al., 2020; Papachristos & Adamides, 2016; Skallerud & Wien, 2019). In this context, vegetables and fruits occupy a central position in consumers' food choices (Aschemann-Witzel & Stangherlin, 2021). Despite this, vegetable consumption in Europe, the United States, and globally falls short of the World Health Organization's recommendations(Dinnella et al., 2016). Consumers in many developing countries are also concerned about food safety issues that arise across the supply chain, from production to consumption (Ababio & Lovatt, 2015; Lagerkvist et al., 2018; Omari et al., 2018). To improve product quality and ensure food safety, many growers are encouraged to adopt Good Agricultural Practices (GAP). However, GAP standards can be challenging, especially in developing countries, where farmers often struggle with both the financial burden and limited access to technical knowledge (Laosutsan et al., 2019).

However, consumers' willingness to pay for such quality improvements largely depends on the perceived and actual sensory benefits. The implementation of GAP within greenhouse systems remains limited, with most small-scale producers lacking the awareness or capacity to apply such standards effectively. This gap between recommended practices and on-ground adoption restricts farmers' ability to meet local and export market standards. Furthermore, while research in other countries has shown that GAP adoption improves the sensory quality, appearance, and shelf life of tomatoes, such empirical evidence is lacking in Somalia. Despite the growing adoption of GAP in greenhouse systems, there is a limited empirical basis for understanding how consumers in Mogadishu perceive the sensory quality of GAP-produced tomatoes compared with non-GAP ones. Understanding these perceptions is crucial for enhancing production practices and informing consumer education and market differentiation strategies. Understanding consumer preferences is essential for guiding farmers, marketers, and policymakers toward production systems that align with market expectations and consumer preferences. Therefore, this study addresses a key research gap by providing the first empirical assessment of how Good Agricultural Practices influence the sensory attributes and consumer willingness to pay for greenhouse tomatoes in Mogadishu, Somalia. The findings are expected to provide practical insights for enhancing quality management, promoting GAP adoption, and supporting market-driven agricultural policies.

The overall objective of this study was to compare consumer preferences and sensory quality attributes of greenhouse tomatoes produced under Good Agricultural Practices (GAP) and those produced without GAP in Mogadishu, Somalia. Specifically, this study sought to evaluate key sensory attributes, including appearance (color), aroma, flavor, texture, and overall acceptability, of both GAP and non-GAP tomatoes. Additionally, it aimed to determine consumers' willingness to pay (WTP) for GAP and non-GAP products and to assess the relationship between sensory liking and economic valuation. To guide the analysis, this study was based on the following hypotheses: The null hypothesis (H_0) states that there are no statistically significant differences in sensory attributes, consumer preferences, or willingness to pay for GAP versus non-GAP greenhouse tomatoes. Conversely, the alternative hypothesis (H_1) posits that statistically significant differences exist in sensory attributes, consumer preferences, or willingness to pay between tomatoes produced under GAP and those produced under non-GAP conditions.

2. MATERIAL AND METHODS

2.1 Experimental Design and Sample Preparation

2.1.1 Study Design and Treatments

An experiment was conducted under a Completely Randomized Design (CRD) to compare tomato production systems following Good Agricultural Practices (GAP) and non-GAP (conventional) management in Mogadishu, Somalia. Two treatments were evaluated: **T_1:** GAP-produced greenhouse tomatoes and **T_2:** non-GAP-produced greenhouse tomatoes. Thirty untrained consumer panelists were selected according to the Institute of Food Technologists' (1981) guidelines (IFT, 1981), which suggests that about twenty-four assessors are sufficient for acceptance and preference testing. The panelists participated in three separate sensory evaluation sessions, each held on a different day, to serve as replicates. In each session, the same individuals evaluated both treatments under blind conditions, with the order of sample presentation randomized. This approach was used to ensure uniformity, minimize variations, and reduce any potential biases.

2.1.2 Tomato Sample Preparation and Handling

Tomatoes of a single commercial variety, *Anna F1* (indeterminate type), were used for all evaluations to ensure varietal uniformity across the treatments. Fruits were harvested at the pink-red ripening stage (30–60% red) to ensure uniform maturity across the treatments. GAP samples were sourced from greenhouse farms that adhered to the FAO guidelines for pesticide use, hygiene, and postharvest handling, whereas non-GAP samples were obtained from farms employing conventional methods. In this study, GAP greenhouses refer to production units that comply with the FAO's Good Agricultural Practices (GAP) guidelines, including reduced dependence on synthetic fertilizers, the use of compost or properly managed organic manures, safe and responsible pesticide application, protection of workers' health and safety, adoption of environmentally sustainable cultivation methods, appropriate post-harvest handling to maintain produce safety, and demonstrated competence in recommended crop management practices. All fruits were washed with potable water, air-dried, and stored at 4 ± 1°C for no more than 24 h before testing. For sensory evaluation, tomatoes were cut into 1 cm^3 cubes, placed in 2 oz plastic containers with lids, and labeled with three-digit random numbers (e.g., 252, 245). The codes were changed for each session to maintain anonymity. The samples were transported in insulated coolers and served at room temperature. The overall experimental and analytical workflow used in this study is summarized in Figure 2, which outlines sample preparation, sensory evaluation, willingness-to-pay assessment, and subsequent statistical analyses.

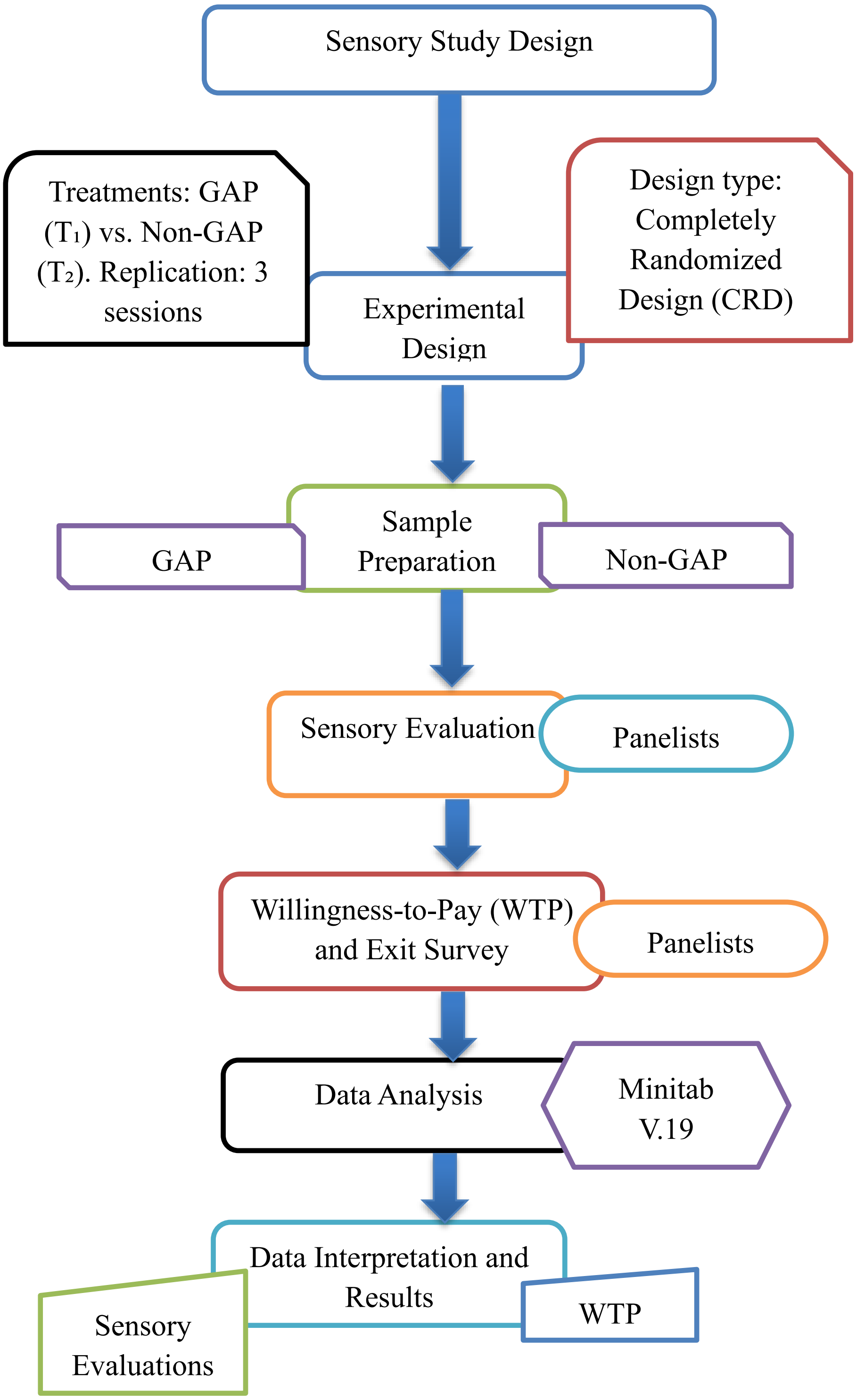

Figure 2. Experimental and analytical workflow for the sensory evaluation

2.2 Sensory Evaluation and Willingness-to-Pay Assessment

2.2.1 Sensory Evaluation Procedure

Sensory evaluation focused on five key attributes recognized as major determinants of consumer acceptance of fresh tomatoes: color (appearance), aroma, flavor, texture, and overall acceptability (Azodanlou et al., 2003; Baldwin et al., 2008). The evaluations were conducted in a well-ventilated, odor-free room under natural lighting. Each panelist received two coded samples (GAP and non-GAP) per session in a random order. Attributes were rated using a five-point hedonic scale: 5 = Like a lot, 4 = Like a little, 3 = Neither like nor dislike, 2 = Dislike a little, and 1 = Dislike a lot. To prevent taste carryover, the panelists rinsed their mouths with room-temperature water and consumed unsalted soda crackers between samples. The researchers supervised all the sessions to ensure adherence to the evaluation protocol. Each session lasted approximately 25 minutes, and the responses were recorded on standardized sensory score sheets.

2.2.2 Willingness-to-Pay (WTP) and Exit Survey

Immediately after each sensory session, the participants indicated their maximum willingness to pay (WTP) for each coded tomato sample using a payment-card method expressed in $/per kilogram. Price ranges were designed to reflect the current market conditions. To reduce hypothetical bias, the participants were informed that one randomly selected respondent would purchase 1 kg of tomatoes at their stated price. Following the WTP exercise, an exit survey was administered to collect demographic and socioeconomic data, including age, gender, household income, and frequency of purchasing tomatoes. All participants provided informed consent, and the study protocol was reviewed and approved by the Faculty of Academic Ethics Committee of the Somali National University.

2.3 Data Collection and Statistical Analysis

2.3.1 Data Structure and Replication

Each of the three sensory sessions was replicated, yielding a total of 180 evaluations (30 panelists × 2 samples × 3 sessions). Each evaluation generated sensory ratings for the five attributes and corresponding WTP data. After confirming the absence of significant session–treatment interactions, the data from all sessions were pooled for the final analysis.

2.3.2 Statistical Analysis

Data were analyzed using Minitab Version 19. Descriptive statistics (mean ± standard deviation) were calculated for each sensory attribute and treatment group. Differences in the mean sensory scores and WTP between the GAP and non-GAP samples were tested using paired-samples *t*-tests. When the normality assumptions were not fully satisfied, the Wilcoxon Signed-Rank test was employed as a non-parametric alternative to validate the findings. Additionally, Pearson's correlation analysis was performed to explore the associations among sensory attributes (appearance, aroma, flavor, texture, and overall acceptability) and their relationship with consumer WTP. Statistical significance was set at a 95% confidence level ($p < 0.05$).

3. RESULTS

3.1 Analysis of Sensory Evaluation of GAP versus Non-GAP Tomatoes

Sensory evaluation of GAP and Non-GAP tomatoes, rated by the same panelists, was analyzed using both paired t-tests and Wilcoxon Signed-Rank tests (See Table 1). GAP tomatoes received significantly higher scores than Non-GAP tomatoes for appearance (4.52 ± 0.69 vs 4.01 ± 0.94, p < 0.000; Wilcoxon p < 0.000), aroma (4.36 ± 0.80 vs 3.76 ± 1.02, p < 0.000; Wilcoxon p < 0.001), flavor (4.40 ± 0.82 vs 3.68 ± 1.12, p < 0.000; Wilcoxon p < 0.000), and overall acceptability (4.21 ± 0.94 vs 3.96 ± 1.12, t = 30.84, p < 0.001; Wilcoxon p = 0.004). Texture (4.17 ± 0.96 vs 4.09 ± 1.03, p < 0.602; Wilcoxon p < 0.572) did not differ significantly, suggesting that texture differences were minimal. The non-parametric Wilcoxon Signed-Rank test, which is more appropriate for ordinal data, indicated no significant difference (p = 0.572). Therefore, we interpreted the texture as effectively unchanged between GAP and non-GAP tomatoes.

Table 1: ***Sensory Evaluation of GAP vs Non-GAP Tomatoes***

Attribute	**GAP Mean ± SD**	**Non-GAP Mean ± SD**	**95% CI of Difference**	**Paired t-test p-value**	**Wilcoxon Signed-Rank p-value**
Appearance	4.52 ± 0.69	4.01 ± 0.94	0.268 – 0.754	0.000*	0.000*
Aroma	4.36 ± 0.80	3.76 ± 1.02	0.331 – 0.869	0.000*	0.000*
Flavor	4.40 ± 0.82	3.68 ± 1.12	0.433 – 1.011	0.000*	0.000*
Texture	4.17 ± 0.96	4.09 ± 1.03	−0.216 – 0.372	0.602	0.572
Overall Acceptability	4.47 ± 0.62	3.96 ± 1.12	0.244 – 0.778	0.000*	0.001*

*p < 0.05 indicates a statistically significant difference between GAP and non-GAP tomato samples.

As shown in Figure 3, Histograms with normal distribution curves illustrate the sensory evaluation scores for the appearance, flavor, texture, and overall acceptability of products produced under GAP and non-GAP conditions (N = 90 per treatment). Across all attributes, the GAP samples exhibited higher mean scores and lower standard deviations, indicating superior and more consistent sensory quality compared to the non-GAP samples. Specifically, GAP treatments recorded mean values of 4.52 (appearance), 4.44 (flavor), 4.17 (texture), and 4.47 (acceptability), all exceeding the corresponding non-GAP means of 4.01, 3.68, 4.09, and 3.96, respectively. The distributions for GAP were more concentrated around higher ratings, whereas non-GAP samples

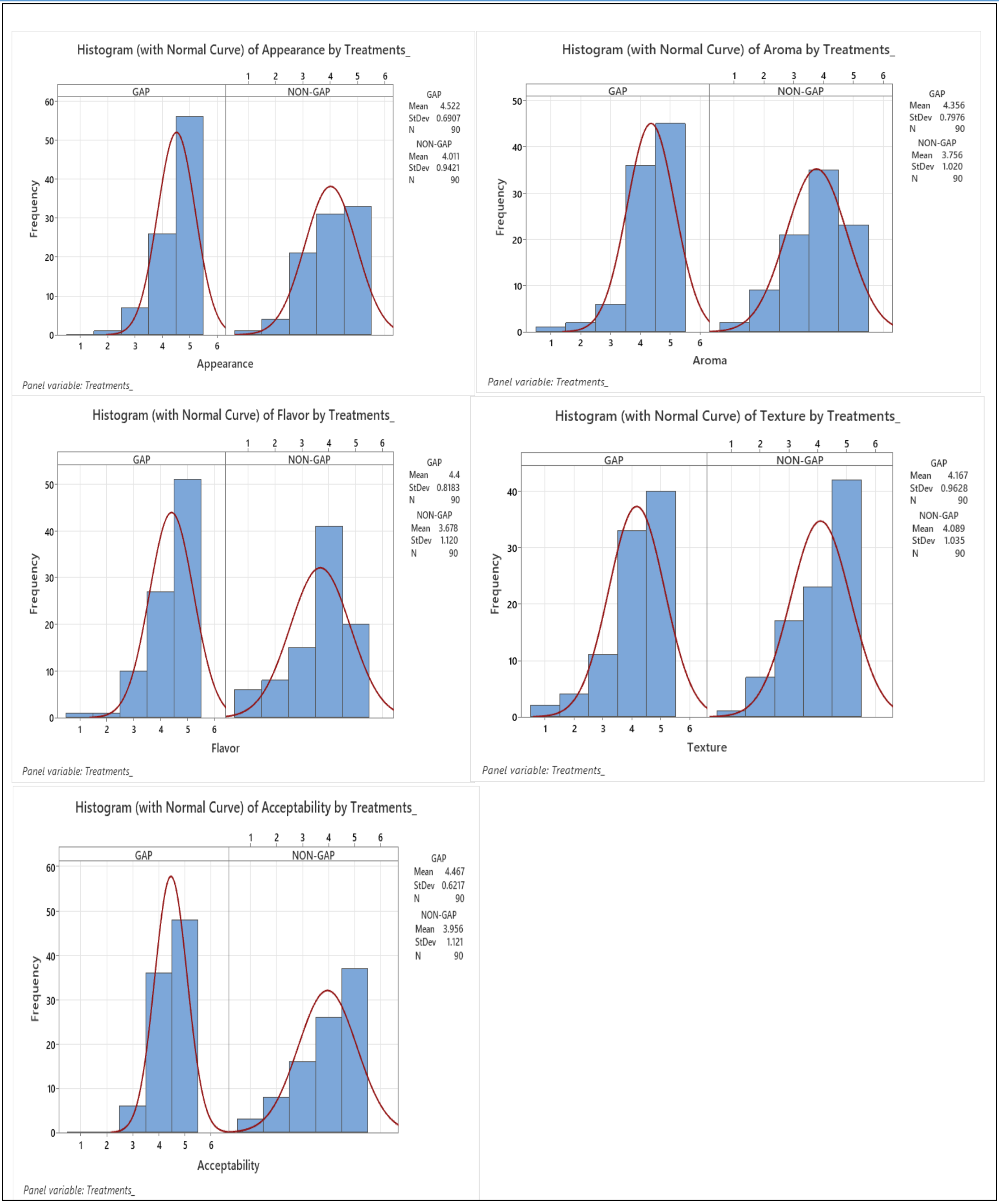

Figure 3: Distribution of Sensory Attribute Scores (Appearance, Flavor, Aroma, Texture, and Acceptability) of GAP and Non-GAP Products with Fitted Normal Curves

Pearson's correlation coefficients were calculated to assess the linear associations between sensory attributes (such as appearance, aroma, flavor, texture, and overall acceptability) and the treatment category (GAP versus non-GAP tomatoes). See Table 2, the findings indicated moderate to strong positive correlations among most sensory attributes. Specifically, flavor and overall acceptability (r = 0.647), aroma and acceptability (r = 0.605), and appearance and acceptability (r = 0.475) exhibited relatively high correlations, suggesting that enhancements in these sensory traits significantly boost consumer preference. In contrast, the treatment showed negative correlations with all sensory attributes (ranging from –0.039 to –0.347). Since treatment was coded as 1 = GAP and 2 = non-GAP, the negative correlations implied that GAP tomatoes generally received higher sensory scores across all assessed parameters. These correlations imply that improvements in appearance, aroma, and flavor not only elevate overall acceptability but also likely increase the willingness to pay for GAP tomatoes.

Table 2: ***Pearson Correlation Coefficients among Sensory Attributes and Treatment***

Variable	Appearance	Aroma	Flavor	Texture	Acceptability
Appearance	1.000				
Aroma	0.427	1.000			
Flavor	0.262	0.449	1.000		
Texture	0.252	0.278	0.366	1.000	
Acceptability	0.475	0.605	0.647	0.424	1.000

3.2 Exit Survey

According to Table 3, the panelists were evenly split between males and females, each accounting for 50% of the respondents. Most respondents (70%) were young adults aged 18–24, with only 6.7% over 31 years of age. Nearly half of the respondents (46.7%) earned between $300 and $499 per month. Regarding household size, the majority (60%) lived in large households with eight or more members. Most respondents (73.3%) purchased tomatoes daily, while 26.7% bought them weekly. Local markets were the main buying location, favored by 80% of respondents, whereas supermarkets and direct farm purchases accounted for 10% each. In terms of awareness of Good Agricultural Practices (GAP), less than half (46.7%) were aware, 30% were unsure, and 23.3% were unaware.

International Journal of Food Sciences
ISSN: 2789-3383 (Online)
Vol. 7, Issue No.2, pp 64 - 82, 2025
www.carijournals.org

Table 3: ***Demography of the panelists***

Variable	Category	Frequency	Percent (%)	Cumulative Percent (%)
Gender	Male	15	50.0	50.0
	Female	15	50.0	100.0
Age	18-24	21	70.0	70.0
	25-30	7	23.3	93.3
	31+	2	6.7	100.0
Monthly Household Income	$100	4	13.3	13.3
	$100-299	7	23.3	36.7
	$300-499	14	46.7	83.3
	>$500	5	16.7	100.0
Household Size	1-2	3	10.0	10.0
	3-5	2	6.7	16.7
	6-8	7	23.3	40.0
	8+	18	60.0	100.0
Frequency of Tomato Purchase	Daily	22	73.3	73.3
	Weekly	8	26.7	100.0
Typical Buying Location	Local Market	24	80.0	80.0
	Supermarket	3	10.0	90.0
	Direct from the Farm	3	10.0	100.0
Awareness of GAP	Yes	14	46.7	46.7
	No	7	23.3	70.0
	Unsure	9	30.0	100.0

3.3 Willingness to Pay (WTP)

A paired-samples t-test was performed (See Table 4) to assess if there was a statistically significant difference in consumers' willingness to pay (WTP) for tomatoes certified by GAP compared to those not certified. This paired design was suitable as the same group of panelists ($n = 180$) evaluated both types of tomatoes under the same conditions, thus controlling for individual preferences. The findings revealed a statistically significant rise in the average WTP for GAP-certified tomatoes over non-GAP ones ($t(179) = 9.20$, $p < 0.001$). The mean difference of 0.84 (95% CI: 0.66, 1.03) indicates that participants consistently showed a willingness to pay more for GAP-certified tomatoes than for conventional ones. Although there was some variability in individual ratings, as indicated by a moderate standard deviation ($SD = 1.23$), the large t-value suggests that the difference observed is substantial and unlikely to be a result of sampling error.

Table 4: ***Paired Samples T-Test for Mean Price (WTP) between GAP and Non-GAP Tomatoes***

Variable	N	Mean	StDev	SE Mean	Mean Difference	95% CI for Difference	t-Value	p-Value
Price (WTP)	180	2.344	0.899	0.067	0.844	(0.663, 1.026)	9.20	0.000

Note: Mean difference calculated as Price – Treatment (GAP vs non-GAP).

4. DISCUSSIONS

These findings align with earlier research that highlights the significant impact of production methods on product quality. Numerous studies have shown that organically grown crops often possess superior nutritional and quality attributes compared to those cultivated through conventional means. For instance, (Worthington, 2001) conducted a meta-analysis of 41 studies, revealing that organic produce contains higher levels of essential micronutrients and lower nitrate levels. Similarly, (Vinha et al., 2014) highlighted the influence of production systems on both composition and sensory qualities. This evidence supports our findings, where tomatoes cultivated using Good Agricultural Practices consistently received higher sensory scores and were more favored by consumers than those produced conventionally.

The superiority of GAP tomatoes observed in this study aligns with recent evidence showing that improved agronomic practices consistently enhance fruit quality traits related to sensory perception, such as color, aroma volatiles, sweetness, and overall flavor intensity (D'Esposito et al., 2024; Zhang et al., 2024). GAP-aligned practices, including optimized nutrient management, soil improvement, and better handling after harvest, are known to increase soluble solids, phenolic content, and volatile compound expression, which directly influence the sensory attributes (Dasgan et al., 2024). Overall, the results demonstrate that adherence to GAP improves the visual, olfactory, and gustatory characteristics of tomatoes, while texture remains largely unaffected, consistent with recent findings that appearance, sweetness, and aroma are more responsive to improved agricultural practices than firmness-related traits (Lipan & Romero, 2024).

Similarly, previous research has highlighted the importance of color and overall appearance in consumer preference. (Jürkenbeck et al., 2019) found that color was the most important attribute for fresh tomatoes among three out of six clusters of German consumers, whereas green and yellow tomatoes were universally rejected. Similarly, consumers preferred red tomatoes with uniform and intense coloration (Jürkenbeck et al., 2019; Oltman et al., 2014, 2016; Rocha et al., 2013). The general appearance or presentation of tomatoes was also shown to influence consumer choice, affecting both general consumers (Verbeke et al., 2008) and younger people (Dinnella et al., 2016; Šugrova et al., 2020), and serving as a quality indicator for mothers (Flax et al., 2021).

These findings suggest that improvements in the visual attributes of GAP tomatoes likely contributed to higher consumer acceptability. Such improvements in quality and safety are increasingly important for consumers, whose purchasing decisions are strongly influenced by their perceptions of health and food safety. In recent years, consumer choices have increasingly been shaped by growing concerns about food health and safety (Timpanaro et al., 2020). Globally, consumers are willing to pay a premium for food perceived as healthy and safe. For instance, Malawian mothers expressed an intention to spend more on nutritious food (Flax et al., 2021), and Turkish consumers demonstrated a willingness to pay for the inclusion of a food safety label (Akgüngör et al., 2001).

These findings demonstrate that adherence to Good Agricultural Practices enhances the sensory attributes and overall consumer acceptability. This is consistent with research showing that optimized agronomic practices result in more uniform sensory outcomes and improved consumer acceptability (Sinesio et al., 2021). The findings revealed a statistically significant rise in the average WTP for GAP-certified tomatoes over non-GAP ones ($t(179) = 9.20$, $p < 0.001$). These results align with previous research (Kalyana Sundram & Matthew, 2025), who reported that consumers are highly aware of and inclined to purchase GAP-certified vegetables, often willing to pay extra premiums for them. Similarly, (Hoek et al., 2017) showed that consumers have a stronger preference for products with both health and environmental labels compared to those with just one label.

4. CONCLUSION AND RECOMMENDATION

This research clearly demonstrates that implementing Good Agricultural Practices (GAP) in the cultivation of greenhouse tomatoes significantly enhances essential sensory qualities and positively affects consumer preferences. Tomatoes produced using GAP consistently surpassed those grown without it in terms of appearance, aroma, flavor, and overall acceptability, indicating that superior agronomic management directly results in better sensory quality. The strong correlations found among sensory attributes, particularly between flavor and overall acceptability, underscore the crucial role of flavor perception in achieving consumer satisfaction. Although texture did not show significant differences between the treatments, the consistently higher ratings in other attributes suggest that GAP contributes to a sensory profile that consumers find more appealing.

Significantly, the willingness-to-pay findings reveal that consumers place a greater financial value on tomatoes produced under GAP, reflecting a robust market demand for produce considered safer and of higher quality. This is consistent with broader public health advantages, as implementing GAP minimizes contamination risks and guarantees safer, superior-quality tomatoes for consumers. The combined economic, sensory, and health benefits underscore the considerable potential for enhanced profitability and community welfare through the extensive adoption of GAP.

In summary, the results indicate that GAP provides a feasible route for enhancing fruit quality, consumer satisfaction, food safety, and profitability in Mogadishu's growing greenhouse industry. Policymakers, agricultural extension services, and producers should focus on promoting GAP and building capacity as a strategic method to improve the performance, safety, and sustainability of the tomato value chain in Somalia.

Practically, this could include training programs, technical support, and incentives for adopting GAP. From a policy perspective, integrating GAP standards into agricultural guidelines and quality certification systems could enhance food safety and competitiveness. Theoretically, these findings contribute to the understanding of how structured agricultural practices influence crop quality, consumer preference, and economic outcomes in developing-country greenhouse systems.

Acknowledgments

The authors would like to thank the Faculty Academic Committee for their ethical approval and all the panelists who participated in the sensory evaluation.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest Statement

The authors declare that they have no known financial or personal conflicts of interest that could influence the work reported in this paper.

Author Declaration

The authors affirm that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere.

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