VITESY

Test Report

Vitesy Fruit Bowl

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PRODUCT INTRODUCTION

The **Vitesy fruit bowl** is a system designed to improve the domestic preservation of fresh fruit through the combination of **passive ventilation** and **integrated active technology.** Its perforated structure promotes natural air exchange, limiting moisture accumulation and preventing condensation formation, while the technology acts on volatile compounds released by fruit, such as ethylene and odor molecules, helping to maintain a more stable microenvironment favorable to preservation. This synergy helps **slow down premature senescence processes,** preserve **tissue firmness,** and **reduce the conditions that favor microbial proliferation.**

FRUIT	INSIGHT
BANANA	Extends the optimal consumption window of bananas by **up to 5 days.**
	Helps preserve banana texture within the **optimal firmness range** for consumption.
KIWI & AVOCADO	The consumption propensity for kiwi and avocado stored in the Vitesy Fruit Bowl is maximal, with **a 0% discard rate,** compared to 77.8% in alternative storage conditions.
	The Vitesy Fruit Bowl **doubles the optimal consumption window** for kiwi and avocado fruits.
LEMON	In conditions of extreme stress (presence of an artificially inoculated infected fruit), Fruit Bowl reduced the incidence of fungal spoilage **from 80% to 20%.**

PANEL TEST AND TEXTURE PROFILE ANALYSIS WITH BANANAS

Climacteric fruit with rapid starch–pectin degradation

PREMISE

This study evaluated the effect of four different storage conditions on the post-harvest evolution of bananas (Musa spp.) over a **15-day period through Texture Profile Analysis** (TPA), **sensory evaluation**, and qualitative **microbiological observations.** Bananas are climacteric fruits characterized by an autocatalytic production of ethylene, the plant hormone responsible for triggering ripening and accelerating senescence. During maturation, enzymatic degradation of pectins and progressive weakening of cell walls lead to softening of the pulp, loss of elasticity, browning phenomena, and increased susceptibility to microbial spoilage. In domestic environments, these processes significantly reduce the optimal consumption window and contribute to food waste.

SETUP

Two consecutive experimental campaigns were conducted using four storage configurations on banana preservation at room temperature:

→ Perforated container with active technology (texture + panel)

→ Perforated container without active technology (only texture)

→ Open container (only texture)

→ Closed container (only panel)

Each configuration was replicated in **triplicate**, resulting in a total of **12 containers** evaluated. Each container housed **three bananas** from the same production batch, selected at a uniform pre-climacteric ripening stage. This approach ensured a reasonable homogeneity of the initial physiological conditions of the plant material, although the intrinsic biological variability of fresh fruit remains an unavoidable source of heterogeneity in post-harvest studies.

To simulate realistic domestic storage conditions and create a controlled ethylene stress environment, **three apples** were intentionally added to each setup, representing a stringent “worst-case” condition for evaluating the effectiveness of the preservation systems.

The perforated containers were designed to promote **passive cross-flow ventilation,** enabling gas exchange while maintaining sufficient humidity to avoid excessive dehydration. The active technology was intended to act on volatile compounds such as ethylene and odors, contributing to a more stable internal microenvironment.

Fruit quality evolution was evaluated through two complementary approaches:

→ **Sensory panel evaluation:** A sensory panel composed of 13 assessors differing in age, sex, cultural background, and ethnicity evaluated the samples. All samples were coded and presented in randomized order to minimize **order-related bias.** The panel evaluated multiple parameters (8) covering the full spectrum of perceivable quality characteristics (peel appearance, ripening uniformity, browning defects, aroma intensity, presence of off-odors, pulp consistency, freshness perception, and overall acceptability). An **overall appreciation score (OAS)** was then calculated to integrate all qualitative dimensions into a single synthetic judgment of product acceptability.

→ **Texture analysis:** Instrumental texture characterization was performed using a modified Texture Profile Analysis (TPA) protocol, providing an objective evaluation of fruit physiological status and enabling direct correlation between sensory perception and measurable physical parameters. The maximum compression force was used as an indicator of fruit firmness: high values reflected intact and turgid tissues typical of early ripening stages, while low values indicated advanced ripening and pectic degradation. Elastic recovery after compression was used to evaluate structural integrity, with higher elasticity associated with better tissue preservation and lower values indicating viscoplastic behavior typical of overripe fruit. The area under the force–time curve quantified the total energy required to deform the sample, integrating both elastic and viscous mechanical contributions.

RESULTS

Sensory Panel Evaluation

The **closed container and the perforated container with active technology** were included in the final sensory panel evaluation. The open-container condition was excluded because the bananas were considered unsuitable for sensory assessment due to severe external browning and poor visual acceptability.

The sensory panel produced the following results:

→ **Closed container:** total score = 634

→ **Perforated container with active technology:** total score = 774

The perforated container with active technology achieved a **22.1% higher overall appreciation score** compared to the closed container.

In addition, 9 out of 13 panelists explicitly stated a strong preference for bananas stored in the perforated container with active technology, describing them as more balanced in texture, freshness, and overall eating quality.

RESULTS
Texture Profile Analysis

Comparison Between Open Container and Active Perforated Systems: Bananas stored in the open condition showed the highest firmness values, reaching approximately **1490g**. While this indicates preservation of structural rigidity, the excessively high firmness was associated with significant water loss and incomplete ripening progression, leading to a less desirable eating texture. In contrast, the Vitesy systems maintained bananas' firmness values within the optimal consumption range. Bananas stored in the perforated configurations showed firmness values between **838 and 875g**, corresponding to the range identified in the scientific literature as optimal for fresh consumption (Loesecke ripening stage 5–6).

Comparison Between Active and Non-Active Perforated Systems: The perforated container equipped with active technology preserved tissue elasticity more effectively. Elastic recovery values above **45%** indicated a predominantly elastic mechanical behavior, characteristic of tissues with preserved cell wall integrity and good turgor maintenance. Conversely, the perforated control without active technology showed signs of accelerated structural degradation. Although this condition achieved relatively high sensory appreciation, it exhibited a dominant viscous component (up to **68.8%**), indicative of advanced pectin solubilization and irreversible tissue deformation.

CONCLUSIONS

Overall, the results demonstrate that the synergistic combination of passive ventilation and active conditioning technology creates a more stable storage microenvironment, capable of slowing ripening progression, preserving optimal texture and sensory quality, and extending the optimal consumption period by approximately five days while maintaining microbiological conditions compatible with a domestic shelf-life of at least fourteen days.

PANEL TEST WITH KIWI AND AVOCADO

Climacteric fruits with rapid breakdown of fibrous structure (kiwi) and progressive lipid-driven transition toward a creamy texture (avocado)

PREMISE

This study evaluated the effect of three different storage conditions on the post-harvest quality of avocado and kiwi fruit five days after purchase. Both fruits were selected due to their climacteric behavior and high sensitivity to ethylene-driven ripening processes, which strongly influence texture, aroma development, and overall consumer acceptance during domestic storage.

The objective was to compare how different microenvironment conditions affect sensory perception, ripening progression, and consumption suitability, with particular focus on the impact of passive ventilation and active conditioning technology in maintaining optimal fruit quality.

SETUP

The sensory evaluation involved a panel of **9 participants aged between 26 and 62 years,** with a mean age of **39.6 years**, representing a heterogeneous demographic distribution. The panel consisted of **55.6% males and 44.4% females.**

Three storage conditions were evaluated:

→ Open container (A)

→ Perforated container without technology (CF)

→ Perforated container with active technology (CFT)

Each configuration was replicated in triplicate, resulting in a total of 18 containers evaluated: 9 containers with avocados and apples, 9 with kiwis and apples. To simulate realistic domestic storage conditions and create a controlled ethylene stress environment, three apples were intentionally added to each setup, representing a stringent “worst-case” condition for evaluating the effectiveness of the preservation systems.

All samples were evaluated **5 days after purchase** under controlled sensory testing conditions. Samples were coded and presented in **randomized order** to reduce bias effects linked to sequence or expectation.

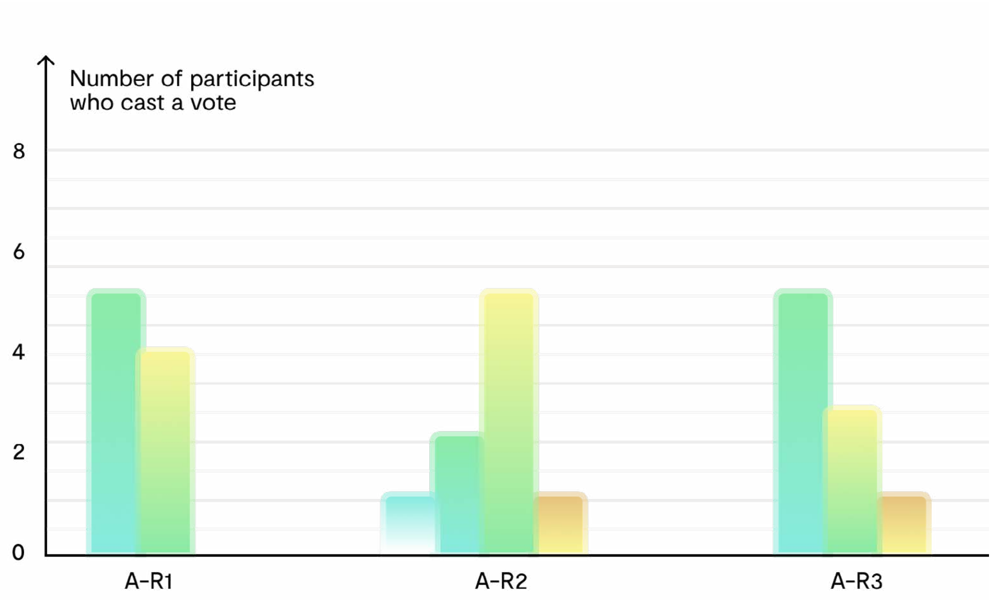
Each participant assessed multiple quality dimensions, including odor intensity, odor compatibility with consumption, visual appearance, ripening stage, texture adequacy, consumption propensity, discard likelihood, and reasons for rejection. This multidimensional approach allowed a comprehensive evaluation of perceived fruit quality and acceptability.

RESULTS

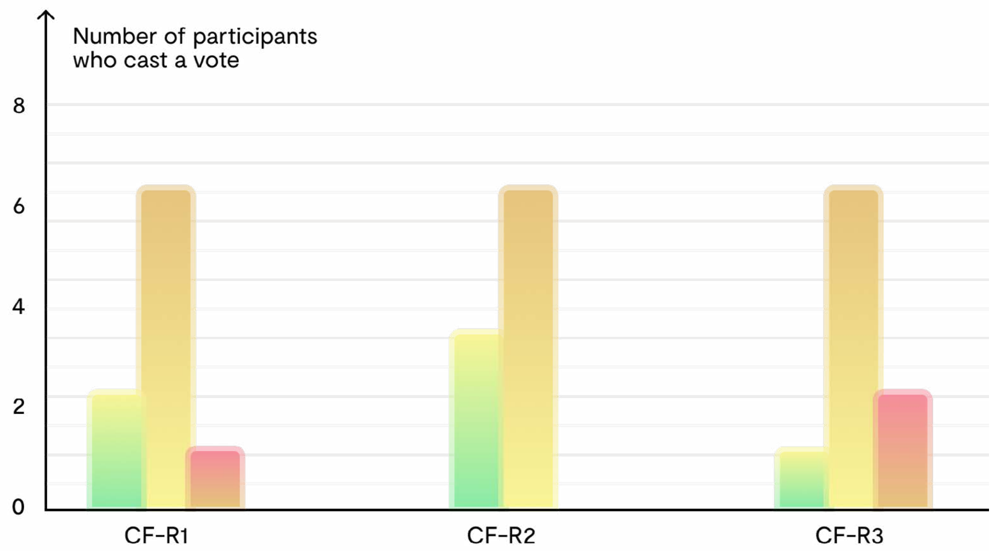
The results demonstrate that the storage conditions substantially influenced the perceived quality and consumption suitability of both avocado and kiwi, affecting key attributes such as ripening stage, texture, aroma profile, visual appearance, and propensity for consumption or discard.

RESULTS
Odor Profile and Compatibility with Consumption

Kiwi: Kiwi samples stored in the perforated system (CF) exhibited the highest odor intensity, likely associated with increased metabolic activity and volatile compound production. Open samples (A) showed a less developed aromatic profile, whereas the CFT condition maintained a balanced and controlled odor intensity. Consistently, CFT samples achieved the highest compatibility with consumption, while the open condition suffered from insufficient aroma development and the CF condition from excessive odor intensity.

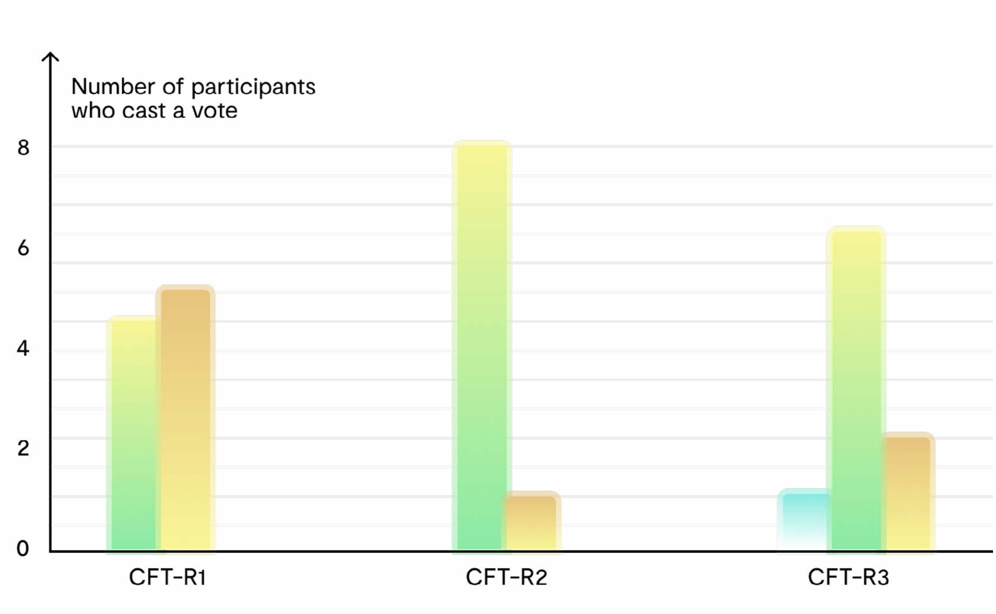


evaluation of the 3 open systems (traditional storage) used as control



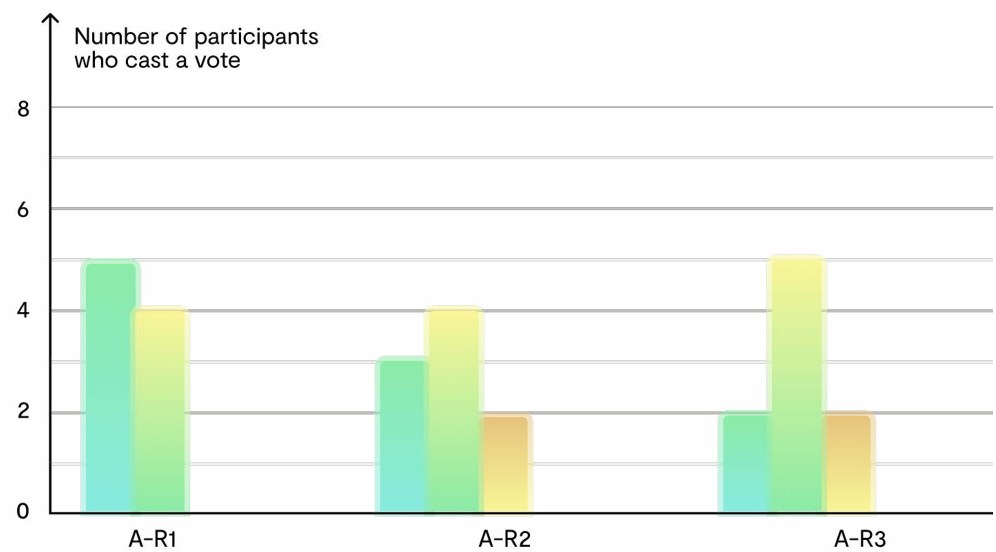
evaluation of the 3 perforated system without technology

Odor Profile and Compatibility with Consumption



evaluation of the 3 systems with technology and perforated system

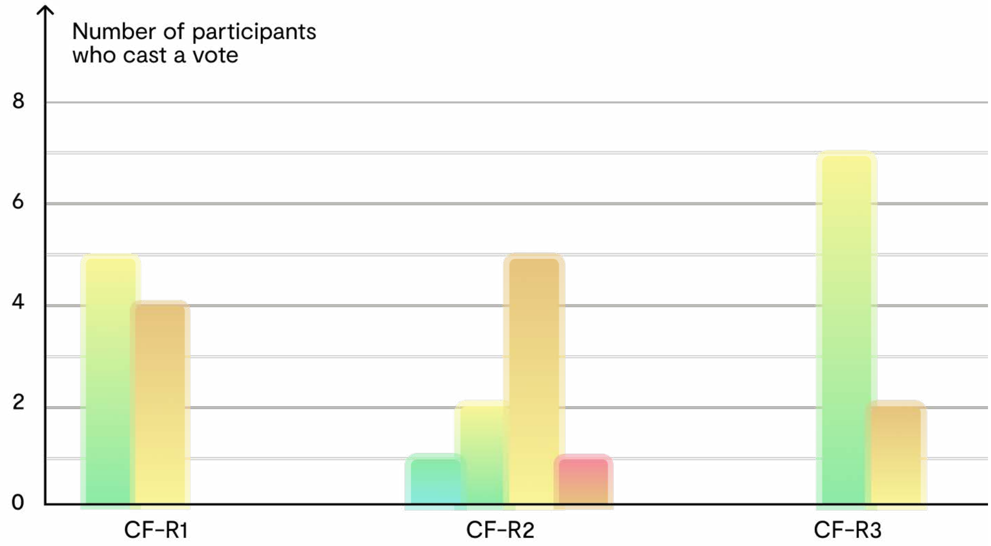
Avocado: The odor evaluation revealed clear differences among the storage conditions. Samples stored in the perforated system (CF) showed the highest odor intensity, suggesting greater accumulation of volatile compounds, while open samples (A) exhibited intermediate intensity. The CFT condition maintained a more controlled aromatic profile and was unanimously judged as compatible with consumption, indicating the highest olfactory acceptability. In contrast, open samples showed lower compatibility, while CF samples received more uncertain evaluations.



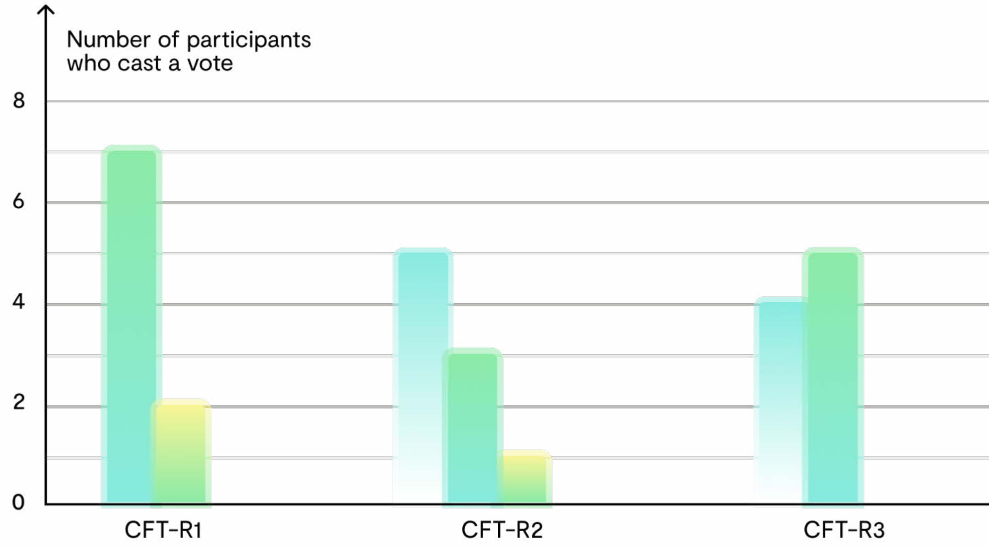
evaluation of the 3 open systems (traditional storage) used as control

Odor Profile and Compatibility with Consumption

evaluation of the 3 perforated system without technology

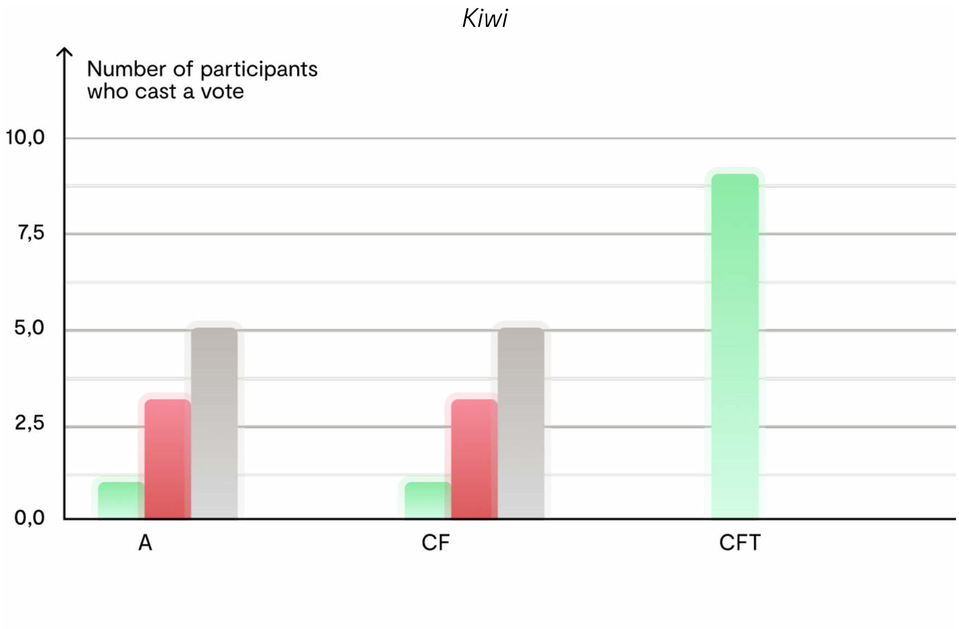


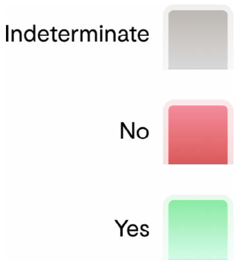
evaluation of the 3 systems with technology and perforated system

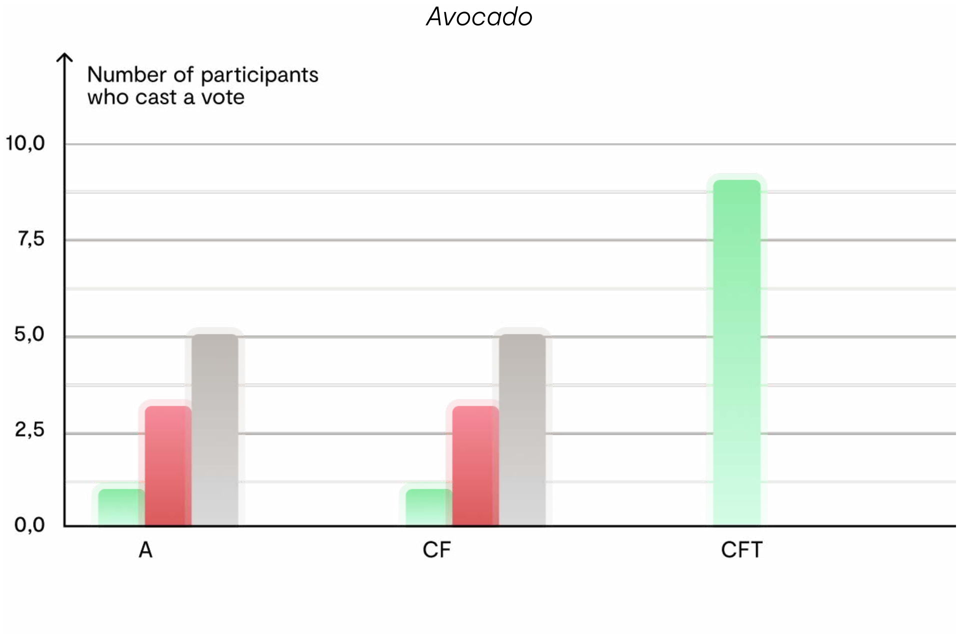


Odor Profile and Compatibility with Consumption

Is the odor of the sample compatible with consuption?



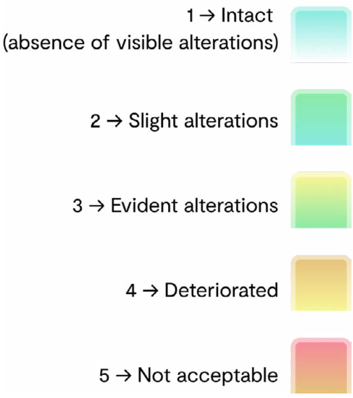


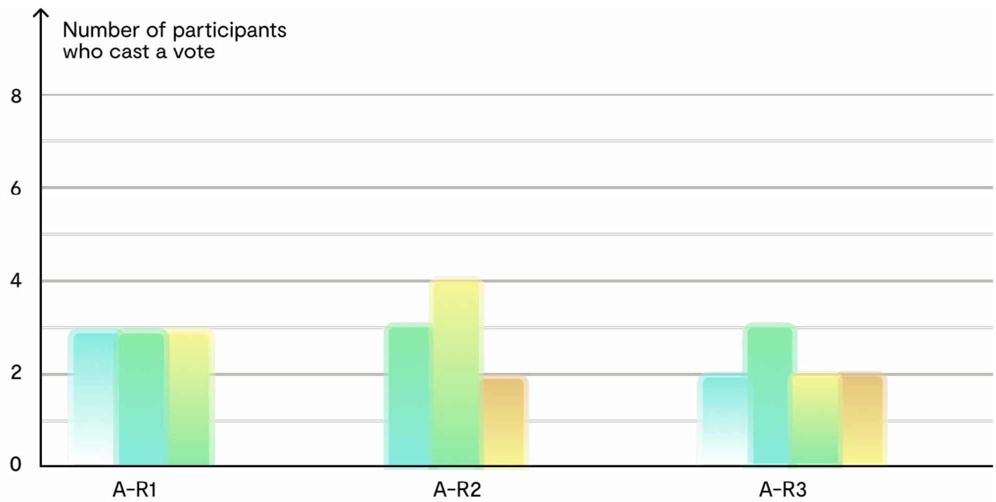


RESULTS

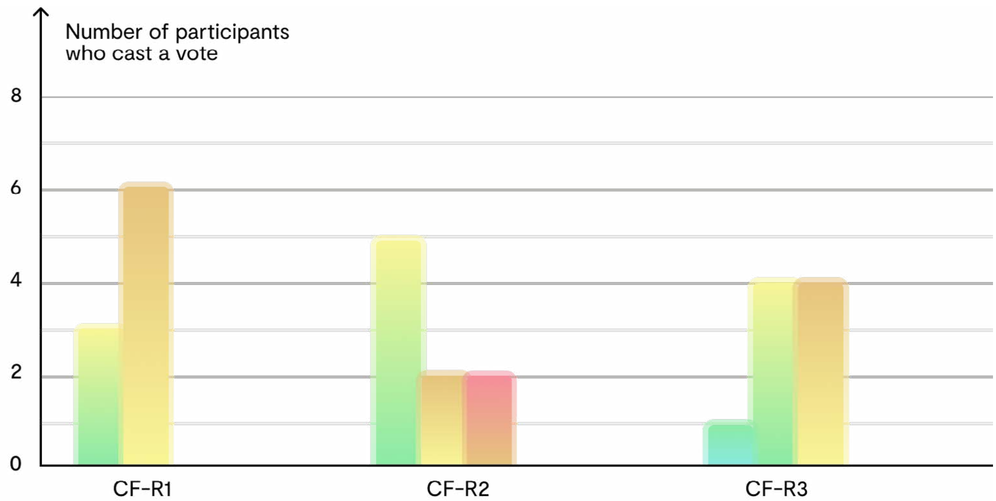
Visual Condition

Kiwi: The visual condition of kiwi samples differed among the storage conditions. Open samples (A) showed variability in evaluations, with the presence of both intact fruit and more evident alterations, indicating non-uniform visual quality. Samples stored in the perforated system (CF) exhibited a greater presence of visible defects and signs of deterioration, suggesting a more advanced progression of ripening-related degradation. The CFT condition showed the **highest levels of visual integrity**, with most evaluations falling into the “intact” category or indicating only minor alterations. This result suggests a greater ability of the system to preserve the visual quality of the product over time.





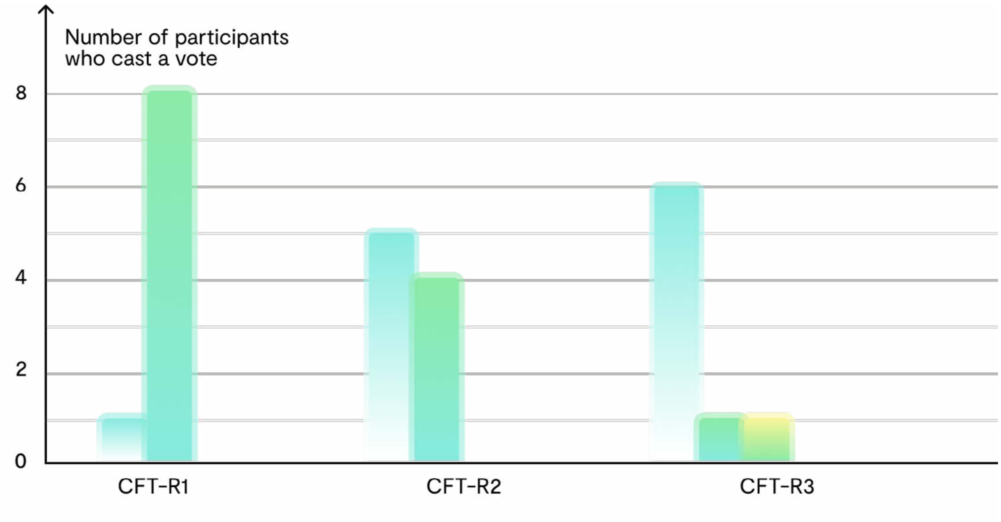
evaluation of the 3 open systems (traditional storage) used as control



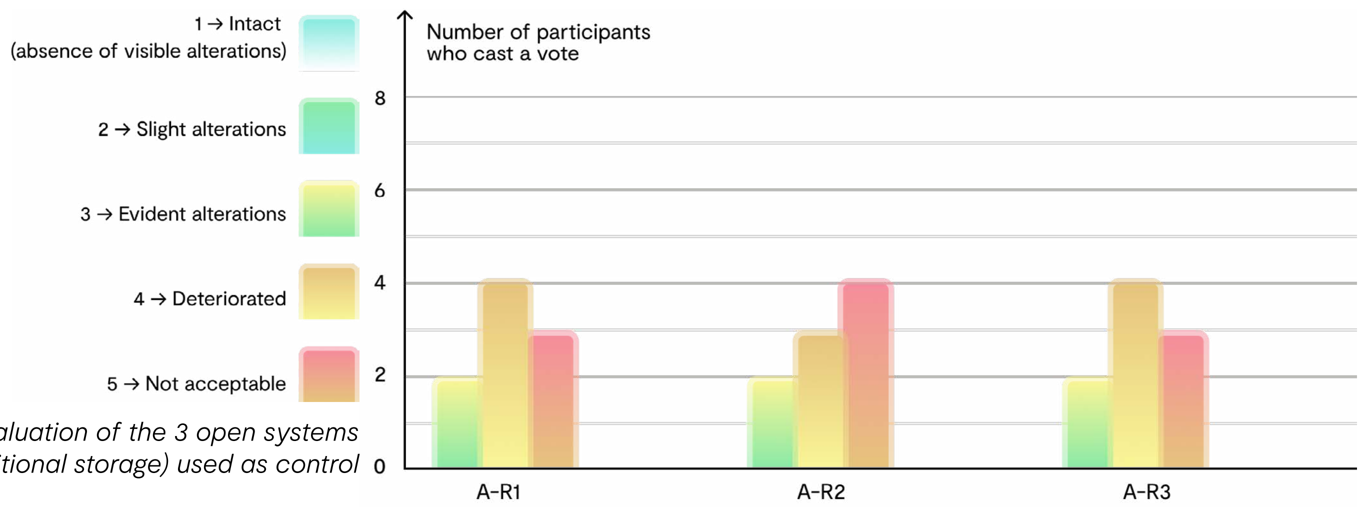
evaluation of the 3 perforated system without technology

Visual Condition

evaluation of the 3 systems with technology and perforated system



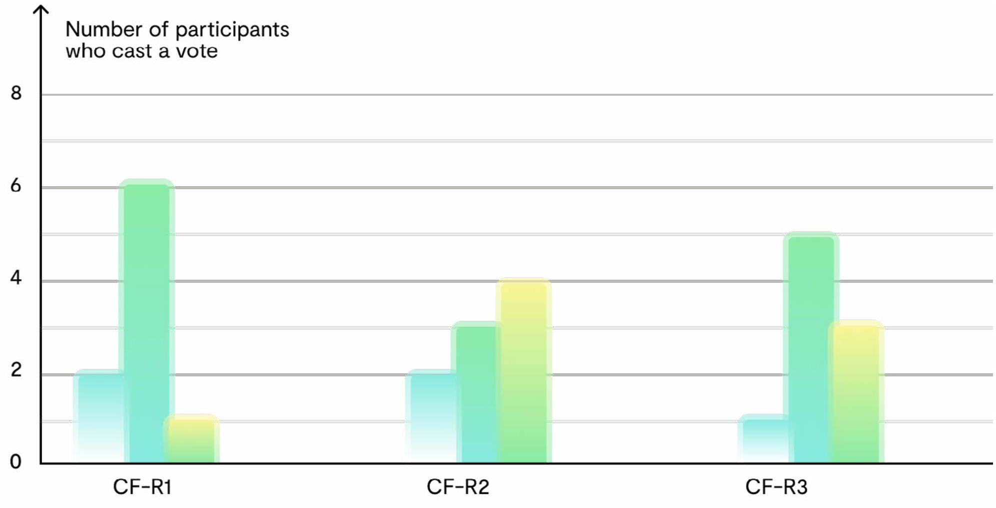
Avocado: Visual appearance showed differences among the storage conditions. Open samples exhibited **more pronounced deterioration, with a greater presence of defects and visible signs of spoilage.** The perforated system (CF) ensured the highest levels of visual integrity, while the CFT condition showed an intermediate quality level while still maintaining a good overall appearance.



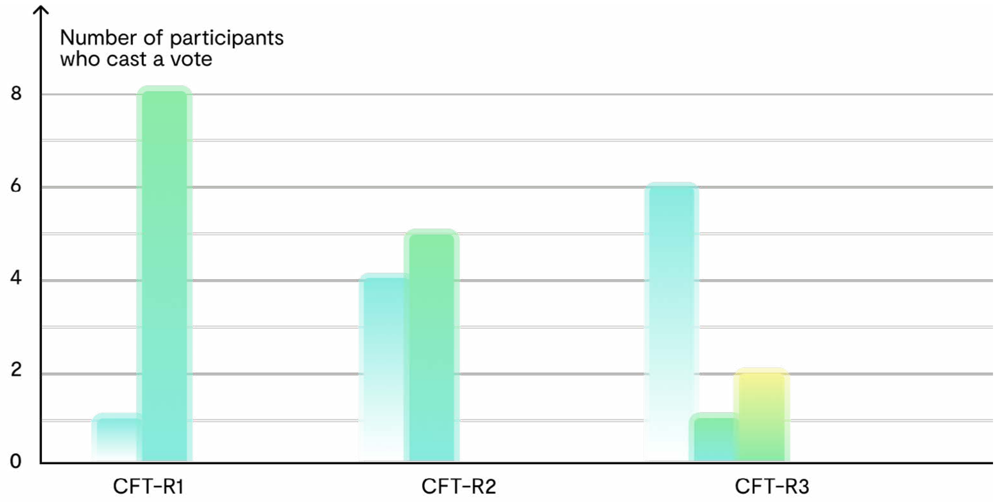
evaluation of the 3 open systems (traditional storage) used as control

Visual Condition

evaluation of the 3 perforated system without technology



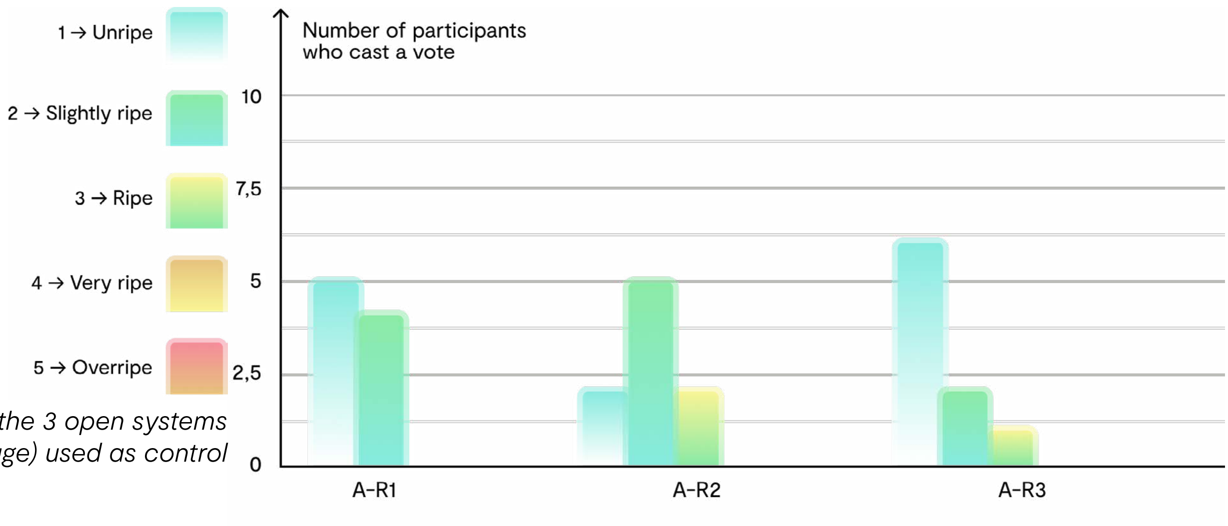
evaluation of the 3 systems with technology and perforated system



RESULTS

Ripening Stage

Kiwi: The evaluation of ripening stage showed different trends among the storage conditions. Open samples (A) were predominantly classified as unripe or insufficiently ripe, indicating a slowdown of the ripening process. In contrast, samples stored in the perforated system (CF) showed a distribution concentrated in more advanced stages, with a significant presence of fruit classified as very ripe or overripe, suggesting an acceleration of the ripening process. The CFT condition stood out for a distribution strongly concentrated in the "ripe" stage, indicating the achievement of an optimal condition for consumption. This result highlights the system's ability to promote a controlled evolution of the product, avoiding both delayed ripening and excessive advancement of maturity.



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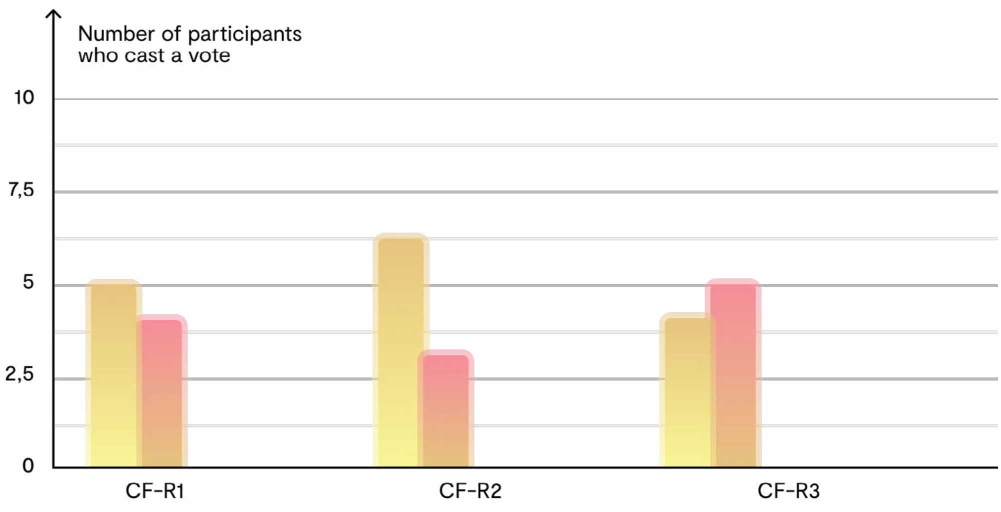
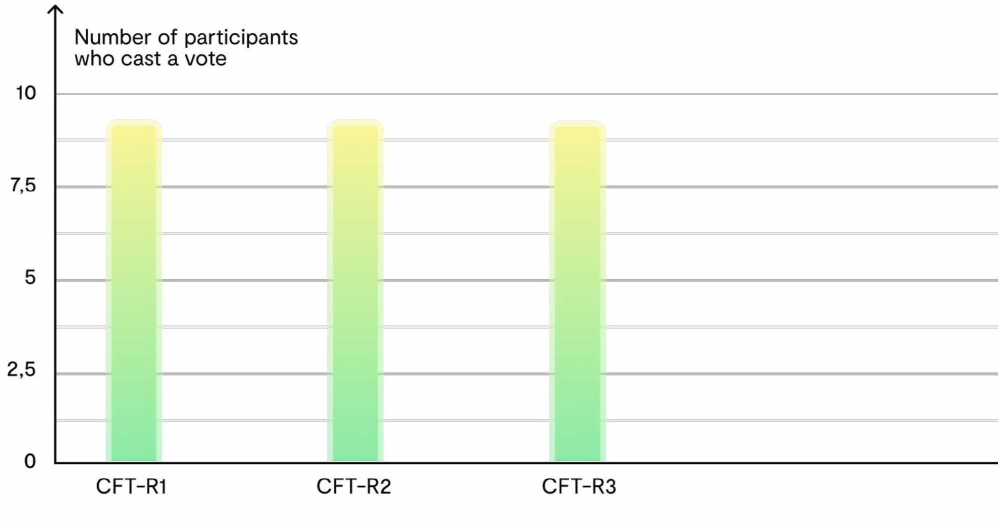


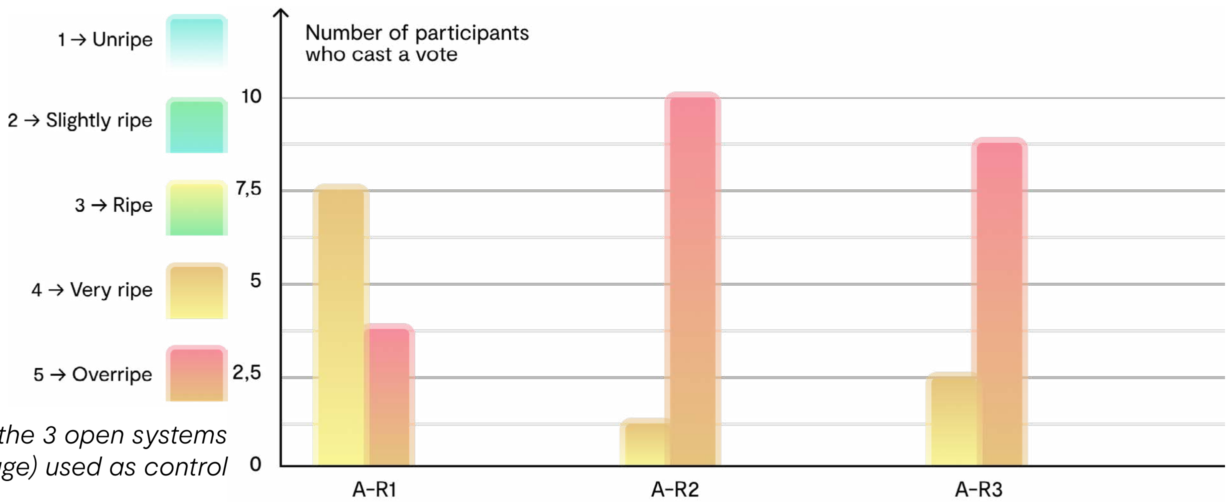
evaluation of the 3 perforated system without technology

Ripening Stage



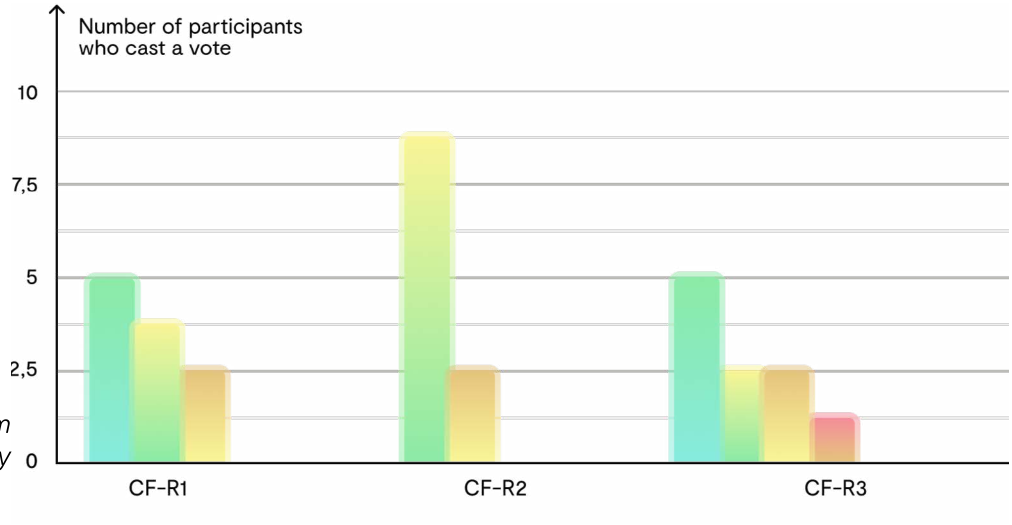
evaluation of the 3 systems with technology and perforated system

Avocado: The distribution of ripening stages revealed a clear distinction among storage conditions. Open samples were frequently classified as overripe, whereas the perforated system maintained fruit at a less advanced ripening stage. The CFT condition stood out for a distribution concentrated around the **optimal ripening stage,** making it the most suitable condition for consumption.

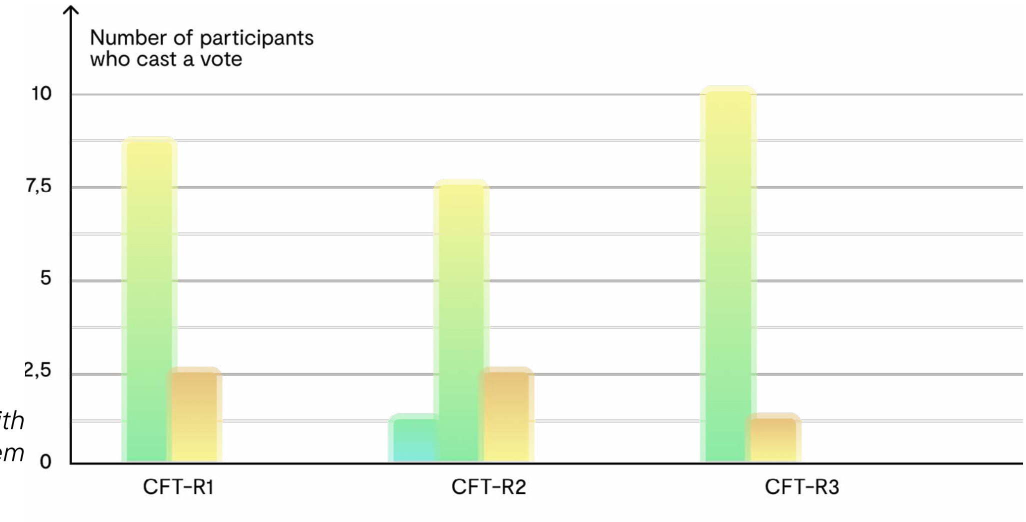


evaluation of the 3 open systems (traditional storage) used as control

Ripening Stage



evaluation of the 3 perforated system without technology

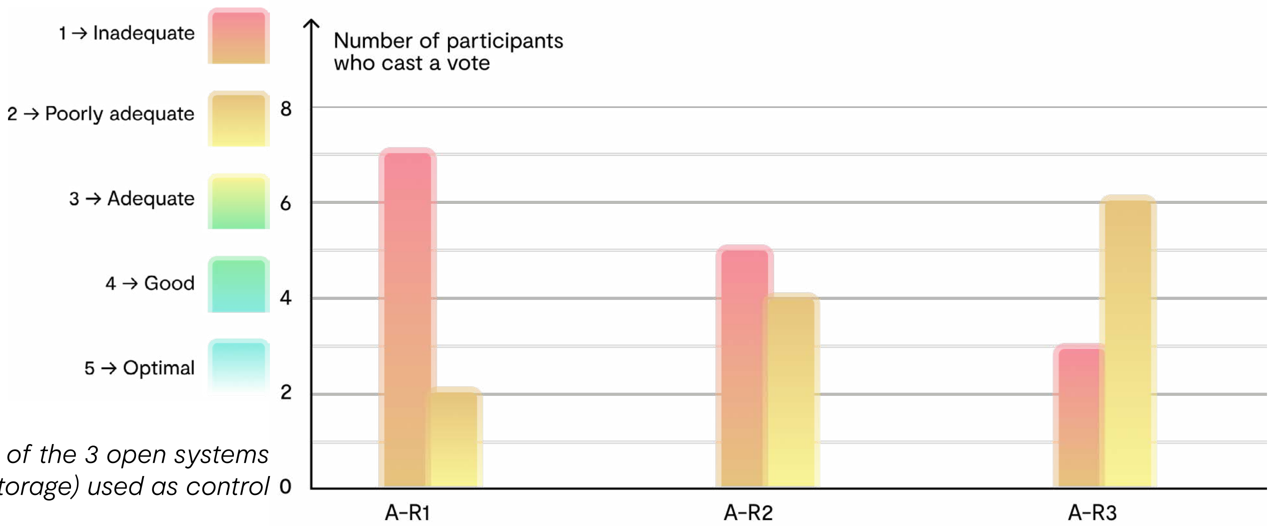


evaluation of the 3 systems with technology and perforated system

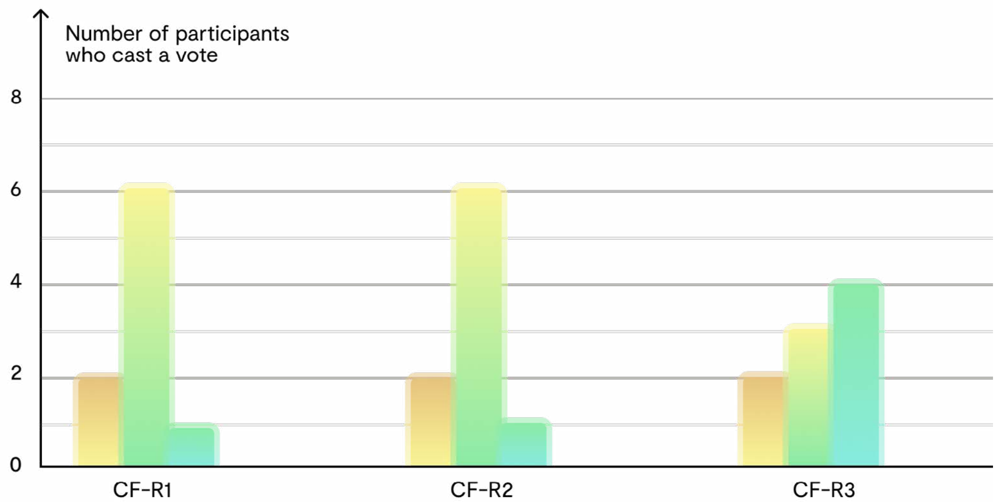
RESULTS

Texture Adequacy for Consumption

Kiwi: Texture evaluation revealed clear differences among the storage conditions. Open samples (A) were predominantly rated as inadequate or only slightly adequate for consumption, indicating a texture unsuitable for eating, likely associated with an unripe stage. Samples stored in the perforated system (CF) generally showed acceptable texture, with evaluations concentrated in the intermediate categories, suggesting an improvement compared to the open condition but without reaching optimal levels. The CFT condition achieved the **highest texture adequacy scores,** with most evaluations falling into the “good” and “optimal” categories. This result indicates a greater suitability for consumption, associated with a more balanced ripening stage.

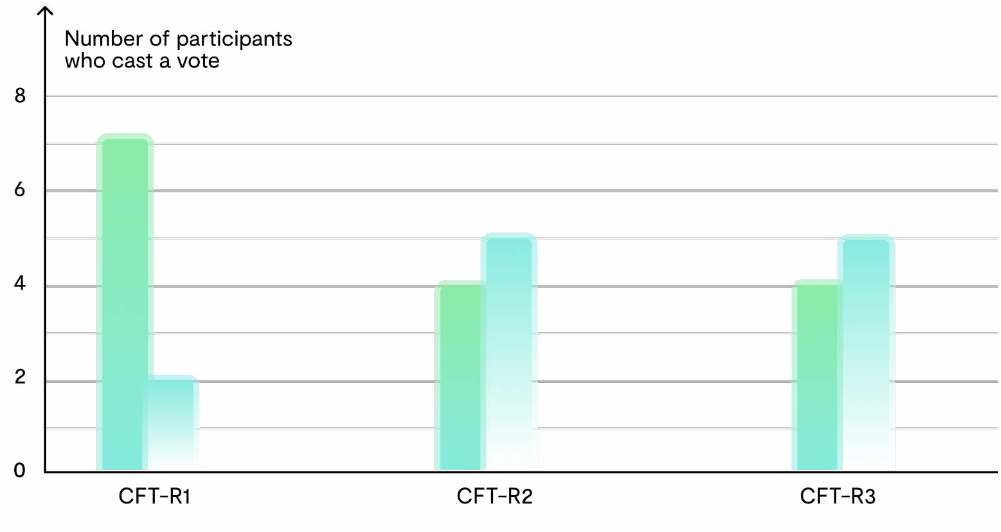


evaluation of the 3 open systems (traditional storage) used as control



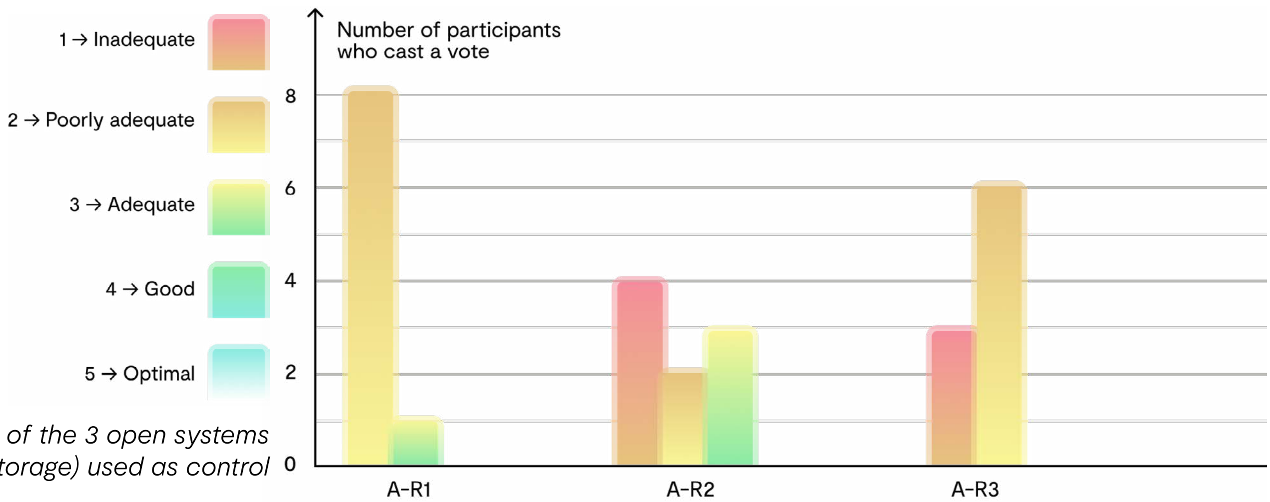
evaluation of the 3 perforated system without technology

Texture Adequacy for Consumption



evaluation of the 3 systems with technology and perforated system

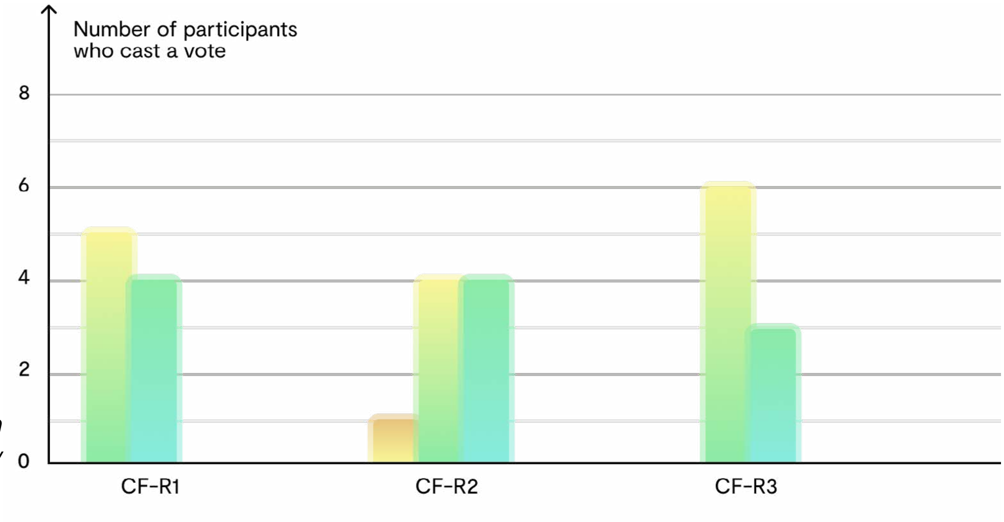
Avocado: Texture evaluations reflected the differences observed in ripening stage. Open samples were predominantly considered inadequate for consumption, indicating an unsuitable texture. The perforated system showed an intermediate condition, while the CFT condition achieved the highest levels of texture suitability, with a predominance of positive evaluations.



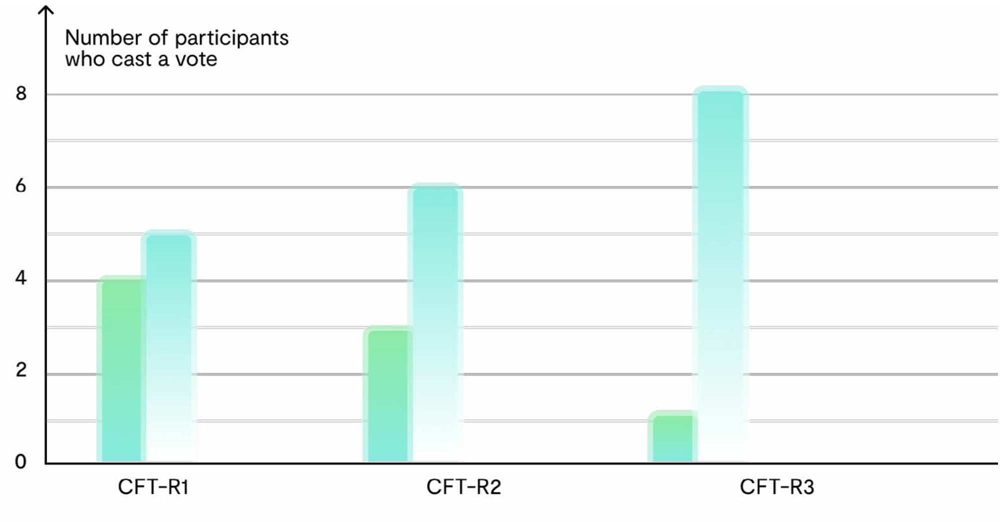
evaluation of the 3 open systems (traditional storage) used as control

Texture Adequacy for Consumption

evaluation of the 3 perforated system without technology



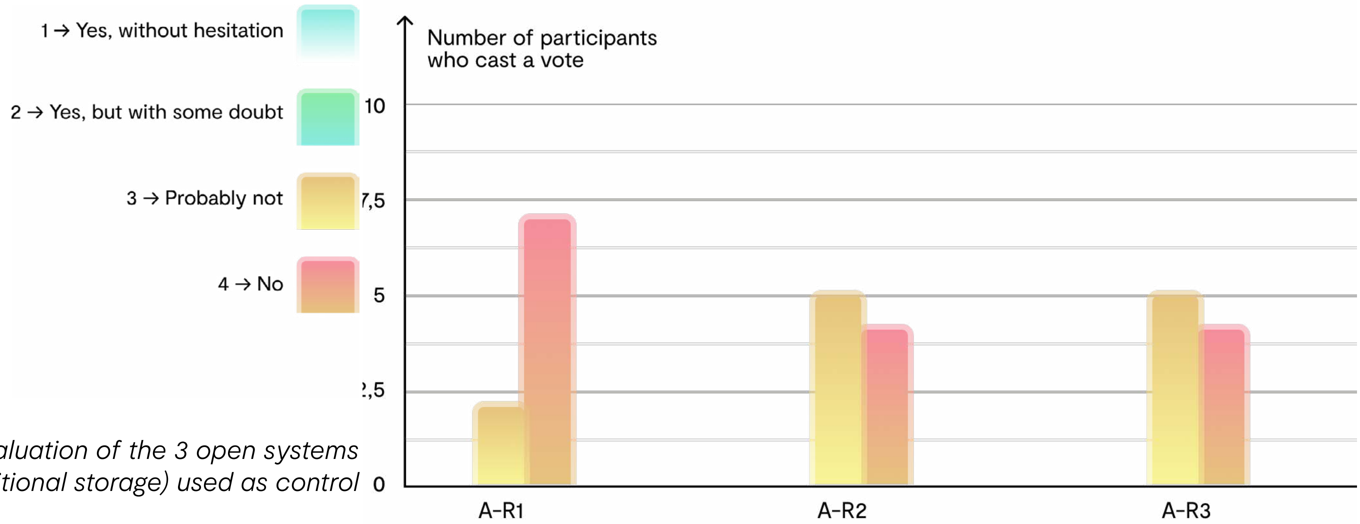
evaluation of the 3 systems with technology and perforated system



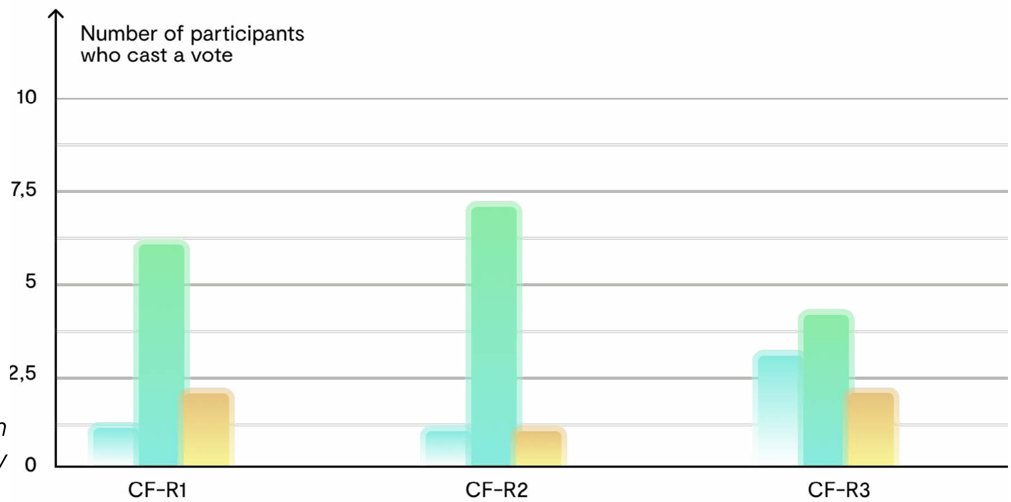
RESULTS

Consumption Propensity

Kiwi:onsumption propensity closely reflected the differences observed in texture and ripening stage. Open samples (A) were predominantly judged as not consumable or probably not consumable, indicating low overall acceptability. The perforated system (CF) showed an intermediate situation, with a predominance of responses corresponding to “yes, but with some doubts,” indicating limited and not fully convincing acceptability. The CFT condition stood out for a high willingness to consume, with most evaluations corresponding to **“yes, without hesitation.”** This demonstrates the system’s ability to produce fruit perceived as **ready and fully suitable for consumption.**

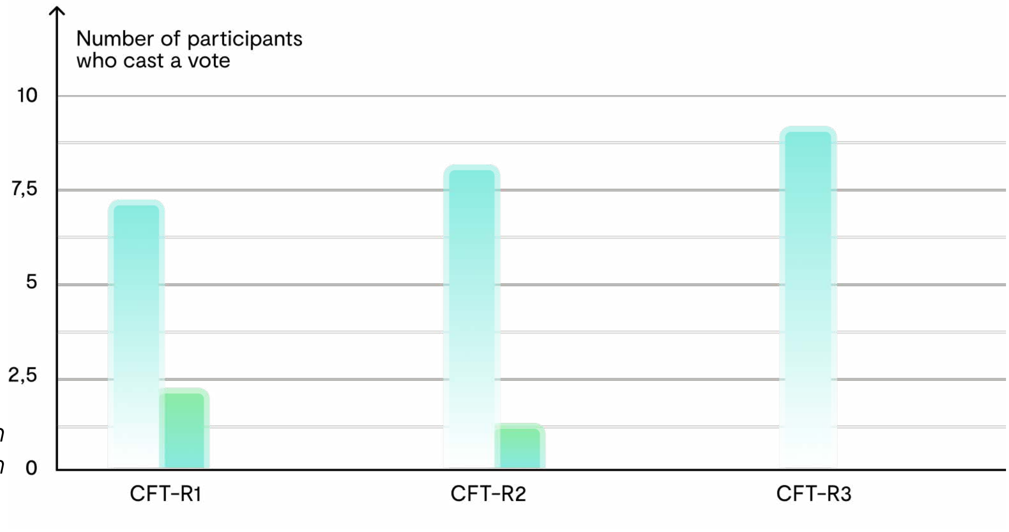


evaluation of the 3 open systems (traditional storage) used as control



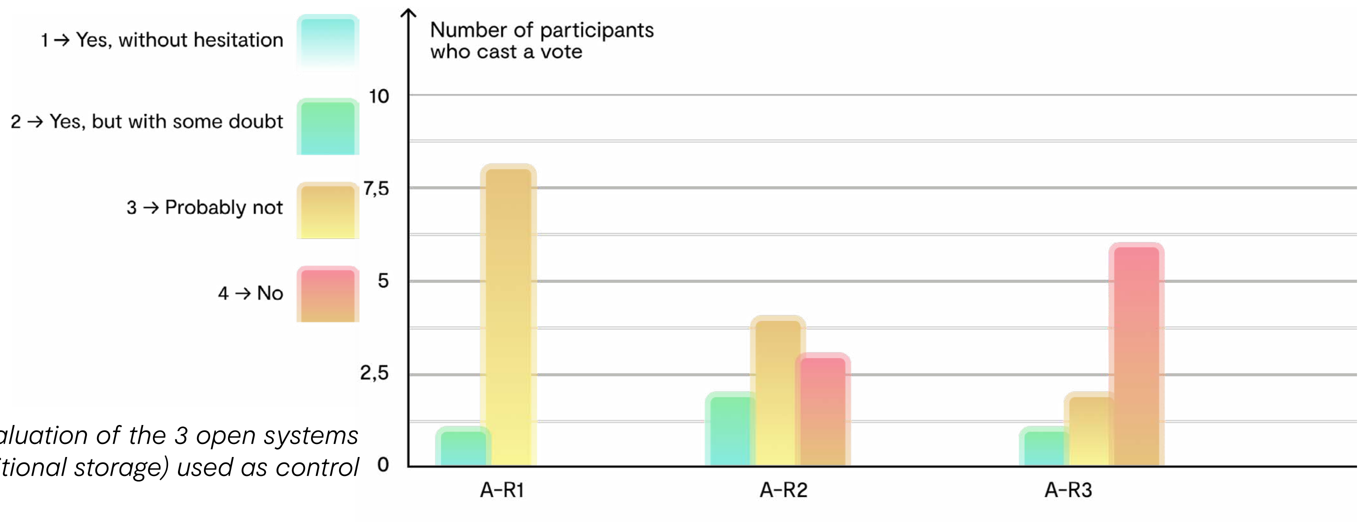
evaluation of the 3 perforated system without technology

Consumption Propensity



evaluation of the 3 systems with technology and perforated system

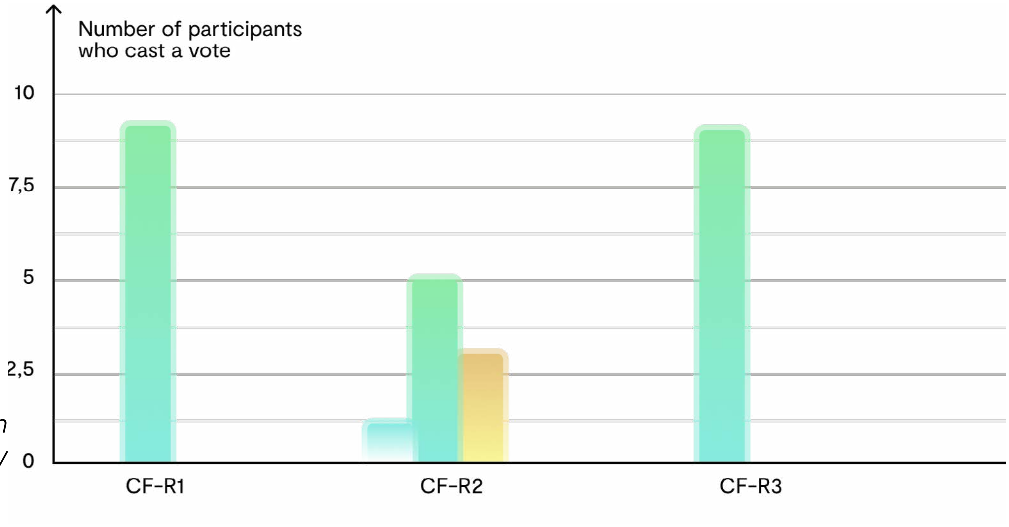
Avocado: Consumption propensity confirmed the trends observed in the previous evaluations. Samples stored under the CFT condition were judged ready for consumption without hesitation, indicating maximum acceptability. Open samples showed low willingness to consume, while the perforated system exhibited an intermediate condition, characterized by uncertainty among participants.



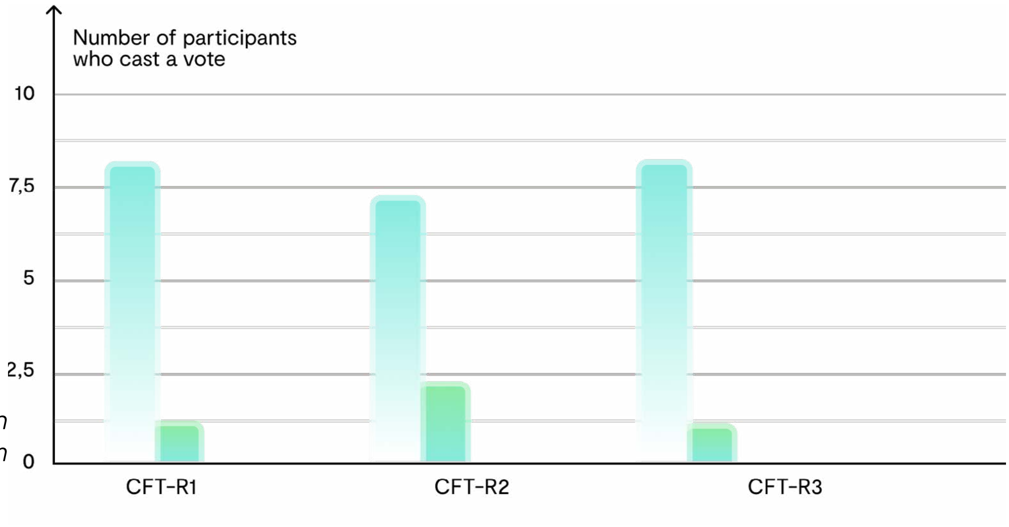
evaluation of the 3 open systems (traditional storage) used as control

Consumption Propensity

evaluation of the 3 perforated system without technology



evaluation of the 3 systems with technology and perforated system

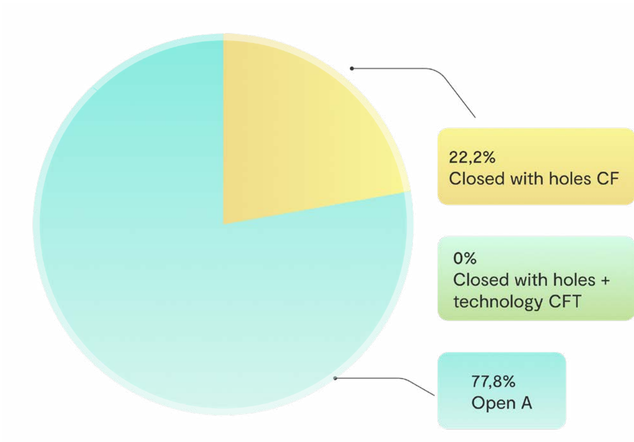


RESULTS

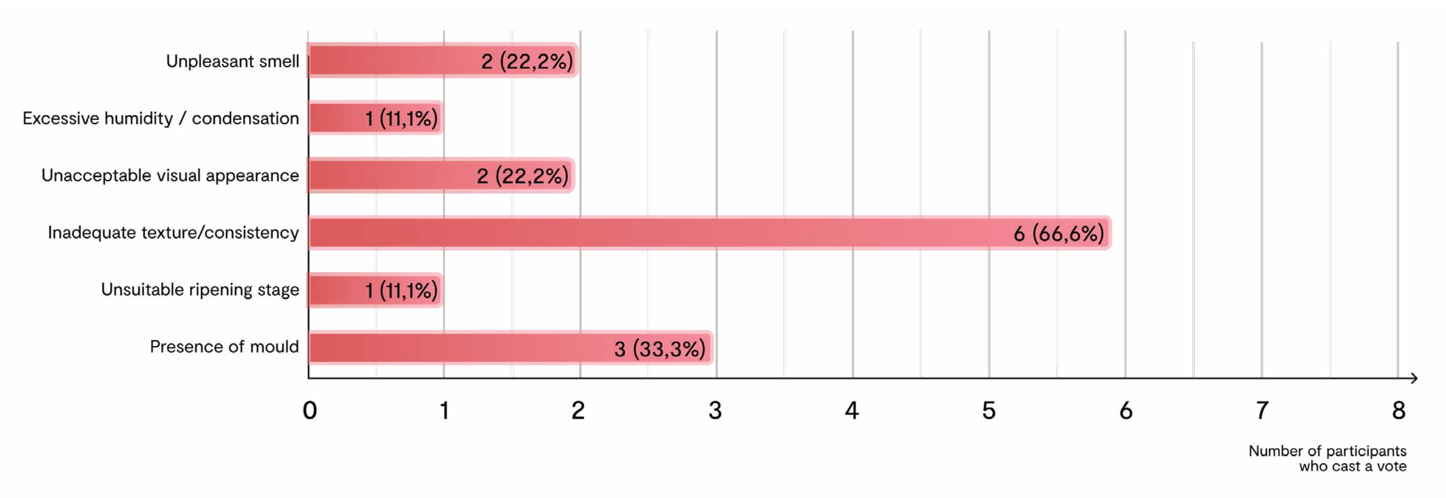
Discard Propensity and Reasons for Rejection

Both in kiwi and avocado discard propensity showed marked differences among storage conditions. Open samples (A) were by far the most frequently associated with rejection, representing the majority of the choices expressed by participants. The perforated system (CF) was associated with discard less frequently, while the CFT condition was never associated with product rejection.

→ **Kiwi:** The main reason for rejection was **inadequate texture,** identified by most participants. **Mold presence** and **visual defects** followed with lower frequency.

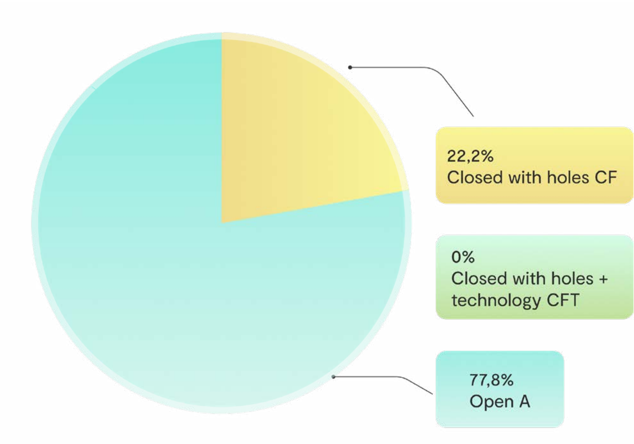


main reasons why the products were rejected



Discard Propensity and Reasons for Rejection

→ **Avocado:** Analysis of the reasons for rejection showed that the main determining factor was **inadequate texture,** followed by **visual defects** and an **unsuitable ripening stage.**



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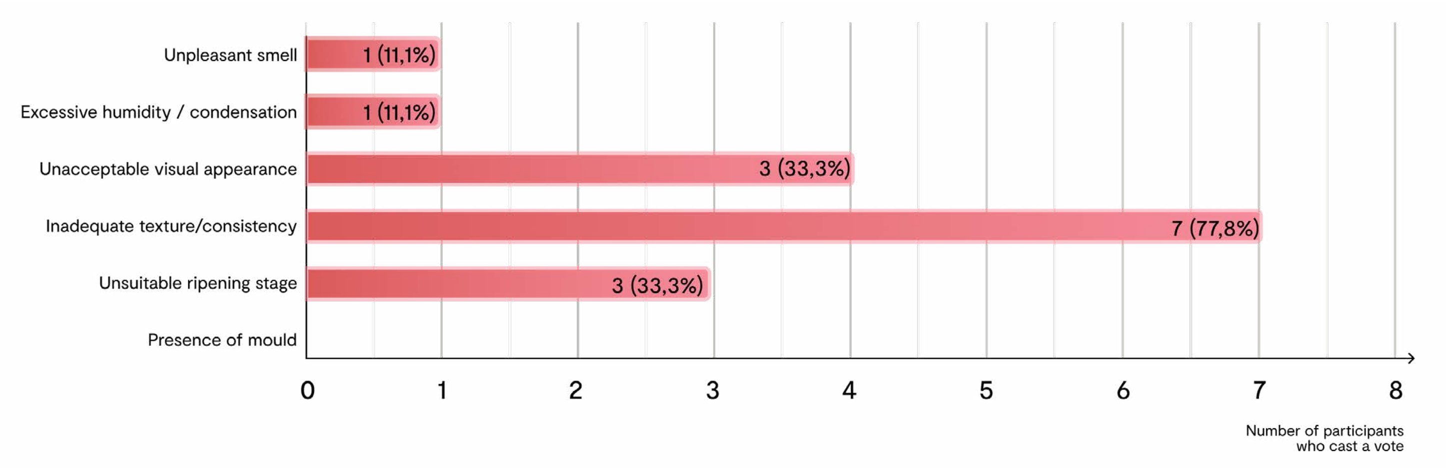

Overall, these results confirm the higher acceptability of samples stored under the CFT condition, which were **never associated with product discard and consistently showed the lowest rejection risk among all tested storage conditions.**

CONCLUSIONS

The results highlight **clear and consistent differences among storage conditions** for both **avocado and kiwi**. Open storage led to the poorest overall performance, characterized by either accelerated deterioration or unbalanced ripening, resulting in low acceptability and high discard propensity.

The perforated system without active technology provided partial improvement in product preservation but showed variability in ripening progression, often leading to either excessive volatile accumulation or insufficient aroma development depending on the fruit.

The **perforated container with active technology** (CFT) consistently delivered the **best performance** across all evaluated parameters. It ensured **optimal ripening stage, improved sensory balance, highest consumption propensity, and complete elimination of discard** cases within the panel. Overall, CFT demonstrated the **most effective control of fruit evolution,** maintaining avocado and kiwi within the most desirable consumption window while optimizing perceived quality and consumer acceptance.

FUNGAL PROPAGATION IN LEMONS UNDER CONTROLLED INOCULATION CONDITIONS

Non-climacteric fruits highly sensitive to post-harvest fungal contamination

PREMISE

This study investigated the effect of different storage configurations on fungal propagation in lemons (Citrus limon) under controlled inoculation conditions. Lemons are non-climacteric fruits particularly susceptible to post-harvest fungal contamination, especially in the presence of surface moisture and pre-existing infection sources. In this context, Penicillium spp. represents one of the most relevant pathogens responsible for spoilage and cross-contamination during storage.

The objective of the test was to evaluate how different microenvironment conditions influence the spread of fungal infection from a single inoculated fruit to adjacent healthy fruits within the same storage system, simulating a worst-case contamination scenario typical of domestic handling and storage.

SETUP

The study evaluated the effect of different storage configurations on fungal propagation in lemons under controlled contamination conditions. Each experimental unit consisted of **five lemons per container,** with the following conditions tested:

→ Open container

→ Perforated closed containers without active technology

→ Perforated closed containers with active technology

Each configuration was replicated in duplicate, resulting in a total of 6 containers evaluated. In each container, one lemon was artificially inoculated with Penicillium spp. to simulate a controlled infection source and trigger secondary fungal spread.

The design allowed evaluation of fungal diffusion dynamics under realistic worst-case contamination scenarios, including direct spore exposure and cross-contamination within confined microenvironments.

RESULTS

After **8 days of storage,** clear differences were observed among the tested conditions:

→ The **open containers** showed the highest incidence of fungal spread, with **approximately 80% of fruits affected,** confirming strong susceptibility to uncontrolled environmental exposure.

→ The **perforated closed containers without active technology** showed an intermediate behavior, with fungal propagation reaching **4 out of 5 fruits in one replicate,** and 2 out of 5 fruits in the other one indicating significant but not complete diffusion of the infection.

→ **The perforated closed containers with active technology** demonstrated the lowest level of contamination, with fungal incidence reduced to **approximately 20%**, indicating a strong inhibitory effect on propagation under inoculated conditions.

The observed effect appears to be **selectively inhibitory on fungal spread rather than sterilizing,** suggesting that the system acts by limiting diffusion dynamics rather than eliminating the inoculated microorganism.

Additionally, in the containers equipped with active technology, **no typical citrus aroma was perceived throughout the test duration.** This phenomenon is consistent with the adsorption or neutralization of volatile terpenes such as **limonene and ß-pinene,** which are responsible for the characteristic citrus odor profile.

CONCLUSIONS

The results indicate that the combination of perforated containment and active technology significantly reduces fungal propagation in lemons under controlled inoculation conditions, decreasing incidence from **80% in open systems to approximately 20% in treated systems.** The system also modifies the volatile profile of the stored fruit, reducing perceptible aroma compounds associated with citrus freshness.

Overall, the active configuration demonstrates a dual functional effect: limiting microbial spread and altering the headspace composition, thereby improving preservation performance under high microbial stress conditions.

VITESY