VITESY

Test Report

Shelfy

Test Report 2023 - Rev. 1 - 11/2023

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Test conducted in collaboration with CSI S.p.A. - IMQ Group

ACRONYMS USED IN THE DOCUMENT:

- **CFU** = Colony-Forming Units
- **GC-MS** = Gas Chromatography-Mass Spectrometry
- **F&V** = Fruit and Vegetables
- **PCA** = Plate Count Agar
- **PCO** = Photo-Catalytic Oxidation (purification technology used in Shelfy and other Vitesy Air Purifiers)
- **VOC(s)** = Volatile Organic Compound(s)
- **tVOC(s)** = total Volatile Organic Compound(s)
- **SAS** = Surface Air System

Insight

Pollutant		**Fridge size**	**Reduction %**	**Time**
Microbiological agents	Bacteria	S	99,37 %	10 minutes
	Natural Contamination	S	96 %	3 days
Odor	Real tVOC	M	80 %	5 hours
	Trimethylamine	S	73 %	5 hours
	Hexanal	M	85 %	24 hours
	Pentyl butyrate	M	88 %	24 hours
Ethylene	Ethylene	S	56,3 %	14 hours

Fridge size:

- Size S: 120-250 l
- Size M: 260 - 370 l

In scientific studies conducted, Shelfy has shown the ability to extend the shelf-life of fruits and vegetables up to 12 days under specific conditions. It's important to note that this extension of shelf-life is influenced by various factors (such as, for example, product seasonality, pre-storage conditions, refrigerator characteristics, frequency of refrigerator door openings, correct product placement within the refrigerator, overcrowding with other products, refrigerator power fluctuations, etc.), and therefore, results may vary significantly. Consequently, it is not possible to provide guarantees of identical outcomes for all foods or situations. We recommend always following storage guidelines and not considering the product as a safeguard against foodborne illnesses or spoilage.
Please remember that Shelfy acts on the air inside your refrigerator, not directly on the food.

Bacterial Load Reduction

Abatement of artificial bacterial load

Test conducted in collaboration with Chimicambiente s.r.l.

PREMISE

Microbial contamination in a refrigerator can lead to food spoilage. It is important to minimize microbial contamination to maintain a high level of food quality inside the refrigerator. In fact, microbial contamination (bacteria, yeast, and molds) accounts for **15% of post-harvest decay in fruits and vegetables**.

Bacillus subtilis is a Gram-positive bacterium belonging to the genus Bacillus, commonly found in the environment. While it is not a human pathogen, it contributes to the decomposition of foods such as vegetables, meat, and dairy products.

It has the ability to form spores, allowing it to survive in extreme environmental conditions. These spores can be transported into the refrigerator environment through the air or food itself and remain dormant, waiting for favorable conditions to germinate and grow, potentially leading to food contamination.

In general, strains of the Bacillus genus serve as important models for validation studies due to their versatility and resistance to external factors. This makes it possible to transfer the results obtained to other bacterial species, such as E. coli, Salmonella, and so on.

SETUP

We evaluated the effectiveness of bacterial reduction by Shelfy placed inside a 180L refrigerator. In order to assess microbial reduction significantly, an artificial contamination was created inside the refrigerator by nebulizing a suspension of **Bacillus Subtilis ATCC 6633** using an ultrasonic vaporizer. The laboratory's protocol for this evaluation involved the following steps:

1. Nebulization of the bacterial suspension inside the refrigerator for 20 minutes.

2. Stoppage of nebulization and activation of the device for the next **10 minutes** (device means “Shelfy” or an analogue device without photocatalytic activity that guarantees the same air flow).
3. Sampling of 30 liters of air through a specific hole created in the refrigerator using an active sampler for orthogonal impact **SAS** (Surface Air System), where an **agarized soil plate**, PCA (Plate Count Agar) was placed to allow the growth of microorganisms present in the air volume that impact on the soil itself.
4. Incubation of the plates at 30°C for 24-48 hours and subsequent quantification of viable microorganisms in the sampled air volume (ISTISAN Method 2013/37).

Microorganisms present in the air adhere to the soil and, after an adequate incubation period, give rise to colonies visible to the naked eye, which can be counted. The level of microbial contamination is expressed as **CFU** (Colony-Forming Units) **per cubic meter of air**.

The entire procedure was repeated both with the active device (Shelfy) and using a similar device in the same step, but without photocatalytic activity (White). This was done to eliminate the potential component of microbial reduction in the air due to the "natural deposition of aerosol particles on surfaces" and to compare results with and without Shelfy.

Furthermore, the entire procedure was repeated in multiple replicates to obtain **robust** and **reproducible data.**

RESULTS

A significant difference (see **Figure 1**) is observed between the test conducted with Shelfy and the test conducted without the photocatalytic technology. This difference indicates a mean logarithmic reduction of 2.2 with a standard deviation of 0.1. In practical terms, this translates to a remarkable **99.37%** reduction in the microbial load within just **10 minutes of operation**. In this result it is considered only tests with an initial inoculum greater than 10,000 CFU/m^3.

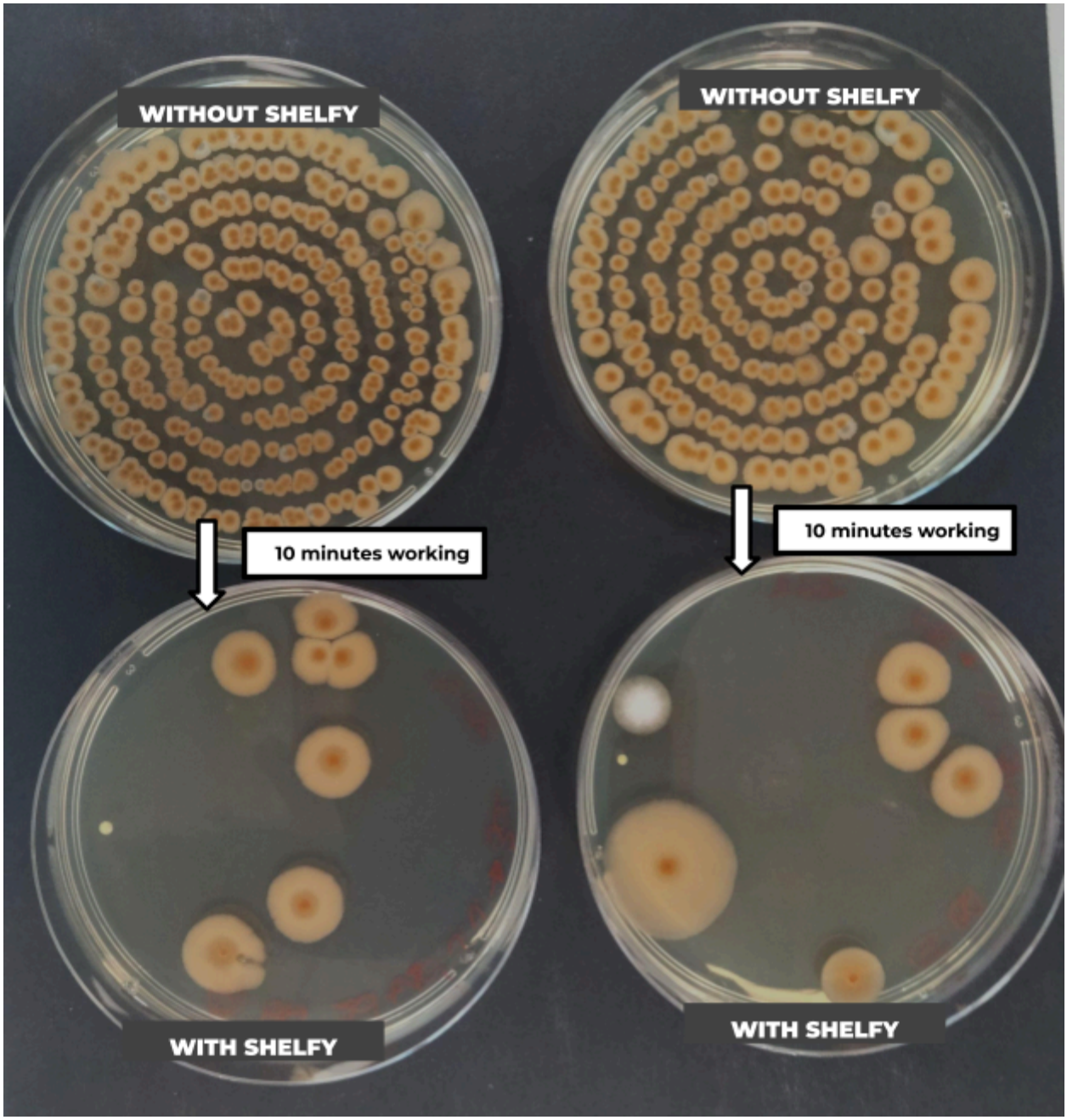

Figure 1 - PCA without Shelfy (left) and with Shelfy (right) after 10 minutes

CONCLUSIONS

From the test performed, it is shown that the tested product **is able to quickly remove bacteria in the air**, minimizing the fridge contamination.

Reduction of Microbial Load in the Air

Reduction of Naturally Occurring Airborne Bacterial and Fungal Load

Test conducted in collaboration with Università degli Studi di Udine

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PREMISE

Microbial contamination in a refrigerator can lead to food spoilage. It is important to minimize microbial contamination to maintain a high level of food quality inside the refrigerator. In fact, microbial contamination (bacteria, yeast, and molds) accounts for **15% of post-harvest decay in fruits and vegetables**.

SETUP

The effectiveness of reducing the **naturally occurring bacterial and fungal load** in the air using Shelfy was evaluated by placing it inside 2 identical 220-liter refrigerators:

- Refrigerator No. 1 - Control
- Refrigerator No. 2 - Containing Vitesy technology (Eco Mode)

The refrigerators were placed in the same room and close to each other. To homogenize internal contamination in the refrigerators, the doors were opened for approximately 5 hours. After the 5 hours, the refrigerators were closed and the Vitesy system was turned on. After 48 hours, the refrigerators were opened and culture media plates were placed on the shelves to evaluate the microbial load present.

The culture media included:

- 6 plates per refrigerator containing Plate Count Agar (PCA agar) for the evaluation of total bacterial load according to **ISO 4833**
- 6 plates per refrigerator containing Yeast Glucose Chloramphenicol Agar (YGC agar) for the evaluation of yeasts and molds according to **ISO 7954**

On each shelf of the refrigerator, 3 plates of each medium were placed.
The plates were open, the lid placed under the part containing the agar, and left for 3 days to facilitate gravity contamination by any microorganisms present in the refrigerator air.

After 3 days, the plates were retrieved, closed, and placed in an incubator at 25°C for 3-5 days to promote the development of contaminating microorganisms. Colony counts were then performed.

The test was repeated 2 times.

The data obtained from microbiological analyses were compared through statistical analysis: Analysis of Variance (One-Way ANOVA) and means were separated using Tukey's test.

RESULTS

Table 1 summarizes the contamination levels of the refrigerators with and without Shelfy.

	Test 1	Test 2
Fridge n.1	72.0 (16.9)	42.2 (15.2)
Fridge n.2 (with Shelfy)	2.1 (0.7)	2.0 (0.2)

Table 1 - Contamination levels: values are presented as the *mean (standard deviation)*

The microorganisms present on both the PCA and YGC Agar plates consisted of molds; no bacteria were observed.

As seen in both tests, the Vitesy technology reduced the microbial concentration in the air. This reduction was significant ($p < 0.05$) and varied depending on the test. In any case, a decrease in contamination was observed, with reductions of 97% in the first test and 95% in the second test, respectively.

CONCLUSIONS

From the tests conducted, it is evident that the tested product is capable of **rapidly reducing the naturally occurring bacterial and fungal load in the air**, minimizing contamination in the refrigerator.

Odor Reduction in Refrigerator:
Test in Real Refrigerator

Reduction of VOCs from natural sources

Test conducted in collaboration with ARCO SolutionS s.r.l., spin-off of University of Trieste

PREMISE

The objective of this test is to define the ability of the Vitesy device to keep the level of VOCs (Volatile Organic Compounds) in the refrigerator low. VOCs are emanated mainly from F&V (Fruits and Vegetables) during the various stages of ripening, and their presence inside the refrigerator **negatively affects the ripening of F&V itself**, accelerating it, and **the organoleptic properties**, i.e. the physical-chemical characteristics of a food perceived by the sense organs (smell, sight, taste).

In this test, **avocados** and **apples** are used to generate VOCs because they are climacteric foods and, as such, continue ripening after being detached from the plant. The ripening phenomenon is induced by **ethylene** (CH_2=CH_2), a colorless and odorless gaseous plant hormone that plays a crucial role in fruit growth, development and storage, even when present in small concentrations, such as ppm (parts per million) or even ppb (parts per billion). Climacteric food, as it ripens, produces ethylene; the more ethylene there is in the air, the more the food is stimulated to produce ethylene itself.

Apples and avocados are among the major ethylene emitters.

SETUP

Two refrigerators of the same brand and model were used for the tests. The internal volume is 370 liters, or 0.37 m^3. The refrigerators were set at 4°C.

Unripe avocados (hard to the touch) and three types of apples were purchased. Each food item was placed with the same arrangement in both refrigerators.

By means of Teflon tubes, air sampling points were created outside the refrigerator so that air sampling could be performed without opening the refrigerator doors. The air in each refrigerator is sampled on the shelf.

The Tiger Ion (PID technology), which measures the tVOC level in the refrigerator in isobutylene equivalent, was used to perform the sampling.

The Vitesy device is inserted in **refrigerator 1**.

VOC levels were recorded for 7 hours; the contamination occurred about ten minutes before t0.

RESULTS

The collected data were normalized using the Z-score. It can be seen that in refrigerator 1 the tVOC concentration remains constant for the first two hours thanks to the Vitesy device, after which it begins to decrease and in a little more than 4 hours returns to values comparable to the initial values (t:-2). **5 hours** after the forced increase in VOCs (t:0) with natural source in refrigerator 1 there is an **80%** reduction.

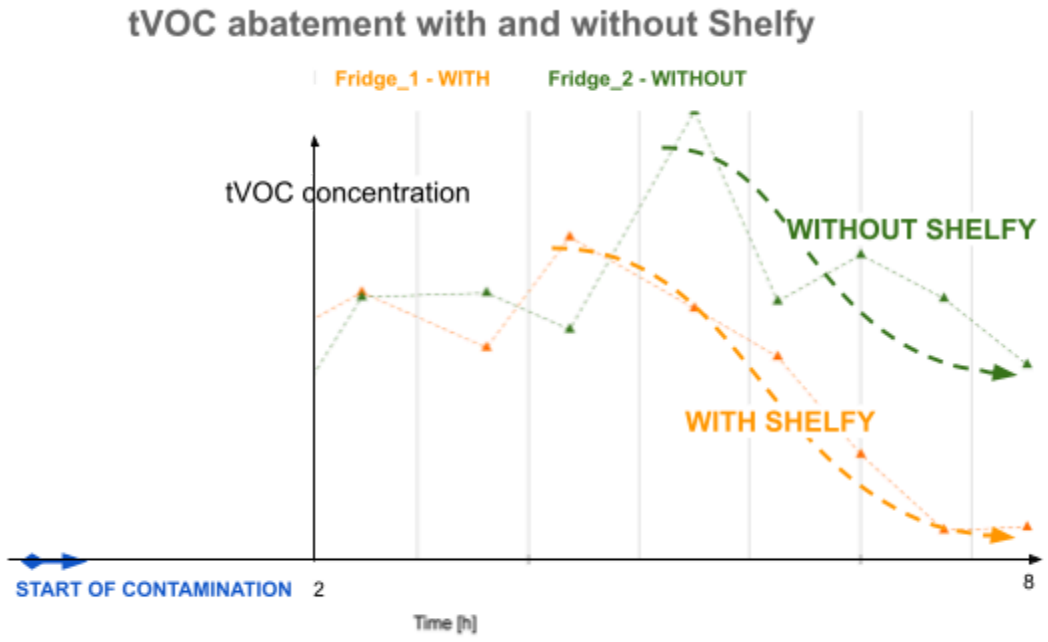


Figure 2 - tVOC (total Volatile Organic Compound) in the two fridges, *the orange curve represents the trend in refrigerator 1, i.e. with Shelfy, while the green curve represents refrigerator 2, without Shelfy (reference white)*

In the refrigerator without the Vitesy device, however, the concentration tends to increase in the first three hours, after which slowly decreases, without returning to values comparable to those at the beginning of the test.

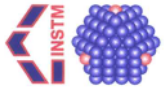
CONCLUSIONS

From the test performed, it is shown that the Vitesy device is able to **keep the level of VOCs inside the refrigerator low**; after increasing the tVOC concentration with natural source (avocados and apples) in the refrigerator, **in 5 hours there is an 80% reduction**.

Odor Reduction in Refrigerator:
Trimethylamine, Hexanal and Pentyl butyrate

Reduction of fish odor, spoiling meat and fermented cheese

Test conducted in collaboration with INSTM, University of Trieste Unit, and ARCO SolutionS s.r.l., spin-off of University of Trieste



PREMISE

The aim of the test is to determine the capabilities of the new Vitesy system to remove a target pollutant from a **closed system** (experimental setup). The identified pollutants are trimethylamine, hexanal and pentyl butyrate and tests have been conducted both with the product and without it, with scheduled sampling.

Trimethylamine is an organic compound known for emitting a **pungent** odor resembling **decomposing fish**. It is a nitrogen compound commonly associated with unpleasant odors in refrigerators.

Hexanal is an aldehyde with a sharp and unpleasant odor, often associated with moldy or rancid smells. Hexanal can develop as a result of the decomposition of foods containing fats, such as vegetable oils or certain types of meat.

Pentyl butyrate is an ester that can have an odor reminiscent of rancid butter or fermented cheese. It can develop when foods containing fats, such as butter or certain cheeses, begin to deteriorate due to lipid oxidation, giving it a fairly distinct and noticeable cheese/rancid aroma.

These compounds not only produce **unwanted odors inside the refrigerator** but also lead to **odor cross-contamination**. This is a process through which odors or aromas from one food item or substances within the fridge transfer to other foods or objects in the surrounding environment. This contamination can have a significant impact on the quality of food and the **overall sensory experience**, making food less appetizing or negatively affecting its taste.

SETUP - Trimethylamine

A cubic plexiglass box with an internal volume of **118 liters** was used for the tests. The plexiglass box was employed to exclude any air infiltrations and prevent dilution effects. This approach aligns with the type of environment being simulated, namely, an environment with limited air exchange, similar to the inside of **refrigerators**.

For qualitative characterization and to assess the reduction of trimethylamine, a **gas chromatograph coupled with a mass detector** equipped with a **thermal desorption system** was used. Compounds within the experimental box were extracted using a low-flow pump, adsorbed onto Tenax tubes, and then analyzed. The Tenax tubes were conditioned immediately before each test to ensure the absence of any volatile organic compounds (VOCs) that might be present. A low-flow pump (Gilian) was used for sample collection, enabling the acquisition of samples for analysis at a rate of 100 mL/min.

Considering the significance of **humidity** typically present inside refrigerators, the box was pre-treated to raise relative humidity levels.

To introduce the pollutant sample, which consisted of air containing trimethylamine, a syringe was employed. Ten minutes after introducing the sample into the test box to stabilize the trimethylamine concentration, samples were collected at predetermined intervals, with a focus on evaluating the m/z 58 ion (the most abundant and representative fragment of trimethylamine).

The test was conducted both with and without Shelfy.

SETUP - Hexanal and Pentyl butyrate

The device is placed inside the refrigerator in off-mode during the saturation of the environment with the pollutant. Hexanal aldehyde and pentyl butyrate were selected as the target molecules, and used in high concentrations, that is the equilibrium concentration of the vapor phase with the liquid phase in the refrigerator volume at the average temperature of 4°C and pressure of 1 atm. A sampling point was set up through a Teflon tube closed at the outer end by a tap with luer-lock connection so that ambient air sampling could be performed without opening the refrigerator door.

The refrigerator was contaminated with the tested target substance by leaving an open glass container containing 0.5 mL of the liquid pollutant inside the refrigerator for 16 hours. Then the container inside the refrigerator was closed and sampling was performed at time t=0, the vapor phase collected was placed in a glass vial with a cap

for headspace analysis containing 5 uL of internal standard. It was verified that the opening and closing of the door required to perform this operation did not significantly change the initial pollutant concentration.

The concentration of the pollutant was measured during 24-hours, by sampling at 0h - 2h - 5h - 24h, tests were performed with and without Shelfy, tests were performed on one pollutant per time.

The samples thus obtained were analyzed in triplicate at GC-MS, the results are related to the area of the internal standard.

RESULTS

Results are synthesized in **Figure 3**.

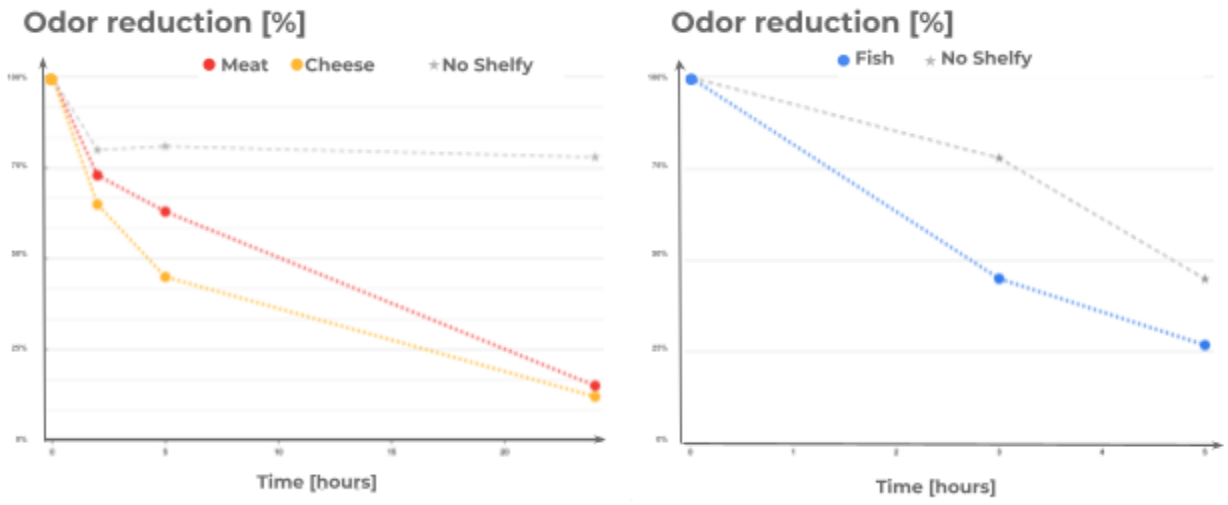


Figure 3 - Reduction of the target molecules

CONCLUSIONS

The Shelfy product tests were conducted **over several days** under conditions, particularly concerning humidity, that resemble those found inside refrigerators.

The choice of pollutants as the compound for these tests was primarily motivated by their characteristic odor and the need to avoid any interfering molecules in the air to be analyzed, which could lead to further assumptions.

Conducting individual tests on different days allowed for the cleaning and reconditioning of the facility, thus avoiding potential artifacts. This approach also ensured excellent reproducibility of the experimental setup.

From the test performed, it is shown that the **device is able to minimize the fridge cross-contamination** by neutralizing unwanted odors and maintaining a **healthy environment inside the refrigerator**.

Ethylene Reduction

Reduction of the aging accelerator of fruits and vegetables

Test conducted in collaboration with ACEA Infrastructure S.p.A. (Gruppo ACEA)

PREMISE

Ethylene is a colorless, odorless, gaseous plant hormone that plays a crucial role in the growth, development, and preservation of fruits and vegetables (F&V).

The removal of this molecule from the air helps slow down the ripening process and minimizes the spoilage of perishable products.

The quantity of ethylene emitted by F&V varies significantly depending on the type of product under analysis, its ripeness, and environmental conditions (such as humidity, the presence of gasses like oxygen and carbon dioxide, and temperature).

SETUP

A cubic plexiglass box with an internal volume of **210 liters** was used for the tests. The plexiglass box was employed to exclude any air infiltrations and prevent dilution effects. This approach aligns with the type of environment being simulated, namely, an environment with limited air exchange, similar to the inside of **refrigerators**.

The real time analysis has been conducted thanks to **SYFT Voice200 ULTRA Advanced SIFT Mass Spectrometer**, that provides instantaneous identification and quantitation of VOCs and inorganic gases using a fully integrated, extensive chemical ionization library.

Considering the significance of humidity typically present inside refrigerators, the box was pre-treated to raise relative humidity levels.

RESULTS

A significant difference is observed between the test conducted with Shelfy and the test conducted without the photocatalytic technology (see **Figure 4**). In **14 hours**, a decrease of only 5% was recorded in the control case, while in the Shelfy test, it reached approximately **56.3%**.

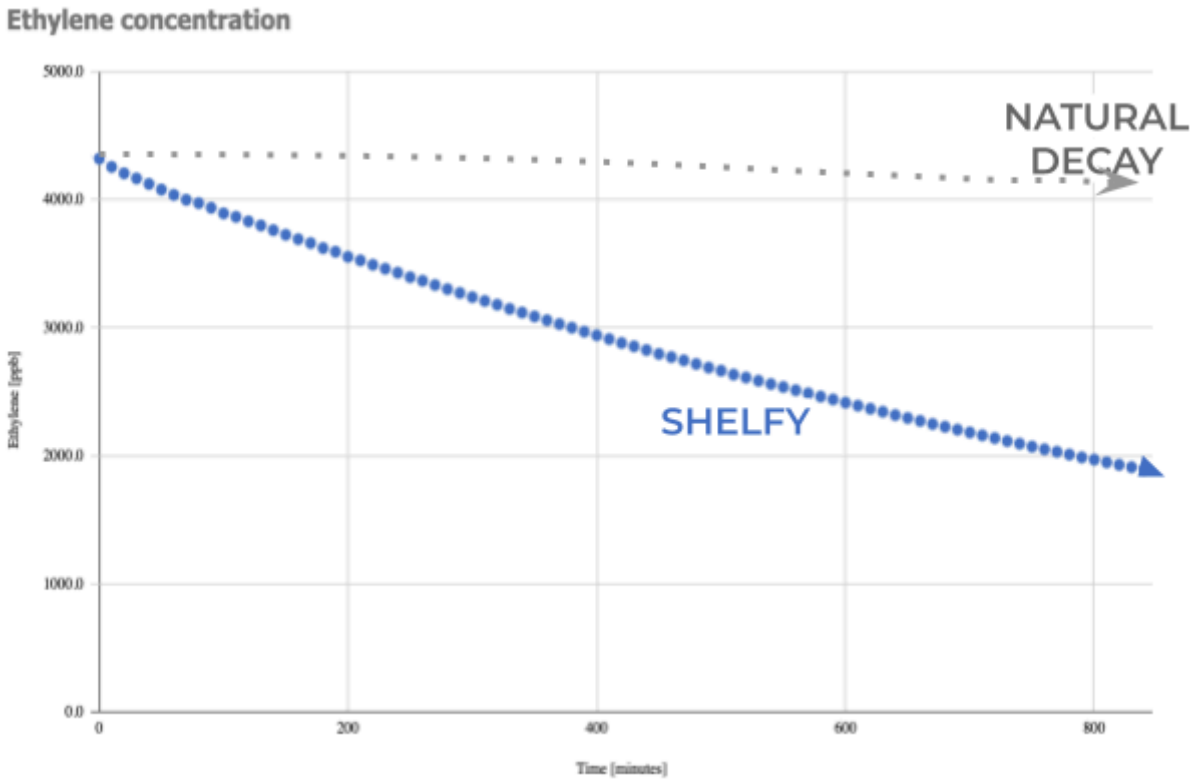


Figure 4 - Real time reduction of ethylene

CONCLUSIONS

From the test performed, it is shown that the device **is able to reduce the ethylene**.

Shelf-life Assessment of Fresh Food Products (fruits, vegetables)

Test conducted in collaboration with CSI S.p.A. (IMQ Group)

PREMISE

An experimental study was carried out according to a work plan defined in agreement with CSI Spa. The study was set up during the period 19/07 – 16/08/2022 at the FPM Laboratory - Food Packaging Materials of CSI Spa, at its Bollate (MI) facility.

The purpose of the test is to evaluate the effect of Shelfy in terms of prolonging the shelf life of fresh food products stored in the refrigerator.
Shelfy treats the air inside the refrigerator through photocatalysis, removing odors and microorganisms such as mold and bacteria.
To carry out this evaluation, the test involved storing fresh food products inside the refrigerator.
As requested by Vitesy, the types of products tested are:

- FRUITS
- VEGETABLES

The products were placed in equal amounts and in equal ways inside two identical refrigerators. The refrigerators are set with temperature + 6°C, in order to create storage conditions similar to domestic storage.
Shelfy was placed inside the first refrigerator.
The device was provided by Vitesy (device - code ZZ-MILSAA00 – ref. DDT 22000062 dated 15/07/2022 Vitesy-Laboratori Fabrici srl).
The device is not present in the second refrigerator.

By monitoring the products over time, in timed steps, and performing microbiological, chemical-physical and sensory determinations on the products, the study aims to evaluate any differences in terms of shelf-life extension between the product stored in the refrigerator with Shelfy compared to the same products stored in the refrigerator without the device.

SETUP

Taking into account some preliminary empirical tests, the inherent characteristics of the products, the representativeness of broader product families, and also depending on the seasonality and availability at the time of purchase, the test was conducted on the following references: strawberry, apricot, apple, cherry tomato, belgian endive, and zucchini.

The Laboratory arranged for the purchase of the samples on behalf of Vitesy. On the day of purchase, the products were placed inside the two refrigerators, previously set at +6°C and sanitized.

The refrigerators used are two refrigerators provided by the CSI Laboratory that were made available for the conduct of the study. These were FRIGOTERMOSTATO FOC 225l – VELP Scientifica.

Figure 5 - Setup at T0: Refrigerator WITH device (left) and WITHOUT device (right)

During the testing period, this equipment was used exclusively for conducting the experiment. An avocado was placed inside both refrigerators with the aim of emitting ethylene and accelerating the ripening processes of fruit and vegetable products.
No analytical tests are planned on avocado.

Following are the analysis conducted to monitor the storage status of the products over time.
These are the parameters identified as significant in relation to the matrices analyzed and the final purpose of the experiment

- **Organoleptic evaluations**
- **Total bacterial load**
- **Mesophilic lactic acid bacteria**
- **Yeasts**
- **Molds**
- ***Enterobacteriaceae***
- ***Escherichia coli* (on fruit only)**
- ***Staphylococcus aureus* (on fruit only)**
- **Moisture**

The study included sample monitoring with 7 analytical steps, timed as follows:

- T_0 = upon purchase of samples – in analysis on 19/07;
- T_3 = +3 days of storage – in analysis on 22/07;
- T_7 = +7 days of storage – in analysis on 26/07;
- T_{10} = +10 days of storage – in analysis on 29/07;
- T_{14} = +14 days of storage – in analysis on 02/08;
- T_{17} = +17 days of storage – in analysis on 05/08;
- T_{22} = +22 days of storage – in analysis on 10/08.

RESULTS

1. STRAWBERRY

Figure 6 - Strawberry T0

Figure 7 - Strawberry T_3days *(with Shelfy - left; without Shelfy - right)*

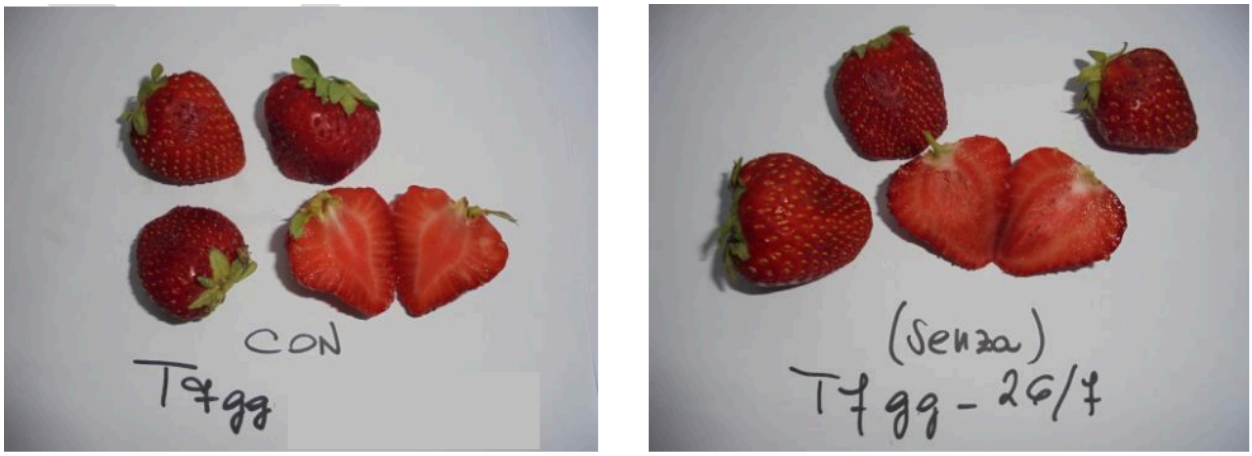


Figure 8 - Strawberry T_7days *(with Shelfy - left; without Shelfy - right)*

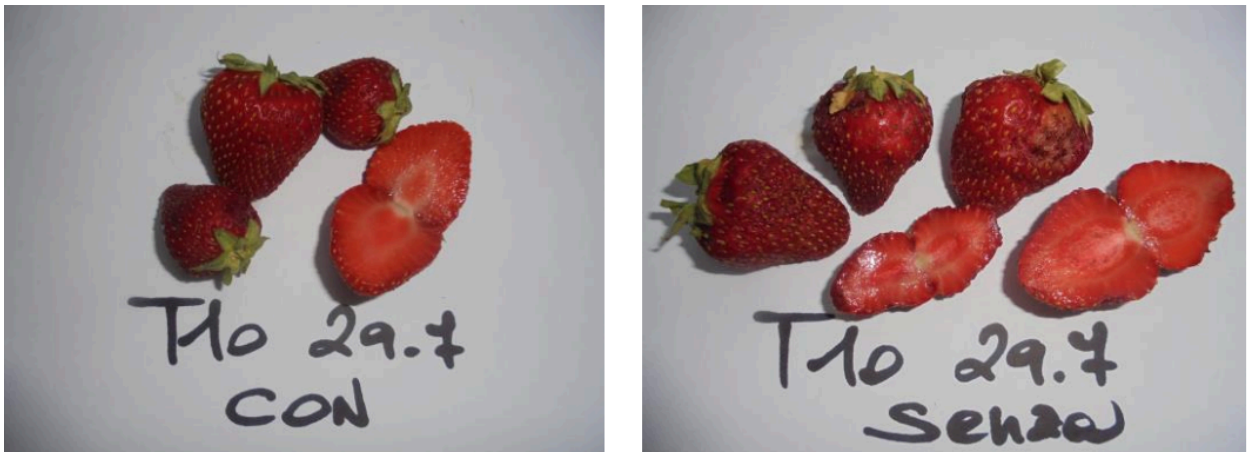


Figure 9 - Strawberry T_10days *(with Shelfy - left; without Shelfy - right)*

Regarding the microbiological evaluations, the parameters found to be the most significant are **Total bacterial load, Lactic acid bacteria, Molds** and **Yeasts**.

For these, the values found show a growth trend that up to almost T_10days is well defined and shows that **the bacterial and fungal contamination is numerically higher** in the sample kept in the refrigerator without device than in the sample in the refrigerator with device.

The **sensory evaluations are in line with this result**, i.e. up to T_10days the strawberries in the refrigerator with device have significantly better sensory characteristics (appearance / texture / stains / mildew); the strawberries in the refrigerator with device have firmer flesh - no rot and mildew spots; the strawberries in the refrigerator without device: less firm flesh with liquid release - stains and mildew - wilting.

2. APRICOT

Figure 10 - Apricot T0

Figure 11 - Apricot T_3days *(with Shelfy - left; without Shelfy - right)*

Figure 12 - Apricot T_7day *(picture on the left: with Shelfy - left side; without Shelfy - right side; picture on the right: with Shelfy - left side; without Shelfy - right side)*

Figure 13 - Apricot T_10days *(with Shelfy - left; without Shelfy - right)*

Figure 14 - Apricot T_14days *(with Shelfy - left; without Shelfy - right)*

Figure 15 - Apricot T_17days *(with Shelfy - left; without Shelfy - right)*

Relative to microbiological evaluations, the parameters found to be the most significant are **Total bacterial load, Lactic acid bacteria** and **Yeasts**.

These parameters show that microbial contamination tends to be higher in the sample kept in the refrigerator without device, the differences in these parameters are in the **1-2 order of magnitude**, and the sensory evaluations track a product evolution over time **in line with the analytical results**.

Up to step T_7days the two samples are comparable.

At T_10days in external appearance the products are still similar; on opening, however, it is evident that the sample stored in the refrigerator without device has a less firm texture and pulp. This difference becomes more pronounced at T_14days, accompanied by the appearance of dark and rotten spots (no evidence of mold) on the fruits stored in the refrigerator without device.

Similar situation at T_17days: in the sample stored in the refrigerator with device, the apricot, although no longer characterized by the firmness and turgidity that characterizes the product at T0, does not show mold/rot nor stains with abnormal

coloration, elements instead found on sample stored in the refrigerator without device.

3. CHERRY TOMATO

Figure 16 - Cherry tomato T0

Figure 17 - Cherry tomato T_3days *(with Shelfy - left; without Shelfy - right)*

Figure 18 - Cherry tomato T_7days *(with Shelfy - left; without Shelfy - right)*

Figure 19 - Cherry tomato T_10days *(with Shelfy - left; without Shelfy - right)*

Figure 20 - Cherry tomato T_14days *(with Shelfy - left; without Shelfy - right)*

Figure 21 - Cherry tomato T_17days *(picture on the left: with Shelfy - left side; without Shelfy - right side; picture on the right: with Shelfy - left side; without Shelfy - right side)*

Figure 22 - Cherry tomato T_22days *(with Shelfy - left; without Shelfy - right)*

The most significant parameter proves to be the mold trend which, from T_17days, in the sample stored in the refrigerator without device, shows an increase up to 10^3 ufc/g (an order of magnitude higher than the values found in the previous steps, for both samples). The molds, after all, as known in food microbiology are typical alternants of the 'tomato' product.

As far as organoleptic characteristics are concerned, the two samples do not show significant differences until T_7days, after which the wilting defect takes over and becomes progressively more pronounced in intensity and % of spread.
At T_10days it is present on about 20-30% of the units stored in the refrigerator without device (it is absent in the cherry tomatoes stored in the refrigerator with device); at T_14days the percentage increases to about 30-40%; in the sample with device the percentage is 10-20%.

In the refrigerator without device, the increase in mold shown by analytical determinations (T_17days) also corresponds to visible mold on the samples. At T_22days, in fact, the sample stored in the fridge without device shows mold and dark spots, **not present in the product in the refrigerator with device**.

4. BELGIAN ENDIVE

Figure 23 - Belgian endive T_0

Figure 24 - Belgian endive T_3days *(with Shelfy - left; without Shelfy - right)*

Figure 25 - Belgian endive T_7days *(with Shelfy - left; without Shelfy - right)*

The evidence from the tests on the 'belgian endive' product identifies that bacterial contamination is higher in the sample without device than in the product with.
As far as the organoleptic characteristics are concerned, the evaluations carried out (on whole head and on partially 'flaked' head) at T_7days show that the product in the refrigerator with device was better preserved: the outer leaves are of better appearance, less 'crumpled' and dark at the edges, and at the 'flaking' test the leaves maintain a greater texture and turgidity.

5. ZUCCHINI

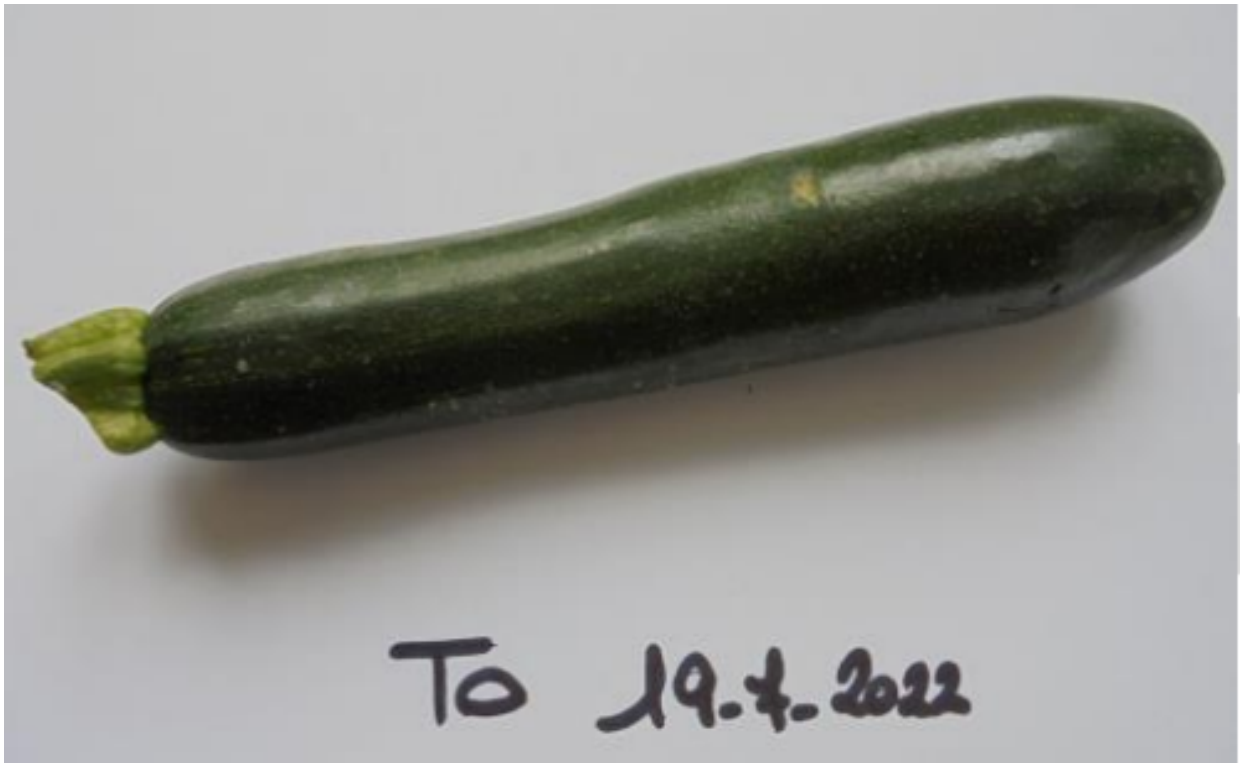


Figure 26 - Zucchini T0

Figure 27 - Zucchini T_3days *(with Shelfy - left; without Shelfy - right)*

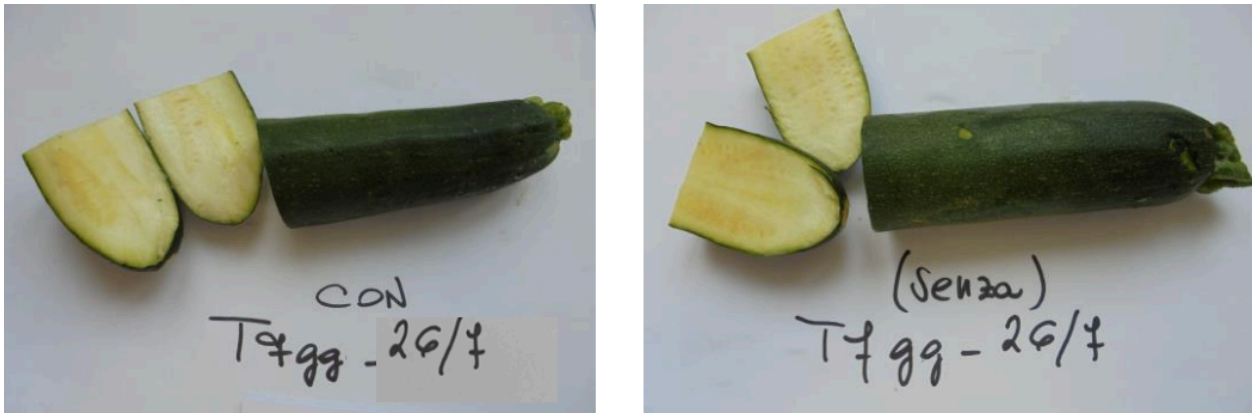


Figure 28 - Zucchini T_7days *(with Shelfy - left; without Shelfy - right)*

Figure 29 - Zucchini T_10days *(with Shelfy - left; without Shelfy - right)*

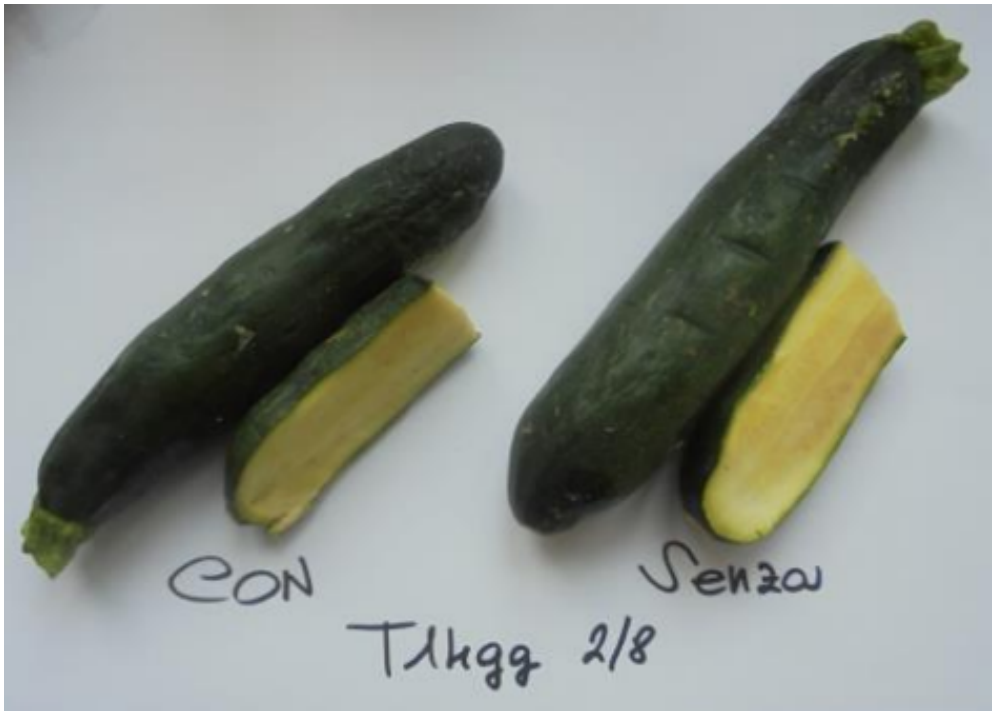


Figure 30 - Zucchini T_14days *(with Shelfy - left; without Shelfy - right)*

Figure 31 - Zucchini T_17days *(with Shelfy - left; without Shelfy - right)*

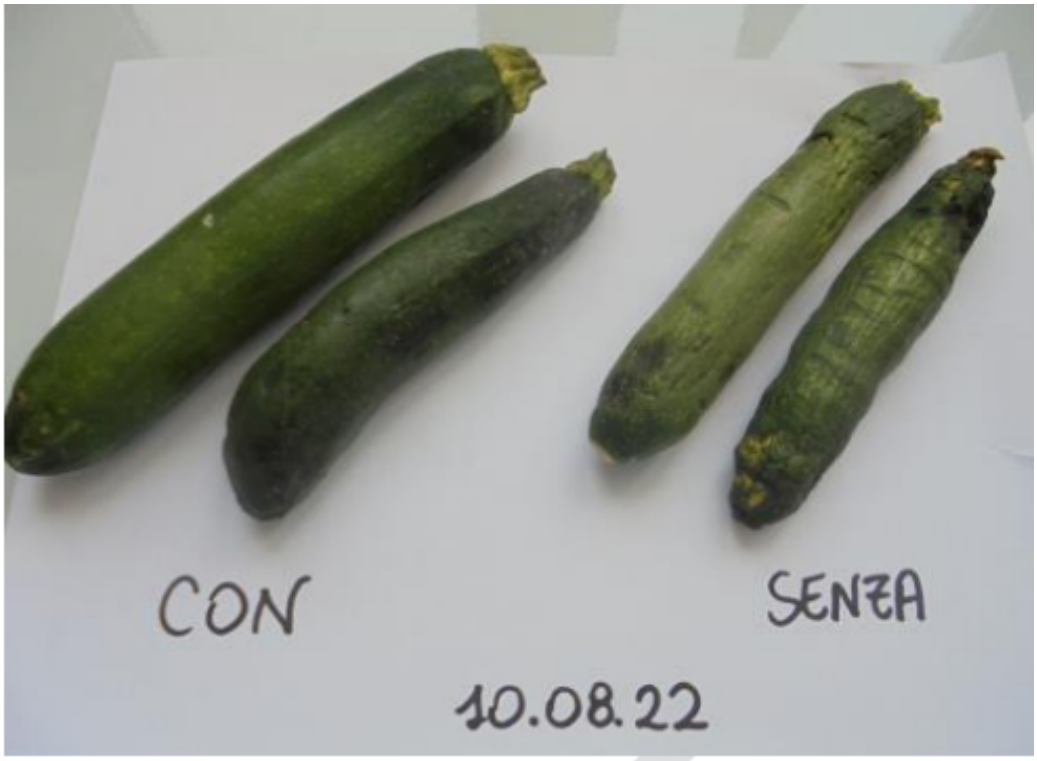


Figure 32 - Zucchini T_22days *(with Shelfy - left; without Shelfy - right)*

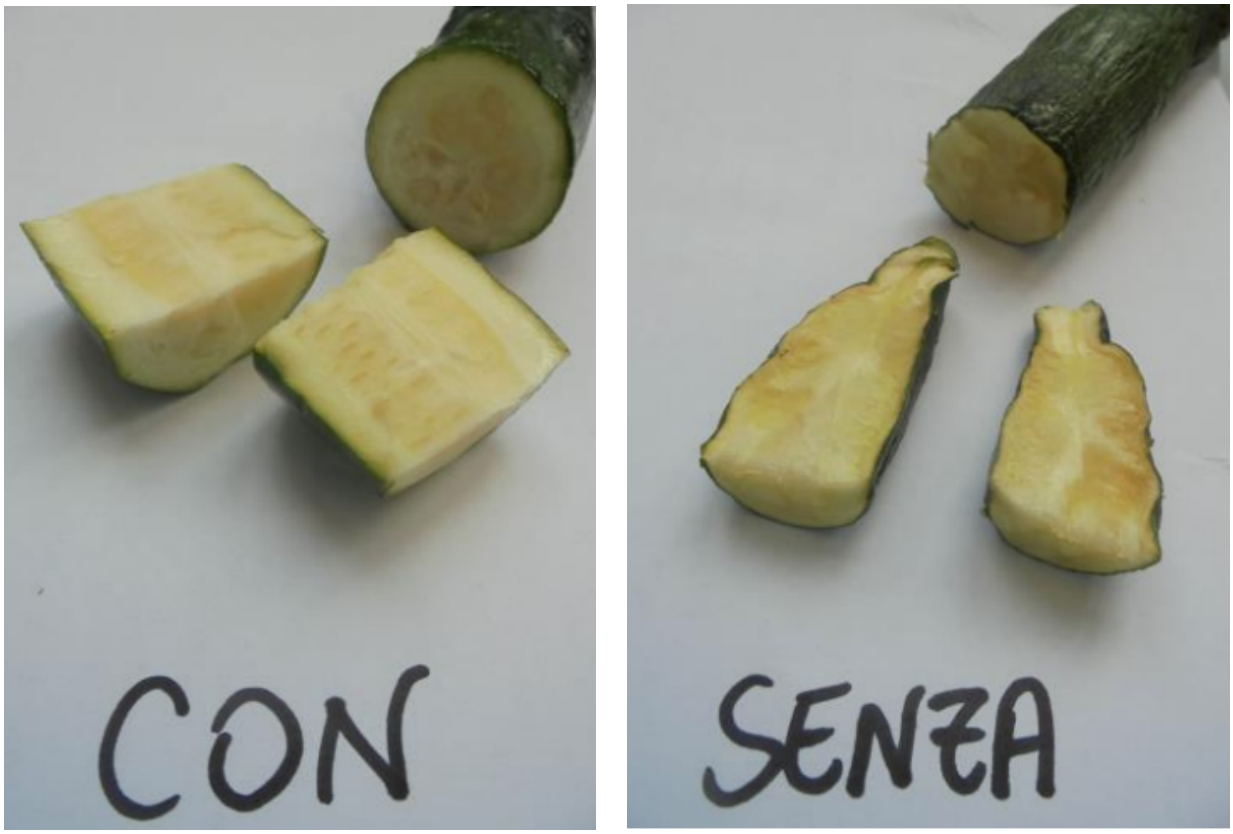


Figure 33 - Zucchini T_22days *(with Shelfy - left; without Shelfy - right)*

For the tested product 'zucchini' regarding the microbiological analysis, the parameter found to be most significant is the **total bacterial load**. Between sample stored in refrigerator with Shelfy and refrigerator without device in terms of bacterial contamination from T_17days the product stored without device has a higher microbial load by about an order of magnitude than the sample kept in the refrigerator with device.

The evidence emerged from the organoleptic evaluations show that up until T_10days the two samples are comparable, then already from T_14days the loss of turgidity and firmness becomes more pronounced in the sample stored in the refrigerator without device; this difference is already evident in the appearance, but is more noticeable when cut.
In the following steps T_17days and T_22days this difference becomes even more pronounced, as shown in the photos above.

It should be noted that until the end of the study (22 days) both samples show no visible rot / stains or mold. Despite the prolonged storage, this should be attributed to the product's own characteristics and to the quality and freshness of the raw material used in the study.

CONCLUSIONS

The evidence from the present study returns **encouraging results about Shelfy's ability to extend the shelf life of fresh food products stored in the refrigerator**.
In the foods tested in the laboratory and stored in the refrigerator with the device, it is observed that **bacterial and fungal contamination tend to be lower (1-2 orders of magnitude) over the time period monitored** than the respective products kept in the refrigerator without the device.
The organoleptic evaluations show that the the device is effective in slowing the aging of the tested products, postponing the appearance of wilting, softening, staining and rotting.
By resuming and summarizing the point considerations made for each reference, evaluations for Shelfy's effect on prolonging the product's shelf life, estimated as a % increase in days of shelf life, can be developed:

	Product shelf life up to ACCEPTABLE (*) level in days		
Product	**WITHOUT device**	**WITH device**	**Variation % (**)**
STRAWBERRY	3	10	***70***
APRICOT	10	17	***41***
CHERRY TOMATO	14	22	***36***
BELGIAN ENDIVE	3	7	***57***
ZUCCHINI	10	22	***55***

(*) depending on the sensory characteristics (in particular: color/appearance - texture), 'acceptable' is meant as the product that although no longer presents the typical characteristics of fresh food is still considered edible and usable for normal domestic use by the End Consumer.
(**) Calculated as: [(no. days WITH – no. days WITHOUT)/(no. days WITH)]x100

It is important to emphasize that the reported indications are for the experimental conditions adopted in the study, thus related to the storing temperature and even more to the quality (microbiological and of freshness) of the raw materials used to conduct the study.