Research Article

Jar Vacuuming Technology Integrated into the Refrigerator

Cemil Üri[1*], Nildeniz Adman Ocak[2], Zeynep Yalçinkaya[3]

[1] Vestel R&D Center, Orcid ID: https://orcid.org/0000-0001-9991-1928, cemil.uri@gmail.com
[2] Vestel R&D Center, Orcid ID: https://orcid.org/0000-0003-2905-4291, nildeniz9435@gmail.com
[3] Vestel R&D Center, Orcid ID: https://orcid.org/0000-0001-6572-3558, zeynep.yalcinkaya94@gmail.com
[*] Correspondence: cemil.uri@gmail.com

(First received October 17, 2022 and in final form March 19, 2023)

Reference: Jar Vacuuming Technology Integrated into the Refrigerator. The European Journal of Research and Development,3(1), 31–36.

Abstract

In order to increase the shelf life of foods, the jar vacuuming technology, which vacuums the food in the jar, is integrated into the refrigerator. Jar vacuuming technology is a system that allows drawing the air inside the food placed in the jar. In traditional techniques, the food to be stored in the jar was first boiled, then while it was cooling in the jar, the pressure was reduced thanks to the heat exchange and the jar was sealed in an airtight manner with the effect of vacuum. First in the world of the jar vacuuming technology adapting for refrigerator, the air inside the jar can be drawn without the need to heat the food, and thus the food can be stored for a long time. After the vacuuming process, the valve inside the system opens, allowing the vacuumed jar to be taken easily. The prototypes of the injection parts of the system were made, the design controls between the parts and the area to be adapted to the refrigerator were checked and strength tests such as tensile, impact strength, and thermal resistance tests were implemented. The safety of the system was tested in abnormal conditions by performing product safety tests. Food groups were vacuumed and their lifespans were checked with sensory evaluation and weight loss tests. Thanks to this technology, the shelf life of tomatoes stored in the standard refrigerator for 10 days exceeds 80 days, thus increasing the shelf life up to 8 times.

Keywords: *Refrigerator, Jar Vacuuming, Food Shelf Life, Jar Vacuuming Technology*

1. Introduction

Each food has a certain shelf life in line with the ingredients it contains. There are various methods applied to increase the shelf life of foods. One of the most common of these is the jar vacuuming technique. This process is traditionally in the form of boiling the food, placing it in a hot jar, and keeping it waiting. (Sandoval et al., 1994) In this way, negative pressure which is below from atmosphere pressure is created in the internal environment with the pressure difference that occurs while the food is cooling, and the jar is vacuumed. Since there is no air inlet or outlet in the jar, the shelf life of the food is extended. In the jar vacuum system integrated into the refrigerator, the air in the jar is drawn by the pump, so the canning process can be done without the need for heating the food.

2. Material and method

A vacuum pump with a maximum vacuum capacity of -65 kPa, working with 12 volts, was used to draw the air inside the jar filled with food placed in the jar vacuum system integrated into the refrigerator. A vacuum switch is used to control the pressure. Thus, the pump operates up to the determined pressure value. In order to easily remove the vacuumed jar from the system, it is necessary to bring the environment to the same level as the atmospheric pressure. For this process, after vacuuming, the solenoid valve opens and air enters the vacuum chamber in the system, balancing the indoor and outdoor pressures. Thus, the jar can be easily taken from the chamber. When the jar is placed in the system, a specially shaped gasket is designed that does not prevent the movement of the jar and creates a leak-proof area.

Table 1 Jar Vacuum Technology Designs

Vacuum Pump	Vacuum switch	Solenoid Valve	Gasket
-30 kPa	0 – 1 bar	Normally Open Position	Design 1
-65 kPa	0 – 2 bar	Normally Closed Position	Design 2


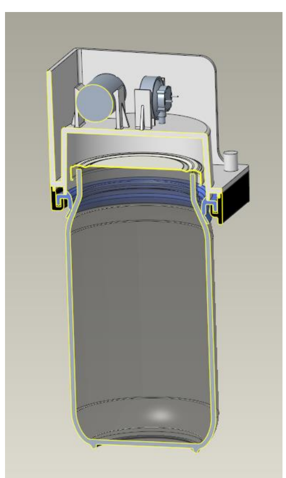
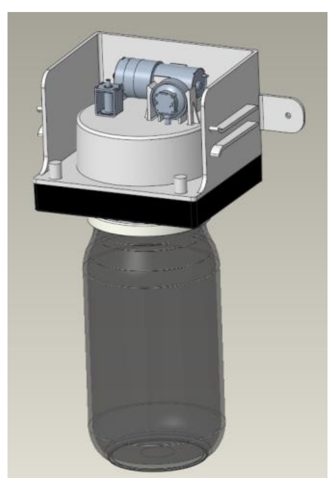
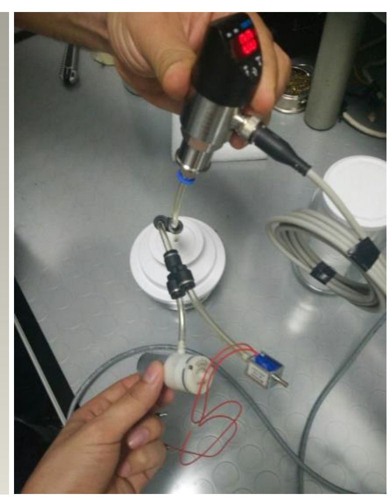

Figure 1 Jar Vacuuming Technology

3. Conclusions

Of the -65 kPa and -30 kPa pumps evaluated for jar vacuuming technology, the -30 kPa vacuum pump could not create the necessary pressure environment for the vacuuming process, and a -65 kPa vacuum pump was used. The geometry of the vacuum switch operating between 0-2 bar values did not comply with the design and the vacuum switch operating between 0-1 bar values was selected. Since the solenoid valve, which was initially selected in the closed position, needs a separate outlet and wiring to be controlled with the card, in the later stages of the work, the valve with the normal position open was selected and it was deemed appropriate to operate in parallel with the vacuum pump. In this way, since energy goes to the valve while the pump is running, the valve comes to the closed position and the sealed environment is not disturbed. When the pump stops working, the air is supplied to the vacuum environment with the valve, which is in the open position due to the cut-off of the energy to the valve, and the jar is easily removed from the system. As a result of the tests performed on the first designed gasket, problems such as leakage, and strain when placing or removing the jar were observed. Considering this feedback, the design was improved and the final gasket design was created.

After the prototypes of the designed parts were processed, they were mounted on the product and strength tests were carried out. The tensile test of the vacuuming system was carried out according to the standard in article 22.11 of the IEC/EN 60335-1 standard. The limit value of the test is 50N. In the test, the system was terminated by relying on a force of approximately 180N. The test for sharp corner control in the design of the vacuuming system was carried out in accordance with IEC/EN 60335-1 standard no. 22.14 and UL 1439. As a result of the test, no deformation was observed in the test apparatus shown in figure 2, and the test was concluded successfully.

Figure 2 Sharp Corner Test Apparatus

For the impact resistance of the system, a test was carried out according to article 21.1 of the IEC/EN 60335-1 standard. The test has a 0.5 joule limit value. As a result of the test, the system resisted up to 0.85 joules. Finally, tests were carried out in accordance with IEC/EN 60695 and IEC/EN 60112 standards to measure the thermal resistance of the plastic raw materials used in the system. All the raw materials used resisted the limit value of 850°C for 60 seconds in the glow wire measurement and the test was terminated. (Figure 3)

Figure 3 Flammability Test

Tomato samples selected as target material for food tests were tested under 3 different conditions for comparison. Related samples were subjected to sensory analysis and weight control analyzes at specified periods. (Table 2)

Table 2 Food Analysis Results

	1. Condition		**2. Condition**		**3. Condition**	
Day	**Sensory Analysis**	**Weight (g)**	**Sensory Analysis**	**Weight (g)**	**Sensory Analysis**	**Weight (g)**
0	0	100	0	142	0	149
3	0,7	93	0,6	140	0,5	149
7	1,2	89	1,5	139	0,6	148
10	1,8	81	Moldiness	-	0,9	147
14	Moldiness	-		-	1,6	146
30	-	-	-	-	1,2	144
45	-	-	-	-	1,4	143

60	-	-	-	-	1,2	143
80	-	-	-	-	1,9	132
90	-	-	-	-	3	131

1. Condition: The products were placed in the refrigerator without packaging.
2. Condition: The products were put in the refrigerator with a freezer bag.
3. Condition: The products were vacuumed with the vacuum technology of the refrigerator and placed in the refrigerator.

Day 0 samples were taken into account to be used as control samples. Sensory analyzes were scored based on control samples. During the experiment, sample weights were checked and noted on the panel days, and the analysis results were given in the table (Table 2). The panel was concluded on the basis of 2 points and below, which is accepted as the freshness criterion. During the sensory analysis, the appearance, taste, and odor characteristics of the foods were evaluated. The sensory analysis scale was determined as "0: no difference / 1: slightly different / 2: different / 3: very different / 4: extremely different". The zero-day scores of the products were accepted as 0. The freshness acceptance criterion is 2 points or less. The panels were held with 6 panelists (Ponce-Valadez et al., 2015).

4. Discussion

In the tensile, sharp corner, impact resistance, and thermal resistance tests performed on the prototypes of the injection parts used in the design of the jar vacuuming technology, the design controls between the parts and the area to be adapted to the refrigerator were completed and their mechanical suitability was decided.

According to the results of the sensory tests, mold growth was observed in the products placed in the refrigerator openly after 2 weeks. Mold growth occurred on the 10th day in the products put in a refrigerator bag. When the products were vacuumed with the vacuum technology of the refrigerator and placed in the refrigerator, no mold growth was observed for 80 days and the test was terminated. It also remained acceptable for up to 80 days. Considering the weight loss at the end of 1 week, there was a weight loss of 11% in the products put in the cupboard open, 2% in the products put in the refrigerator with refrigerator bags, and 1% in the products put in the refrigerator using the vacuum technology of the fridge (Castro et al., 2006) (Anyasi et al., 2016). When all the results were examined, it was seen that the best examples were the ones placed in the cabinet using the vacuum technology of the refrigerator.

Thanks to the work carried out for the first time in the world, thanks to the valve used in the design without the need to heat the food, the air inside the jar that causes deterioration is drawn and the food can be stored for 8 times longer than its current state. Thanks to the design, the valve opens after vacuum, allowing the vacuumed jar to be used comfortably.

References

[1] Sandoval, A. J., Barreiro, A., Mendoza, S., (1994). Prediction of hot-fill-air-cool sterilization processes for tomato paste in glass jars, Journal of Food Engineering, 23(1994) 33-50.

[2] Castro, L. R., Cortez, C. O., & Vigneault, C. (2006). Effect of sorting, refrigeration and packaging on tomato shelf life, International journal of food, agriculture and environment, 4(1): 70-74.

[3] Anyasi, T. A., Aworh, C. O., & Jideani, A. I. O. (2016). Effect of packaging and chemical treatment on storage life and physicochemical attributes of tomato (Lycopersicon esculentum Mill cv. Roma), African Journal of Biotechnology, 15(35), 1913-1919.

[4] Ponce-Valadez, M., Escalona-Buendía, H. B., Villa-Hernández, J. M., León-Sánchez, F. D., Rivera-Cabrera, F., Alia-Tejacal, I. & Pérez-Flores, L. J. (2015). Effect of refrigerated storage (12.5 _C) on tomato (Solanum lycopersicum) fruit flavor: A biochemical and sensory analysis, Postharvest Biology and Technology, 111 (2016) 6–14.