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**FRESH PRESERVATION
PERFORMANCE EVALUATION OF
BLUEZONE® FRESH PRESERVATION
TECHNOLOGY**



Headway Technology Co., Ltd.

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Revision History

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TABLE OF CONTENTS

1	Introduction.....	1
2	Objective	1
3	Test Summary	2
3.1	System Description	2
3.2	Quality Control and Assurance.....	2
4	Result on Fresh Preservation Efficiency in Walk-in Refrigerator on Ship	4
4.1	Test Result of Period #1	4
4.1.1	Description	4
4.1.2	Result.....	5
4.2	Test Result of Period #2	7
4.2.1	Description	7
4.2.2	Results	7
4.3	Test Result of Period #3	8
4.3.1	Description	8
4.3.2	Result.....	8
5	Conclusion	17

Table of Figures

Figure 1 - BlueZone Model 300 on COSCO JUDA.....	2
Figure 2 - A Corner of Walk-in Refrigerator.....	3
Figure 3 - Test 1_Hand Record of Chief	4
Figure 4 - Test 1_Cucumber after D21.....	5
Figure 5 - Test 1_Vegetable after D21	5
Figure 6 - Test 1_Pears after D21	6
Figure 7 - Test 1_Rotten Part of Pears	6
Figure 8 - Test 2_Strawberry on Day 2	7
Figure 9 - Test 2_Strawberry after D3	8
Figure 10 - Test 3_D4 FF&V.....	9
Figure 11 - Test 3_D 6 FF&V	9
Figure 12 - Test 3_Mold Spot of Strawberry.....	10
Figure 13 - Test 3_D9 Strawberry Start Rot.....	10
Figure 14 - Test 3_D11.....	11
Figure 15 - Test 3_ D13.....	11
Figure 16 - Test 3_D13 Lactucas	12
Figure 17 - Test 3_D16.....	12
Figure 18 - Test 3_D16 Lettuce with Black Lining.....	13
Figure 19 - Test 3_D19.....	13
Figure 20 - Test 3_D19 Rotten Grape.....	14
Figure 21 - Test 3_D19 Rotten Lettuce	14
Figure 22 - Test 3_D22.....	15
Figure 23 - Test 3_D22 Rotten Grape.....	15
Figure 24 - Test 3_D27	16

1 Introduction

Headway Technology Co., Ltd. (hereinafter, Headway) is a professional manufacturing and service provider of high-tech marine equipment that was established in Qingdao, China and today represented in 56 countries and regions of the world with 120 service stations. Our product line covers environmental protection, marine communication and navigation and automation.

This report describes a series of two terms of storage tests that took place onboard COSCO JUDA conducted with BlueZone® Fresh Preservation Technology, especially from 6th March to 1st April.

2 Objective

The objective of this project was to conduct a shipboard performance evaluation of the BlueZone® Model 300 unit manufactured by Primaira, LLC. with aim to extends the shelf life of fresh fruit and vegetables (FF&V). With the limit of test condition, the test was conducted and recorded by chief and other ship crew.

3 Test Summary

3.1 System Description

BlueZone® Fresh Preservation Technology works by removing ethylene and microbial load from the atmosphere of refrigerated containers. The claimed purification capacity of Model 300 unit is up to 2,500 ft³ (70 m³).

The vessel COSCO JUDA was equipped with three walk-in refrigerators separately for Fruit & Vegetable, Meat & Fish and Groceries. Each walk-in has independent temperature sensor that was displayed in kitchen. The BlueZone® Model 300 was installed in Fruit & Vegetable refrigerator, with an estimate volume of 65m³. The temperature of walk-in refrigerator was set at 4°C.



Figure 1 - BlueZone Model 300 on COSCO JUDA

3.2 Quality Control and Assurance

The test has been observed by the chief under the guidance of Test Procedure provided by Headway in January 2018. For the convenience of ship crew, the procedure was composed in Chinese with a translated version of User Manual. A copy of Test Procedure in English can be translated and provided upon request.

BlueZone® Model 300 unit has been installed according to the instructions on User Manual under the supervision of Cheng'guo, Liu, Senior Engineer of Headway, to ensure a stable performance of the unit.

The tests include a total of 3 test periods, starting from 12th February 2018 till 3rd April 2018. The walk-in refrigerator has been cleaned and ventilated between each period. All Fruit has been carefully cleaned and wiped dry to prevent contamination and simulate shipboard practice.



Figure 2 - A Corner of Walk-in Refrigerator

4 Result on Fresh Preservation Efficiency in Walk-in Refrigerator on Ship

4.1 Test Result of Period #1

4.1.1 Description

The first period of test was started from 12th February 2018 to 5th March 2018. Ship crew purchased pears, cucumbers and lettuces for test purpose.

All FF&V were cleaned and stored on a separate shelf with white paper underneath. Chief was responsible for keep a record of the freshness of vegetable and take picture as often as possible.

After the test period, Headway engineer went back to COSCO JUDA for test data, from the data sheet provided by chief, the data shows that all FF&V were in perfect shape and taste during the entire period, which was not meet what Headway engineer witnessed onsite. Therefore, the data record by chief was considered invalid and will not be used in the final evaluation.

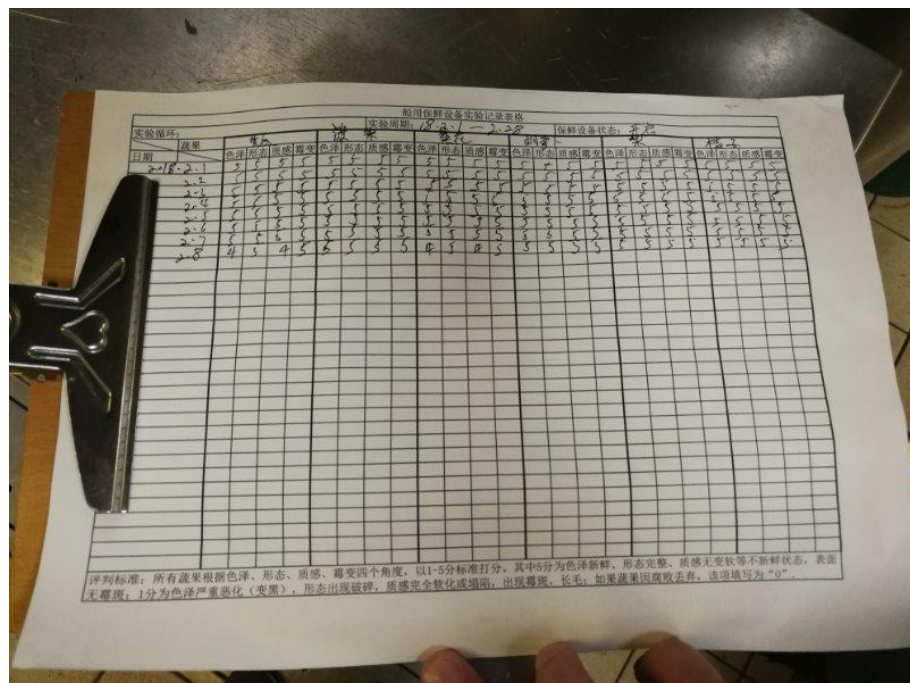


Figure 3 - Test 1 _Hand Record of Chief

4.1.2 Result

From what Headway Engineer has witnessed, the FF&V stored in walk-in was in a basically good condition.

The cucumbers were in a solid state with good taste after 21 days of storage.



Figure 4 - Test 1_Cucumber after D21



Figure 5 - Test 1_Vegetable after D21

The vegetables were still in good condition, but the color of leaves has already start turning into yellow, they are still eatable. Based on the experience of chief, the freshness of vegetable can be rated 4 out of 5.

As for the pears, four pears were stored on the shelf, two of them were in good condition, with a freshness rated 4 out of 5. The other two was partly rotten. Based on the observation onsite, the rotten part was the contact surface of two neighbor pears. Therefore, Headway engineer draw a basic

conclusion the rotten was caused by the lack of contact with treated air.

Based on the description of ship crew, the BlueZone® Unit was kept running during the whole period. No alarm nor malfunction were observed. The intern-crew was doing the routine maintenance and cleaning



Figure 7 - Test 1_Pears after D21

according to user manual.



Figure 6 - Test 1_Rotten Part of Pears

4.2 Test Result of Period #2

4.2.1 Description

The second period of test was conducted from 5th March 2018 to 14th March 2018 during the trip from China to Indonesia. As a contrast test, BlueZone® Unit was powered down. The walk-in refrigerator has been thoroughly ventilated before storage of FF&V. Due to the lack of communication during the shift of two chiefs, some of the vegetables for tests were eaten during the voyage. However, the intern-crew still managed to keep some picture of strawberries during the voyage.

4.2.2 Results

The strawberry stored in walk-in refrigerator starting to turn color white on day 2 stored and shown serious mold and rotten on day 3 All strawberries were disposed after day 5 due to rotten.



Figure 8 - Test 2_Strawberry on Day 2

As for the rest of vegetables, all vegetables and fruit for test was consumed within 2 days. The left-over vegetable did not survive through D10. And most leafy vegetables were considered “not fresh” within two weeks. According to the chief, the status and shelf-life of all FF&V stored were slightly better than his experience. Headway engineer consider that was

due to the cleaning before test period 2.



Figure 9 - Test 2_Strawberry after D3

4.3 Test Result of Period #3

4.3.1 Description

The third period of test was conducted from 16th March 2018 to 1st April 2018 during the trip from Indonesia to China. BlueZone[®] Unit was powered on during the whole voyage. Fruit and vegetables stored were: Strawberry, Grapes, lettuces, cherry tomato and cantaloupe. The walk-in refrigerator was thoroughly ventilated and cleaned before test, all FF&V were carefully cleaned and wipe dry as other test periods.

Chief and inter-crew took full responsibility of keep track of the freshness of FF&V and taking pictures.

4.3.2 Result

The shelf-life of FF&V were extended greatly with BlueZone[®] Unit. During 27 days of storage, the cherry-tomato and cantaloupe shows no sign of change on surface. Strawberry start rotten from day 8 to day 15;

Grape start rotten from day 17 to day 25. Lettuces start rotten from day 13 to day 19. A detailed report with picture were listed as below:

Day 4 :



Figure 10 - Test 3_D4 FF&V

All FF&V were perfectly fresh on day 4, while strawberries has already rotten on day 4 in test 2.

Day 6 :

Most FF&V are still in very good fresh. Two of the strawberries got mold spot on the surface.



Figure 11 - Test 3_D 6 FF&V



Figure 12 - Test 3_Mold Spot of Strawberry

Day 9:

One box of strawberry has shown massive mold spot. Chief has considered them were starting rotten



Figure 13 - Test 3_D9 Strawberry Start Rot

Day 11

The strawberries which started rot has gone worse, while there still are some more strawberry that was in very good condition.



Figure 14 - Test 3_D11

Day 13

Half of the strawberry has gone rotten and has been disposed. The rest of the strawberries were still in good condition. Lettuce started shown black



Figure 15 - Test 3_D13

lining on leaves. Lactucas start turning into color yellow, with leaves start rotting.



Figure 16 - Test 3_D13 Lactucas

Day 16

The rest of strawberries has gone rotten on the surface that was in contact with the container. All strawberries have been disposed by chief. The black lining of lettuce has gone worse.



Figure 17 - Test 3_D16

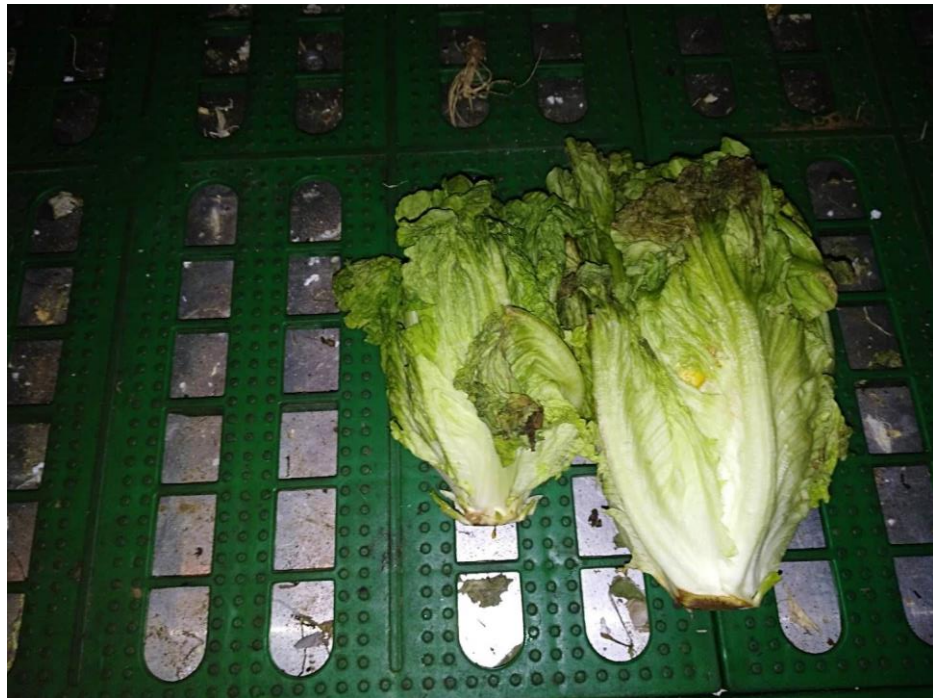


Figure 18 - Test 3_D16 Lettuce with Black Lining

Day 19

One bunch of grapes has serious rotten, lettuce was also considered “not eatable” due to large part of rot. Both Lettuce and the rotten brunch of grape were disposed.



Figure 19 - Test 3_D19



Figure 20 - Test 3_D19 Rotten Grape



Figure 21 - Test 3_D19 Rotten Lettuce

Day 22

The other bunch of grape has gone partly rotten, most of grapes has lost the sphere shape and shown listless, chief has consider the grape “not eatable” and disposed them.



Figure 22 - Test 3_D22



Figure 23 - Test 3_D22 Rotten Grape

Day 25 &27

Both cantaloupe and cherry tomato were in perfect shape and have no change. The ship finished the trip from Indonesia on 1st April (D27). Both cantaloupe and cherry tomato stayed good condition during the trip.



Figure 24 - Test 3_D27

5 Conclusion

It has been proven that the BlueZone® Fresh Preservation Technology has shown great performance in preserve FF&V onboard the ship. According to the chief on COSCO JUDA, the shelf life of FF&V has been tremendously extended during the test period #3. Under most circumstances, the leafy vegetable will not last for two weeks, and strawberry won't last for two days.

It is also observed that the fresh fruit are often rotten on the side that in contact with the container. Therefore, it might improve the performance of the unit if a special designed container with maximum contact of air was applied to FF&V.

Furthermore, for test purpose, all rotten (parts of) FF&V was not timely removed from the shelf. The situation might be better if FF&V were regularly cleaned as required onboard ship.