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The Changes of Quality of Fresh Shiitake (*Lentinus edodes*) in Storage under Controlled Atmosphere Conditions

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Abstract

The changes of quality of Fresh Shiitake (*Lentinus edodes.*) was studied in this research work by investigating the effect of low O_2 content and high CO_2 content, well known as CA Treatment in storage, on the respiration rate and PPO Activity that was the main factor in Shiitake quality decay. CA Condition was conducted in 3 research periods that combined the O_2 content (1%, 5% and 10%) and CO_2 content (5%, 10%. 15%, and 20%), and air treatment as the control. The lower O_2 content was the lower respiration rate that was showed in combination of 20% CO_2 and 1% O_2 (the lowest), and the controll air treatment was the highest. Very low O_2 content, conversly, did not show a satisfying result to the product.

Keyword : Shiitake Mushroom, Control Atmosphere (CA) Storage, O_2 Consumption, CO_2 Evolution, Polyphenoloxidase Activity (PPO), Quality Preservation.

Introduction

Fresh Shiitake (Lentinus edodes) has short life in postharvest period. Burton K.S., 1988 reported that Fresh Shiitake has still retain an acceptable quality for 1 - 3 days storage in ambient temperature, and arround 7 days when held in 5°C. Moreover Fresh shiitake has higher respiration in ambient air, that cause highly perishable and should be consumed or processed promptly after harvest. In other fact, however, people are more pleasure to consume fresh shiitake than dried one. They eat for its flavor and texture. Therefore recently Mushroom Industries completely pay attention to this problem.

Controlled Atmosphere (CA) Storage is a system

for holding produce in an atmosphere that differ substantially from normal air in respect to the proportion of N_2 , O_2 , and CO_2 (A.Lloyd Ryall et.al.,1972). In general, CA Storage most likely would prove to be beneficial for vegetables and fruits that deteriorate rapidly or those that complete ripening after harvest. One of the factors of quality loss in mushroom is the high respiration, therefore it was expected that low O_2 content and/or high CO_2 content will delay its respiration. Browning reaction is an other phenomena of quality decay during storage and transportation. It occurs when phenolic substant, Polyphenoloxydaze (PPO) enzym and oxygen are brought togather under appropriate condition such as pH, temperature, and water activity (Hsu A.F.,et.al., 1988), so it expected that absence of oxygen (low content) will inhibit the browning reaction. Many research concerning in CA Storage of fruits (apple) and vegetables (broccoli) were held, however at present, the research data of CA Storage concerning the appropriate condition of fresh shiitake is limited.

The objective of this research is to study the effect of low O_2 content and high CO_2 content on the respiration rate and PPO activty of Fresh Shiitake during Storage, then to find the appropriate combination of O_2 and CO_2 gas for storage of Fresh shiitake.

Materials and Methods

Fresh shiitake hand-harvested from commercial plantation was selected in quality level 3 to 4 according to producer, then brought to laboratory. Forty two pieces (720 gram) were placed into each square polyprophylene box, tight to hermitically and placed into the Constant Temperature Chamber.

Eight pieces of fresh shiitake were taken from each box then weighed for quality assessment. After taking sample, each box was hermetically closed again, then flushed with the given combination gas. It was conducted for 20 to 32 days with 5 days interval. The polyprophylene box (9.3 liters of 287x357x120 mm, 2 mm thickness) was expected no permeability through the wall. Two glass pipes (dia. 8 mm) were connected in the box in order to simply to flush a given gas. Two holes that closed with silicon septum stopper were constructed to sampling gas.

The research period was conducted in 3 different times, i.e. research I : CO_2 :20% combinated with O_2 :10%, 5%, and 1%; and air as controll (T:5°C). research II : O_2:5% combinated with CO_2:5%, 10%, and 15%; and air as controll (T:5°C). research III : O_2:1% combinated with O_2:10%, 5%, and 1%; and air as controll (T:0°C and 5°C).

Gas mixing was made based on partial volome ratio by mean of flow meter (buble soap). Gas content, sample size 0.5 ml, was analyzed by Chromatography GC-14A (TCD, SUS Column of W-100, O.D 1/4"x1.8 m) for 24 hours with 2 hours interval. Percentage of gas content was expected by the mean of 2 sample points that taken from 2 silicon septum. This measurement was conducted after done the PPO assessment (chemical analysis). The O_2 consumption rate, one of measuring respiration methods, was calculated from the different of gas content during the elapse time in Kg of product Shiitake(%/Kg.H).

The activity of Polyphenoloxydase enzym was showed by measuring optical density of supernatant (0.4 ml) of shiitake that was mixed with 6 ml cathecol solution, then measured in room temperature 30°C by spectrophotometer UV-200 (at 420 nm wavelength for 30 minutes with 10 minutes interval). The activity of PPO enzym was predicted by choosing the maximum value of the change of optical density during an elapse time (10 minutes). This measurement was modified based upon the method done by Yamaguchi et.al. 1988. Pure gas of O_2 , CO_2 and N_2 was prepared to make a combination gas through the chamber, then flushed to each polyprophylene box every 24 hours (Figure 1).

Results and Discussions

1. O_2 Consumption Rate and CO_2 Evolution Rate

The O_2 consumption rate in CO_2:15% showed the lowest value among the other treatments, then followed by CO_2:10%, CO_2:1% and Controll air treatment respectively (Figure 3 of research III). It's showed similarly in CO_2 evolution rate in figure 4. It means that in low oxygen content (1%), the difference of CO_2 content influenced the rate of O_2 consumption, as one of measuring method in respiration rate. Negative value in each graph was expected as an anaerobic respiratory

process. Sometime, especially when the oxygen supply is deficient, both aerobic and anaerobic respiration occur simultaneously in a plant tissue. Some cell may be respiring anaerobically, while others are carrying on aerobic respiration. Both anaerobic and aerobic respiration liberate carbon dioxide. Conversely the controll air treatment that has higher O_2 content and lower CO_2 content has highest O_2 consumption rate.

Both of O_2 consumption rate and CO_2 evolution rate during storage became lower at the longer storage time (Figure 3 and 4). It was expected that carbohydrate in the product was growing weak in respect to consume oxygen molecule along storage period time. This indication was clearly growing lower in controll air treatment. It means, that keeping low the respiration rate of Shiitake will maintain at the low respiration rate for longer. In other word, The life of product (Shiitake) will be preserved longer. Oxygen in various content with CO_2 constant 20% in research I showed more significantly different in respiration rate among the treatments than CO_2 in variouse content (O_2:1% and 5% constant, in Figure 3). However, The treatment of different CO_2 content (in O_2 constant) would be just clearly appear in O_2:1% (Figure 3 research 3)

2. The Activity of Polyphenoloxydase

The efect of high carbon dioxide content was significantly appeared in figure 5 (research I), however it make difficulty to distinguish the treatment of O_2 content , in other word that was not significantly different among the treatment of O_2 content in combination with high CO_2 content (constant 20%). All datas, research I and III show that the value of optical density was found the highest in buffer solution pH 5.0 (research II, that was not appeared in this paper, has similarly tendency to research I). It means that pH optimum for reaction of cathecol as a substrate catalyzed by polyphenoloxydase of mushroom shiitake is at pH 5.0. However Tzuu-Tar Fang et.al. 1974 reported that optimum pH of that was 6.0 - 6.5 in measuring optical density at 395 nm wavelength. Therefore it is an capable reason to choose pH 5.0 in each research to compare the effect of gas treatment during CA Storage. In addition, the treatment of high CO_2 content and low O_2 content cause the pH of shiitake in temperature 1°C has high or alkali tendency (pH 6.44 to 7.15)and temperature 5°C of that

has constant beetwen pH 6.4 to 6.7. Conversely the controll air treatment showed the low tendency of pH (acid) along storage time (Figure 2). This study suggested to store fresh shiitake in low O_2 content (1%) and high CO_2 (15%) and temperature 0°C. It is necessary to investigate more concerning this case to get more data.

Conclusion

Storage of fresh shiitake in treatment gas, differ to normal air, and temperature 0°C will incline pH of fresh shiitake to 7.2 higher than control air treatment. The lower O_2 content was the lower respiration rate was showed in combination of 20% CO_2 and 1% O_2 (the lowest), and the controll air treatment was the highest. Very low O_2 content, conversly, did not show a satisfying result to the product. The optimum pH condition for activity of PPO was pH 5.0.

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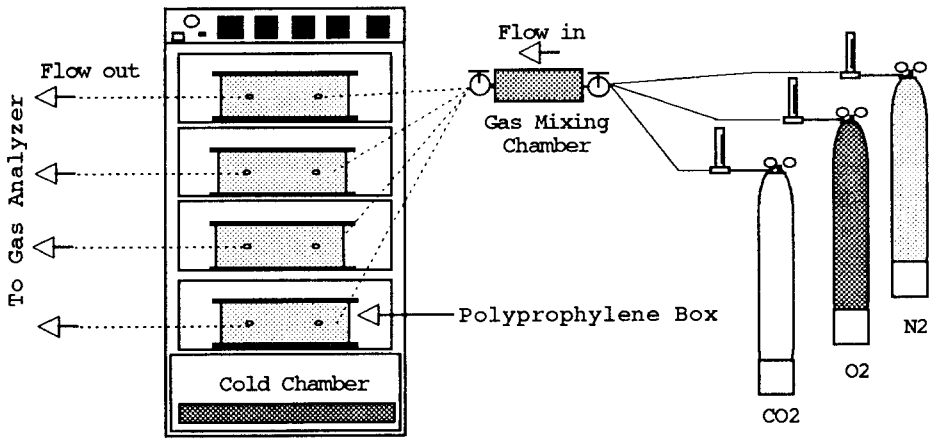

Fig 1. Gas Mixing System and Four Treatment Boxes inside Cold Chamber.

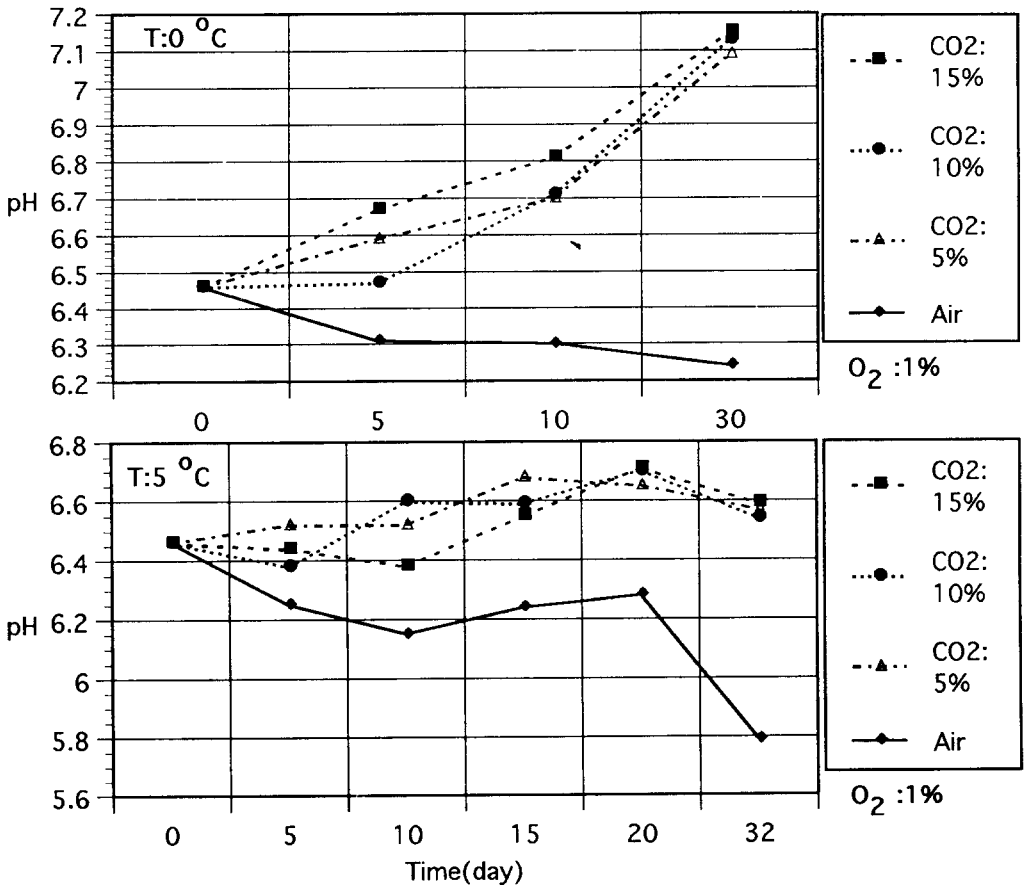

Figure 2. The Real pH Development of Fresh Shiitake during Storage.

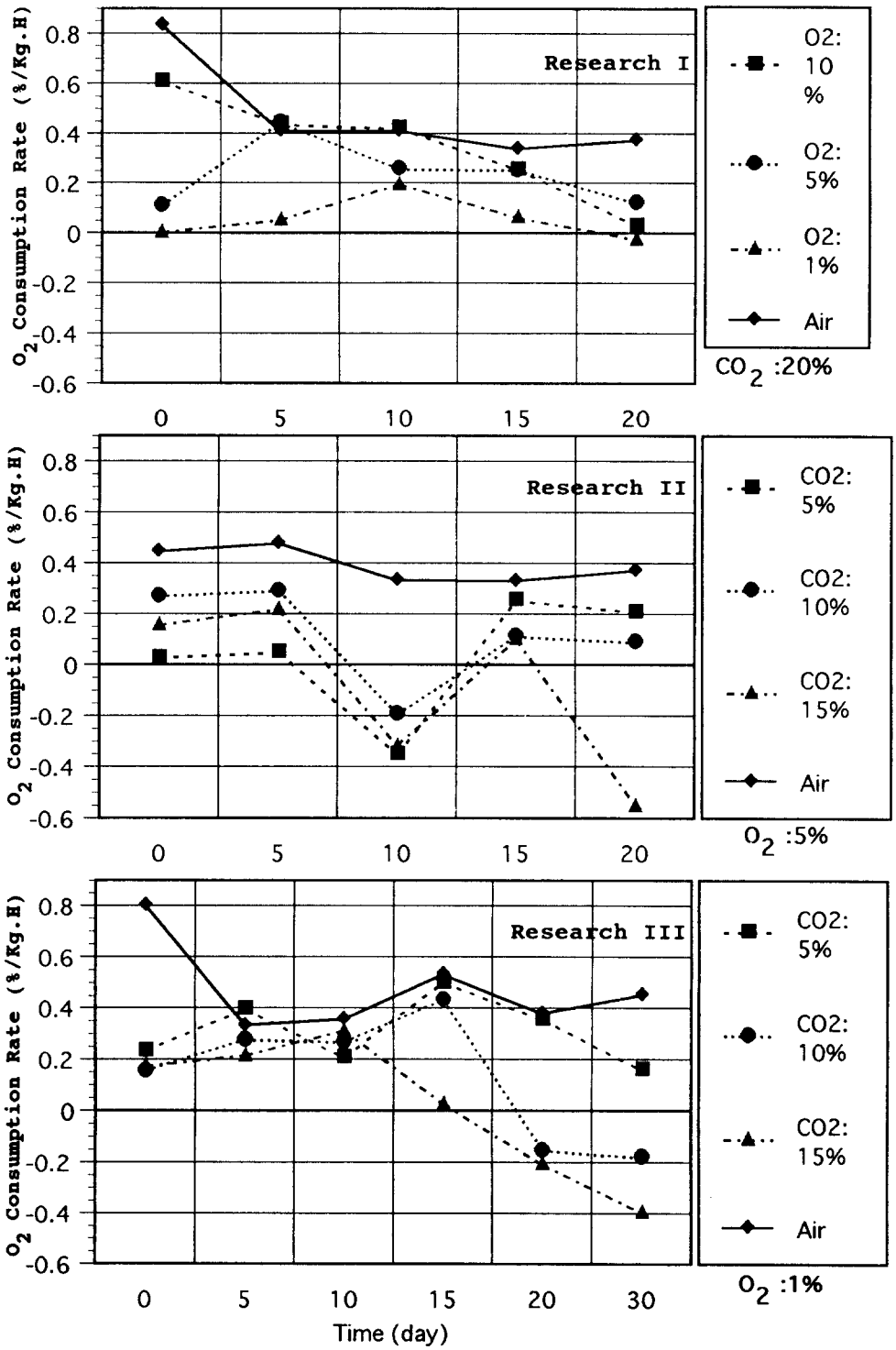

Figure 3. The O_2 Consumption Rate of Fresh Shiitake during Storage in 3 Research Times (I, II, III).

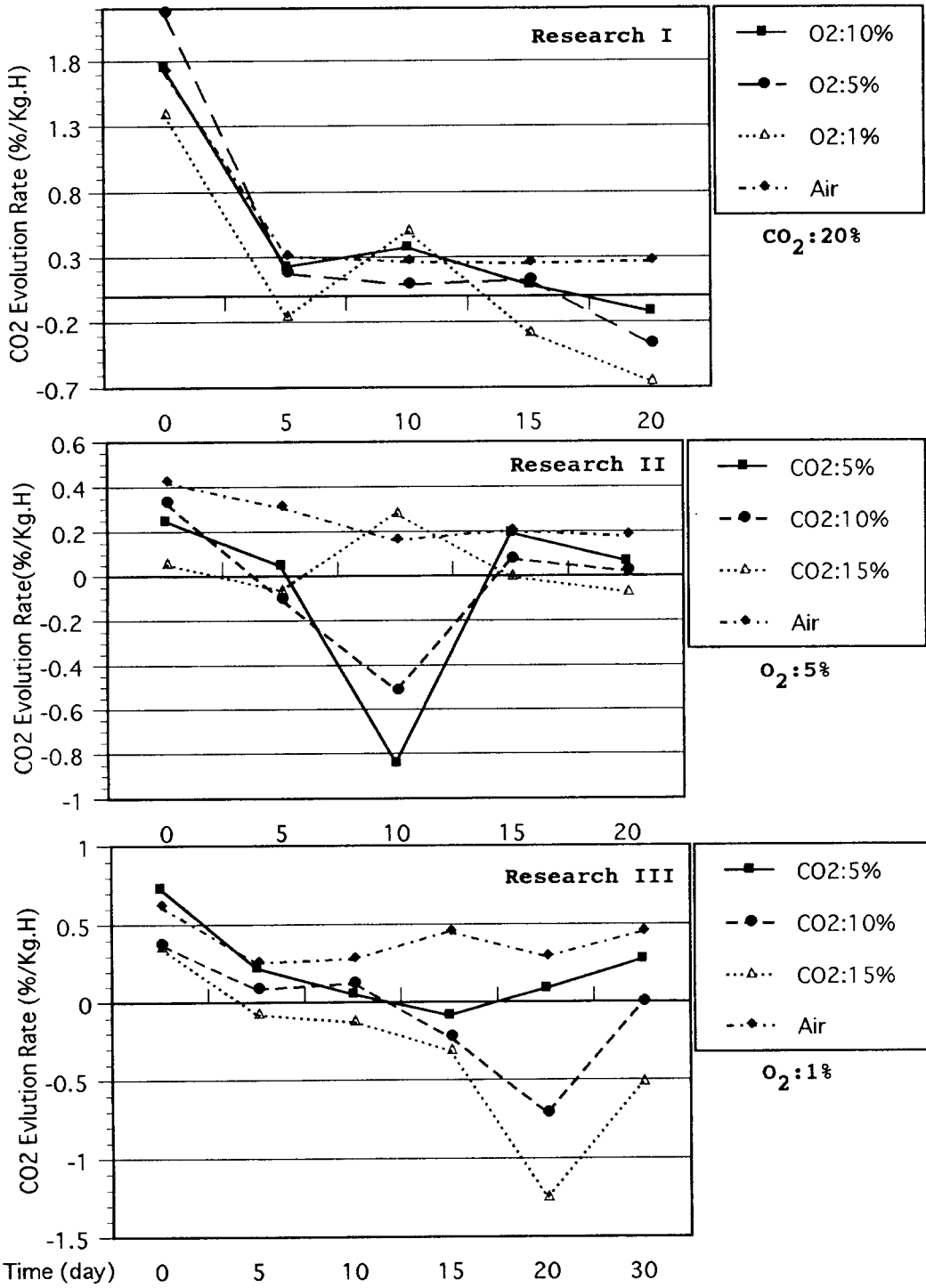

Figure 4. CO_2 Evolution Rate of Fresh Shiitake during CA Storage of Treatment Gas.

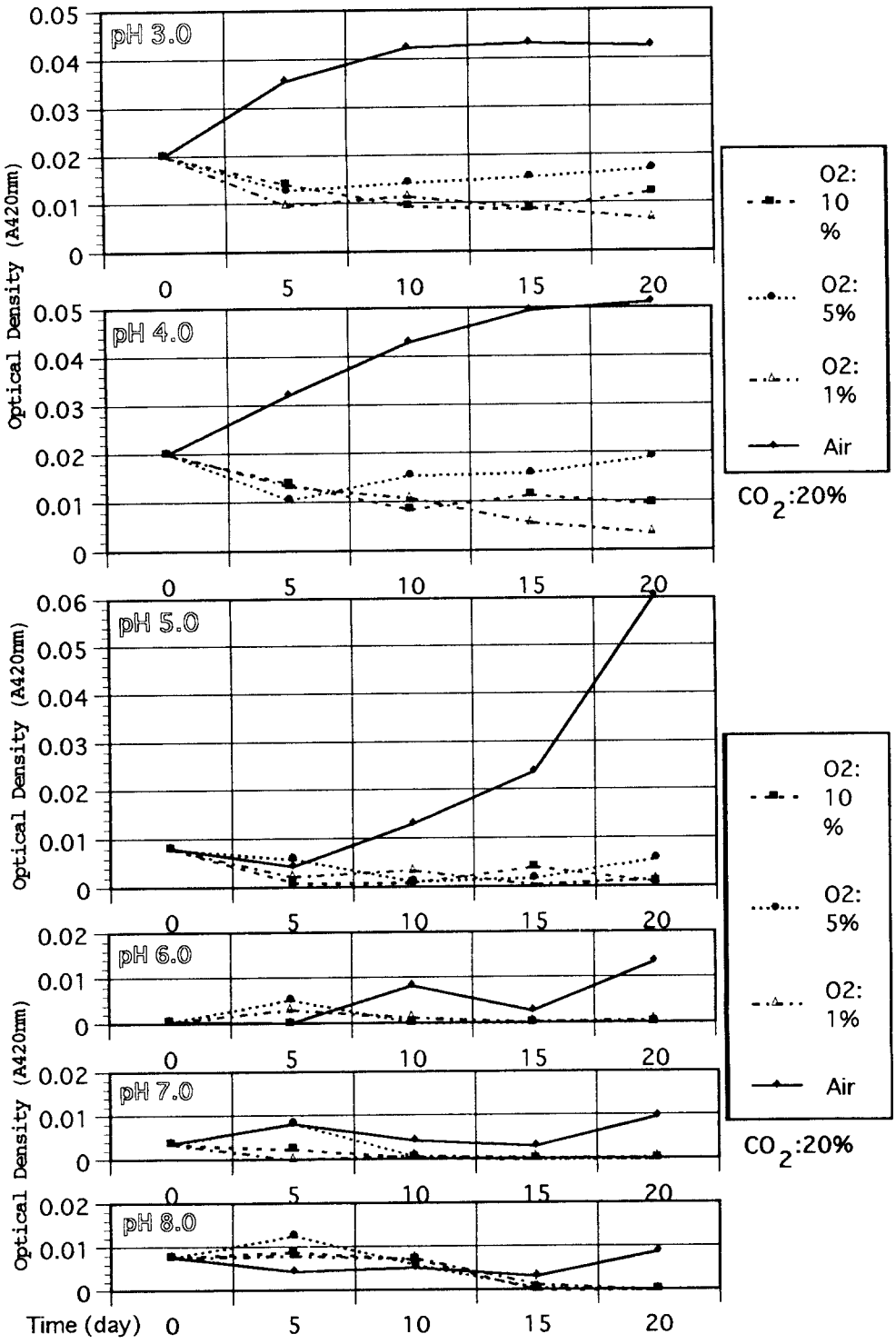

Figure 5. Polyphenoloxydase (PPO) Activity of Fresh Shiitake during CA Storage in Condition pH 3.0 to 8.0 (Research I)

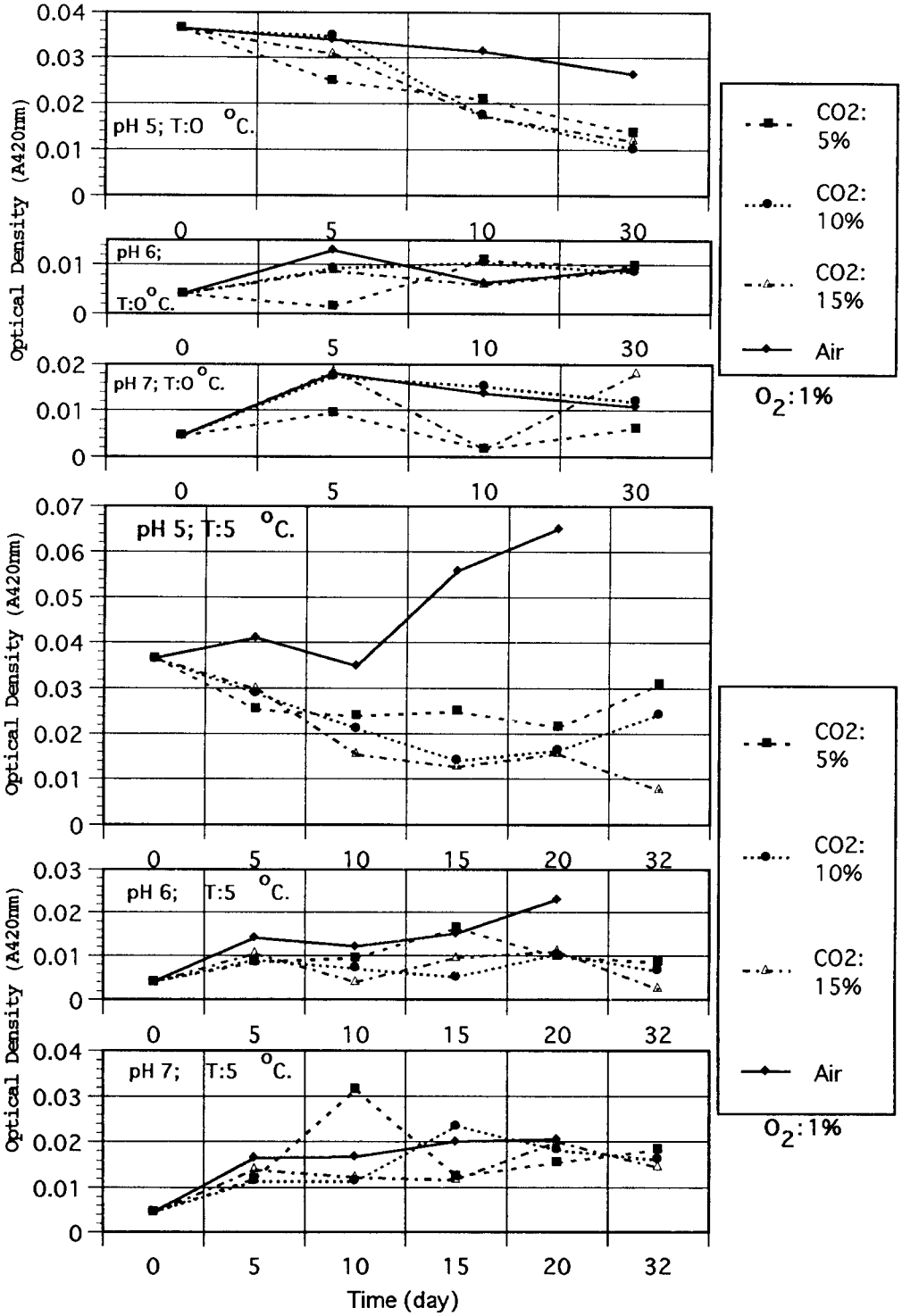

Figure 6. Polyphenoloxydase Activity of Fresh Shiitake during CA Storage in Condition pH 5.0 - 8.0; T:0°C and 5°C (Research III).