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Application of simplex lattice design for development of moisture absorber for oyster mushrooms

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Abstract

Polymeric films used in MAP have lower water vapour transmission rates relative to the transpiration rates of fresh produce such as oyster mushrooms (*Pleurotus ostreatus*). As a consequence, water condensation may be found inside the package, promoting decay of the product. The use of moisture absorbers to control the relative humidity inside packages is effective in reducing saturation and condensation for fresh produce. However, common moisture absorbers have low absorption capacity or, in opposite, fast rate of absorption which is undesirable for storing high transpiring products. Therefore, this study was undertaken in order to develop a moisture absorber with high moisture holding capacity. The experiment was designed according to a simplex lattice method with three factors (calcium oxide, sorbitol and calcium chloride) and a range of 0.2 – 0.6 g of desiccant mass. These three desiccants were mixed in varying proportions and the change in moisture content of each of the mixed desiccants was measured at regular intervals up to 5 days at 10 ºC. Pareto analysis showed that calcium chloride had the most significant effect on final moisture content of mixed absorber. The optimized desiccant mixture contained 0.5, 0.26 and 0.24 of calcium oxide, calcium chloride and sorbitol respectively yielding moisture holding capacity of 0.813. These results present good perspectives for the application of a moisture absorber for packaging of oyster mushrooms.

Keywords: calcium chloride; calcium oxide; packaging; simplex lattice; sorbitol

1. Introduction

Packaging is a fundamental tool in order to retain general quality and the use of Modified Atmosphere Packaging (MAP) in postharvest preservation of horticultural commodities has been recognized as one

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important technology to reduce losses, maintain quality and extend shelf life throughout the distribution chain [1, 2]. MAP has been extensively studied for mushrooms, with positive effects regarding quality. However, condensation of moisture inside the packages, off odour and off colour developments are common problems in mushrooms packing, due to the low water vapour transmissions rates (WVTR) of the films used [3-7]. The excess of water that moisten produce surface will cause an unpleasant package appearance but also increase water activity and consequently create the ideal conditions for microbial growth and subsequent decay of the product [5, 6].

A possible solution to control the in-package relative humidity (IPRH) and therefore extend the shelf life of respiring produce is the use of moisture absorbers [8-11]. The use of sorbitol, xylitol, sodium chloride and potassium chloride has already been applied in green tomatoes, increasing their shelf-lives and suppressing mold growth [8].

Ben-Yehoshua et al. [10] used calcium chloride (CaCl2) to control IPRH of bell peppers and the use of 5 g of desiccant per fruit maintained the RH between 80 and 88%, with less lost weight and higher quality maintenance. In the work of DeEll et al. [11] the addition of sorbitol in MAP allowed a better maintenance of general quality of broccoli heads when compared with control treatment.

Regarding mushrooms, very few studies were conducted on the use of desiccants in fresh produce packaging. Roy et al. [5, 6] studied the use of sorbitol (15 g sorbitol/100 g mushrooms) to control IPRH of Agaricus mushrooms at 10℃, concluding that the desiccant application in the package increased the product shelf life and that higher sorbitol quantities increased product weight loss. Other commercially available food-grade moisture absorbers such as clay and silica were used in modified humidity packaging of fresh mushroom [7]. The authors obtained global better storage quality regarding maturity index and discoloration when 9 minipacks (3.5 g each pack) were used in a 225 g tray.

For Pleurotus mushrooms, [12] also used sorbitol and silica gel (10–15 g/150 g of mushrooms) to control IPRH, concluding on one hand, that sorbitol deteriorated texture, whereas silica gel increased the weight loss of produce. In a different approach, [13] developed a moisture absorber for fresh mushrooms using different combinations of desiccants. The authors suggested a combination of bentonite, sorbitol and CaCl2 (in proportions of 0.55, 0.25 and 0.2 g. g−1) to fit mushrooms requirements (moisture holding capacity of 0.9 g. g−1 mixed desiccant that remained in powder form during 120 h of storage at 10 ℃). Moreover, appearance of Agaricus mushrooms improved with the use of 5 g of mixed desiccant in 250 g of mushroom punnets when compared with produce packed without desiccant.

Oyster mushroom (Pleurotus ostreatus) is a common edible mushroom, highly appreciated for its unique flavour and nutritional composition. Once harvested, Pleurotus deteriorate rapidly and high weight losses are found in postharvest period [6, 12, 14]. In particular with Pleurotus, very few studies can be found regarding the use of moisture absorbers to achieve higher quality retention [6, 12].

Existing moisture absorbers approved for use in food packaging have low absorption capacity or absorb moisture too quickly, making them unsuitable for food packaging. This study aims to develop a moisture absorber with the correct moisture holding capacity for mushrooms. This will be achieved by combining three desiccants, calcium oxide (CaO), sorbitol and CaCl2 in varying proportions and identifying the combination of the three desiccants which gives optimum performance. Simplex lattice technique was used to design the experiments and optimize the proportion of ingredients for the mixed desiccant.

2. Materials & Methods

Three desiccants selected for the present study were CaO, $CaCl_2$ and sorbitol. Each desiccant was oven dried at 60 ºC for at least 1 h before mixing. Simplex lattice design was used to determine the number of experimental runs and the proportion of three desiccants in each experimental run (Table 1). It is a mixture design in which sum of the fractions of the desiccants is unity [15].