A COMBINATION PLASTIC PERMEABLE FILM SYSTEM FOR CONTROLLING POST-HARVEST MUSHROOM QUALITY

K. S. Burton*, Carol E. Frost and R. Nichols
Institute of Horticultural Research, Littlehampton, W. Sussex, BN17 6LP, U.K.

SUMMARY: A combination of microporous and a relatively impermeable film was used to overwrap mushrooms. The modified atmosphere created by respiration could be controlled by adjusting the area of microporous film which in turn reduced the loss of mushroom quality assessed by developmental stage, colour, weight loss and disease incidence.

INTRODUCTION

The concept of using modified atmospheres (MA) to extend storage life of fresh produce, developed from the early work of Eidd and West (see e.g. Smock, 1979). However for short-lived, fast-respiring produce, of which mushrooms are a good example, the process of generating a suitably modified equilibrium-atmosphere within the confines of a commercial store can be defeated by the frequent need to open the store to achieve a reasonable turnround of produce. As a consequence an empirical approach has been to study the effects of the self-generated MA produced inside small, discrete units, such as an overwrapped prepack, on the development and quality of the enclosed produce. In principle, as a result of respiration, oxygen is consumed, carbon dioxide is produced, and a rough equilibrium concentration of these gases is established, depending on temperature, mass and nature of the produce and gas permeabilities of the overwrapping. A range of horticultural produce has been studied in this way and the limitations outlined (Hardenburg, 1971; Geeson et al., 1985).

Nichols and Hammond (1973, 1975) found that development of mushrooms inside an overwrapped prepack was modified, presumably as a result of changed oxygen, carbon dioxide and water vapour concentrations (Sveine et al., 1967; Gormley and MacCanna, 1967; Murr and Morris, 1975; Nichols and Hammond, 1976). However, the generation of an anaerobic atmosphere inside the intact overwraps surrounding the mushrooms was considered possibly hazardous (Sugiyama and Yang, 1975), although the risk was slight (Kautter et al., 1978). To prevent this it is now common practice to perforate the overwrapping film to allow ingress of air. This is not conducive to optimum storage, particularly at ambient
temperatures. Since further progress was constrained by a dearth of suitable gas-permeable films, we devised and describe here a system using two films in combination, one of which (microporous) serves to regulate the gas exchange because it is highly permeable relative to the other. The effects of the two film system on mushroom quality (development stage, colour, weight loss and disease incidence) are assessed.

MATERIALS AND METHODS

Mushroom sporophores (Agaricus bisporus), strain U3, were grown and harvested under normal commercial conditions at the IHR-L Mushroom Unit. Clean, button mushrooms (development stage 2, Fig. 2 and Nichols and Hammond, 1976) free from bacterial blotch or bruises were selected and accurately weighed into styrene punnets, five per punnet, with a total weight of 100 ± 2 g. Eight layers of quilted kitchen towel paper were placed in the bottom of each punnet to absorb condensed water. Direct contact between the paper and mushrooms was prevented by a sheet of Tygan plastic mesh. The punnets were over-wrapped using one of the film combinations outlined below or left open, and then placed in a store at 18 ± 0.5°C, 90-95% relative humidity for four days.

Treatment 1 was a complete over-wrapping by means of orientated polypropylene film (Van Leer plc), with a quoted oxygen permeability 940 ml m⁻² d⁻¹ atm⁻¹.

Treatments 2, 3 and 4 consisted of overwrapping with the same film as in treatment 1, but holes of total area of 40, 80 and 240 mm² respectively were punched from the film for each pack. Over the holes a rectangle of microporous film (‘VALMIC’ Van Leer plc) 250 x 250 mm (quoted air permeability approx. 5.6 x 10⁻⁹ ml m⁻² d⁻¹ atm⁻¹) was attached, so creating a porous but opaque "window".

Treatments 5 and 6, consisted of punnets of mushrooms overwrapped with Borden PF-A micro-perforated film, or left open, respectively and simulate current marketing practices for overwrapped or unwrapped mushrooms.

After 24, 48 and 72h of storage, 1 ml of head space gas was withdrawn through a seal on the film to measure the oxygen and carbon dioxide concentrations in each overwrapped punnet. The gas levels were measured using an Alltech CTRI column and a thermal conductivity detector in a Shimadzu GC-8A gas chromatograph. The chromatograph was calibrated using standard calibration gas mixtures from Phase Separations (Queensferry, Clwyd, U.K.). No correction was made for the possible co-elution of argon with oxygen.

After 4 days storage, the mushrooms were removed from the punnets, weighed. Colour was measured, developmental stage scored (Hammond and Nichols 1976) and quality subjectively assessed by:– odour, incidence of visible symptoms of disease (Pseudomonas scleroti and Aphanocladium album, Fletcher et al., 1986) and mycelial bloom (outgrowth of mushroom hyphae). The colour of the top of the mushroom cap was measured by the Hunter Colorimeter (Hunter Assoc., Lab Inc., Virginia, USA) in the L,a,b mode (colour parameters).

The experiment was repeated twice; in each, 40 mushrooms were examined per treatment (8 punnets, 5 mushrooms per punnet).

RESULTS

There were no significant differences between the two experiments except for the 'b' parameter, so the results were pooled and averaged.