

## Effect of Pretreatments on the Characteristics of Dried Grey Oyster Mushroom (*Pleurotus sajor - caju*)

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### ABSTRAK

*Natrium hypoklorit, Natrium metabisulphit dan glyserol didapati berkesan dalam mengurangkan keperangan cendawan kering. Penambahan glyserol juga memperbaiki jalinan cendawan kering yang dibasahkan semula, sementara CaCl<sub>2</sub> dan tawas mendapatkan hasil yang berjalanan mantap, kalsium lebih berkesan dari tawas. Perlakuan dengan 0.3% cysteine-HCl dapat memelihara 82% dari asid askorbik dalam cendawan kering berbanding dengan cendawan segar. Suhu pengeringan yang terbaik untuk warna dan jalinan adalah 40°C, sementara yang paling sesuai untuk pemeliharaan asid askorbik adalah 60°C. Glyserol dapat mengurangkan kekecutan semasa pengeringan dan memperbaiki kebolehan cendawan kering dibasahkan semula, dengan sifat sifat yang hampir menyerupai cendawan segar. Penilaian deria menunjukkan cendawan tiram kering yang telah dibasahkan semula bagus diterima dan perlakuan perlakuan menyebabkan peningkatan mutu jalinan dan warna yang ketara ( $p < 0.05$ ). Penilaian deria menunjukkan tiada perbezaan ketara bagi citarasa dan penerimaan keseluruhan cendawan kering yang telah dibasahkan semula berbanding dengan cendawan segar.*

### ABSTRACT

*Sodium hypochlorite, sodium metabisulphite and glycerol were effective in reducing the browning of dried mushrooms. Addition of glycerol also improved the texture of rehydrated dried mushrooms while CaCl<sub>2</sub> and alum produced a firm textured product, calcium being more effective than alum. Pretreatment with 0.3% cysteine-HCl helped preserve 82% of the ascorbic acid content in dried mushrooms compared to fresh mushrooms. The best drying temperature for colour and texture was 40°C; 60°C was best for ascorbic acid retention. Glycerol reduced shrinkage during drying and improved the ability of the dried mushrooms to rehydrate almost to an extent characteristic of fresh mushrooms. Sensory evaluation showed that dried grey oyster mushrooms were well accepted; pretreatments caused a significant improvement in texture and colour ( $p < 0.05$ ). The panellists gave insignificantly different scores for flavour and overall acceptability for all the rehydrated dried mushrooms even when compared to the fresh mushrooms.*

### INTRODUCTION

Malaysia imported RM20 million worth of dried mushrooms in 1986. The Ministry of Agricultural actively promotes the cultivation of grey oyster mushrooms because of ease of production, nutritional value, suitability of climate and Malaysia's abundant agricultural waste. Mushrooms are a good source of protein, vitamin B-complex, ascor-

bic acid; and have a higher mineral content than meat, fish or vegetables (Bano *et al.* 1981; Tee *et al.* 1988). Canning and drying could be used to preserve mushrooms, but the quality of the finished product is often not comparable to fresh ones. Komonosky *et al.* (1970) reported that the use of 400 ppm Cl<sub>2</sub> and 300 ppm SO<sub>2</sub> and drying at 43°C for 4 h followed by 1 h at 77°C produced dried mushrooms with a light, attractive colour and a bacterial count of less than 7000/g. Loss

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of ascorbic acid during processing and storage can be reduced by pretreatment with  $\text{SO}_2$  (Bender 1958; Bolin and Stafford 1974) and cysteine-HCl (Mohamed *et al.* 1993). This study compared the effects of drying temperatures and some pretreatments (hypochlorite, metabisulfite, cysteine-HCl, alum, glycerol and calcium) on the colour, ascorbic acid of dried grey oyster mushrooms, texture as well as the organoleptic evaluation of the rehydrated dried mushrooms.

## MATERIALS AND METHODS

Grey oyster mushrooms (*Pleurotus sajor-caju*) purchased from two suppliers in Bandar Baru Bangi and Sri Serdang, were thoroughly mixed and randomly grouped for treatment, drying and analysis to minimise variation.

Fresh whole mushrooms were handwashed with running portable water and dipped for 15 m in 0.05% aqueous Na hypochlorite to reduce bacterial load. They were drained and soaked for another 15 m in the various solutions and dried as a single layer at 40°C, 50°C or 60°C in a 100m/min air velocity, circulating, 121.5 x 101.5 x 54.5 cm<sup>3</sup> oven (Memmert<sup>R</sup> LL80, West Germany) to constant weight.

The pretreatments are:

- control for colour;
- 0.05% Na hypochlorite (second dip)
- 0.1% Na metabisulphite for texture;
- 0.5%, 1.0% and 2.0% glycerol
- 1.0% and 2.0%  $\text{CaCl}_2$
- 2.0% and 4.0% Alum (Aluminium potassium sulphate) and for ascorbic acid retention;
- 0.1%, 0.2% and 0.3% cysteine-HCl

Colour of ground samples placed in a dry petri dish was determined using a Hunter Lab Tristimulus colorimeter with a white tile number C 2 22991 as reference ( $L = 91.25$ ,  $a = -0.9$  and  $b = 0.5$ ). Ascorbic acid was determined by titrating with standardised 2,6 dichlorophenolindophenol solution in the presence of  $\text{HPO}_3$  (AOAC, 1980). For texture measurements, samples were rehydrated for 5 m at 60°C, cut to 3 x 1 cm<sup>2</sup> and were selected so as to have similar thickness (measured with a vernier caliper). Texture measurements were done on at least six pieces of rehydrated dried mushrooms using an Instron 1140 Universal testing machine with a Kramer shear cell (50 kg load), at 50 mm min<sup>-1</sup> crosshead speed.

Sensory evaluation was done by 15 taste panellists for colour, taste/flavour, texture and overall acceptability of fresh and rehydrated mushrooms served in the form of soup, on a hedonic scale of 1-9 (9 = most liked).

Data were statistically evaluated using Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) on SAS statistical program, using an IBM compatible PC.

## RESULTS AND DISCUSSION

Grey oyster mushrooms are perishable within 2-3 days after harvesting, characterised in browning, liquefaction, loss of moisture, texture, aroma and flavour. The mushrooms required 5 h drying at 60°C, 7 h at 50°C and 11 h at 40°C to reach constant weight (Fig. 1).

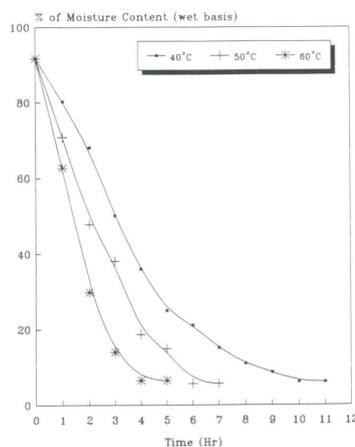


Fig. 1: Drying rate of dried mushroom moisture content (%) vs. time (H)

### Colour

The lightest coloured dried mushrooms were produced at 40°C drying temperature probably because they undergo the minimum non-enzymic browning. At 40°C the Na metabisulphite pretreated mushrooms produced the lightest products, followed by Na hypochlorite pretreatment and finally the cys-HCl pretreatment. Only these three pretreatments produced products lighter coloured than the control; all the other pretreatments resulted in products darker than the control. For mushrooms dried at 50°C and 60°C, all the pretreatments improved the colour of the products except for  $\text{CaCl}_2$  pretreatments. At all the drying temperatures, both hypochlorite and

Na metabisulphite treated mushrooms were significantly ( $p < 0.05$ ) lighter than the control. Na metabisulphite treated dried mushrooms were significantly lighter in colour than hypochlorite treated dried mushrooms most likely because sulphites retard both enzymic and non-enzymic browning and exert a bleaching action on any pigments present; hypochlorites on the other hand, only have the ability to bleach and reduce the microbial load. Glycerol treated samples dried at 50°C and 60°C had a high L value (not significantly different from Na metabisulphite treated samples) but relatively lower in b values. On rehydration the glycerol treated samples were darker than metabisulphite treated ones. Cys-HCl treatment has been repeatedly shown to produce less colour change than the control but more than metabisulphite pretreatment (Mohamed *et al.* 1993) because it is only effective in preventing enzymic browning but not non-enzymic browning in model systems (Mohamed and Leong 1987).

Fig. 2b shows that at 40°C only Na metabisulphite, 2% Alum and 0.2% cys-HCl pretreatment produced dried mushrooms which were more yellow than the control. At 50°C all pretreatments resulted in products less yellow than the control. At 60°C, only the metabisulphite, hypochlorite and glycerol treated products were

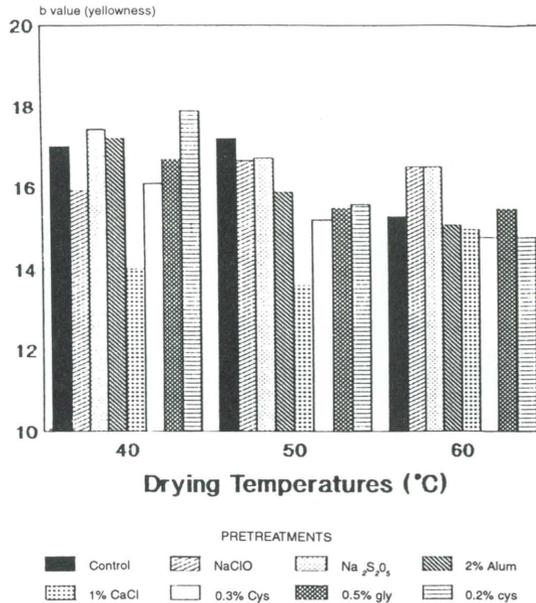


Fig 2b: Yellowness (Colour) of dried mushroom

more yellow than the control. The reason for the development of the yellow colour is yet to be studied.

Texture

Increasing drying temperature caused increased firmness of the product probably because the mushrooms dried faster thus the time for the breakdown of the cell structural components like pectin or cellulose were reduced. CaCl<sub>2</sub> was most effective in preserving the firmness of rehydrated dried mushrooms, followed by alum pretreatment and finally, glycerol. Increasing the concentration of Ca, Alum or glycerol, resulted in increased firmness of rehydrated dried mushrooms (Fig. 3). Statistical analysis showed highly significant difference ( $P < 0.01$ ) in firmness between the chemical treatments (CaCl<sub>2</sub>, Alum, glycerol) but not between concentrations or drying temperatures used. Calcium has the ability to react with soluble pectin between the cell walls to form insoluble calcium pectate which increases the rigidity of the tissue (Lindsay 1985). Alum was also able to react with pectin to improve crunchiness and rigidity of the product (Matz 1962) but did not seem to be as effective as calcium. Glycerol produced a softer textured product than calcium and alum because it functions as a solvent that replaced water in the dried product. However, glycerol

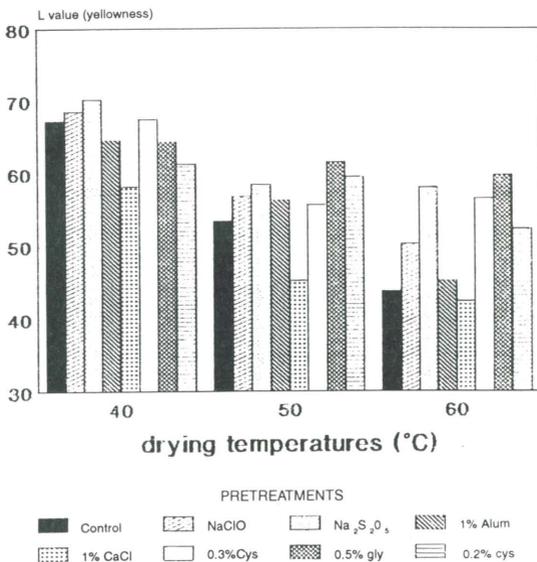
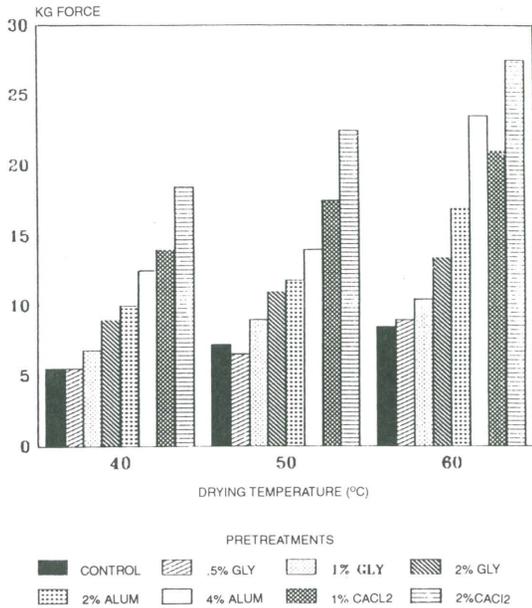


Fig. 2a: Colour (lightness) of dried mushrooms under different pretreatments



1. GLY= Glycerine

Fig. 3: Texture of rehydrated dried mushrooms

helped reduce shrinkage during drying, maintain texture and improve the ability to rehydrate to a level characteristic of fresh mushrooms.

**Ascorbic Acid Content**

Ascorbic acid is the least stable of all vitamins and is easily destroyed during processing and storage (De-Man 1979). Grey oyster mushrooms contained 87mg/100g ascorbic acid on dry weight basis (Fig. 4). Cys-HCl has been shown to be more effective than Na metabisulphite or glycerol in retaining the ascorbic acid of dehydrated products (Mohamed *et al.* 1993). Increasing concentrations of cys-HCl increased the ascorbic acid content of dried mushrooms over the range studied. A plateau for maximum ascorbic acid retention was not reached with increasing cys-HCl concentration even when the amount used was very high (0.3%). Cys-HCl (0.3%) pretreatment together with drying at 60°C, helped retain 82% of the ascorbic acid in dried mushrooms (71.7 mg/100g). The mechanism for protection of ascorbic acid by cys-HCl was thought to be due to the reduction of o-quinones to a colourless complex, forestalling ascorbic acid reaction with quinone. Cysteine-HCl was only effective in inhibiting enzymic

browning but not non enzymic browning (Mohamed and Leong 1987). Hypochlorite is an oxidising agent and is not expected to improve the ascorbic acid level in dried mushrooms.

The ability of a much lower concentration of cys-HCl (0.024%) to protect ascorbic acid in dehydrated pickled/candied pineapples and guava has been reported by Mohamed *et al.* (1993). Increasing drying temperature also increased the ascorbic acid content of dried mushrooms showing that ascorbic acid is more adversely affected by longer drying time than higher drying temperature. This is partly because the enzymes responsible for the destruction of ascorbic acid are probably still active for some time at the lower drying temperatures since blanching of mushrooms before drying was not carried out. Blanching has been reported to reduce the attractiveness of dried mushrooms (Komonowsky *et al.* 1970). However, even with blanching, the shorter drying time helped reduce the amount of ascorbic acid oxidised in the dried products (Mohamed and Hussein 1994)

**Sensory Evaluation**

All the rehydrated dried mushrooms were not significantly different in terms of colour com-

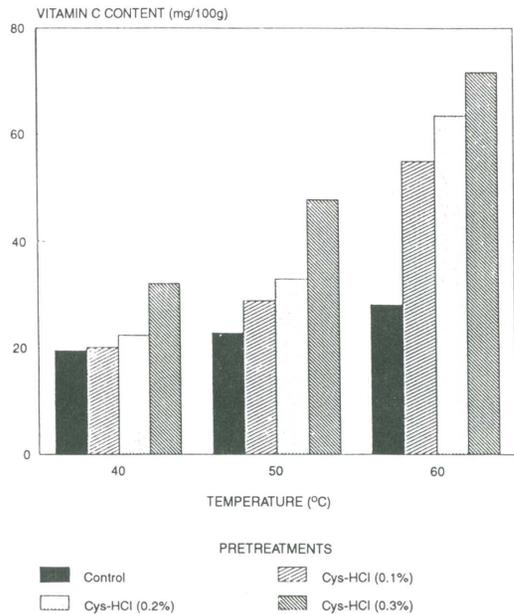
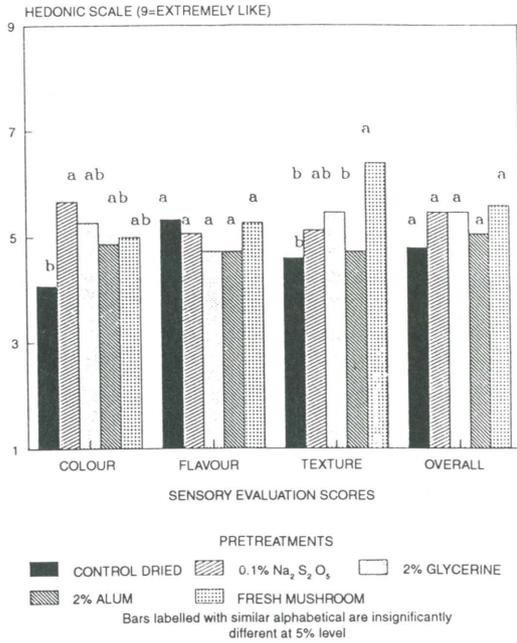


Fig. 4: Vitamin c content in dried mushroom

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MUSHROOMS DRIED AT 40 C  
 Fig. 5: Sensory evaluation of mushroom soup served to 15 taste panellists

pared to fresh mushrooms when served in the form of soup. In fact, the scores for metabisulphite and glycerol treated samples were higher than those of fresh mushrooms. However, pretreated dried mushrooms scored significantly more favourably than untreated dried mushrooms in terms of colour (Fig.5).

Glycerol pretreatment significantly improved the texture of rehydrated dried mushrooms, making the product insignificantly different (p>0.05) from fresh mushrooms (Fig.5).

REFERENCES

A.O.A.C. 1980. Official Methods of Analysis, Washington D.C., 13th Edn.

BANO, Z., S. RAJARATHNAM and N. NAGARAJA. 1981. Minerals and the heavy metal content in the sporophores of *Pleurotus spp.* Mushroom Newsletter for the Tropics **2(2)**: 3-7.

BENDER, A.E. 1958. The stability of Vitamin C in a commercial fruit squash. *J. Sci. Food agric.* **9**: 754-764.

BOLIN, H.R. and A.E. STAFFORD. 1974. Effect of processing and storage on provitamin A and vitamin C in apricots. *J. Food Sci.* **39**: 1034-1036.

DE-MAN J.M. 1979. *Principles of Food Chemistry*. Westport; Connecticut: The VII Publishing Co Inc.

KOMONOSKY, M.F., B.TALLEY and R.K. ESKEW. 1970. Air drying of cultivated mushrooms. *Food Technology* **24**:1020-1024.

LINDSAY, R.C. 1985. Food additives. In *Food Chemistry* ed. R.F. Owens. New York: Marcel Dekker Inc. 2nd Edn.

MATZ, S.A. 1962. *Food Texture*. Westport, Connecticut: AVI Publishing Co.

MOHAMED, S. and S.H. LEONG. 1987. Prevention of browning in canned Langsat (*Lansium domesticum*). *Pertanika* **10(2)**: 143-149.

MOHAMED, S., K.M.M. KYI and Z.M. SHARIF. 1993. Protective effect of cysteine-HCl on vitamin C in dehydrated pickled/candied pineapples and guava *J. Sci. Food Agric.* **61**: 133-136

MOHAMED.S. and ROSLI HUSSEIN 1994. Use of low temperature blanching, CYS-HCl, N-acetylcys and Na Metabisulphite to improve the firmness and Nutreient content of dried carrots. *J. Food Processing and Preservation*. In press

TEE E.S., MOHD ISMAIL NOOR, MOHD NASIR AZUDIN and KHATIJAH IDRIS. 1988. Nutrient composition of Malaysian foods. Asean Food Habits Project. National sub-comitee on protein: Food Habits Research and Development, Malaysia.

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