Mushroom J. 1986, Nov, No 167, 387-391

Mushroom Processing Retaining Colour Without Losing Weight

204

by T. R. Gormley

Processed mushrooms must be blanched so that they will retain an acceptable white colour. However, this can lead to a weight loss of between 20 and 30 per cent, which is bad economics for the processor. Research at Kinsealy Research Centre has come up with some solutions to this problem. Breading of unblanched mushrooms prior to freezing is one. Another successful technique is to treat mushrooms with xanthan gum prior to blanching in the case of frozen or canned mushrooms.

A bright colour is a major requirement for the successful marketing of mushrooms. In fresh mushrooms the whiter the better; frozen mushrooms must also be white, while the requirement in the canned product is for a creamy-white appearance. In all cases the absence of brown colour or brown patches is essential.

Fresh mushrooms have an active enzyme system. Damage or rough handling releases this enzyme and browning commences. In freezing, the formation of ice disrupts the tissues and releases the enzyme. Despite the fact that the mushrooms are held at temperatures below −20°C, browning will slowly develop in the frozen product.

In canning, the slow temperature come-up time in-can will also activate the enzymes and severe browning will result. For these reasons mushrooms for freezing or canning should be blanched in steam or boiling water; this de-activates the enzymes and maintains whiteness but loss in weight, due to shrinkage, is in the range 20 to 30 per cent with obvious economic implications.

Extensive research has been carried out at Kinsealy in the last decade on ways of reducing or overcoming this weight loss in processed mushrooms. This article describes some of them.

Frozen breaded mushrooms

One way of overcoming discolouration in unblanched frozen mushrooms is to cover them with a batter/crumb. A procedure/recipe typical of many tested at Kinsealy is as follows. Fresh mushrooms are held at 2°C for 24 hours prior to treatment. They are then washed, coated with spiced chicken batter at a suspension concentration of 450g/700ml water, rolled in pinhead yolk crumb, and then blast frozen loose for 0.5 hours at −30°C. The samples are stored in deep freeze at −18°C and are fried in oil at 190°C for three to five minutes, when required, directly from the freezer. Alternatively, they can be partially fried in oil for three minutes at 190°C prior to freezing. The frozen par-fried product is then finish-fried in oil at 190°C for one to three minutes when required.

Of the two, the unfried product has the better sensory properties and the more favourable weight gain (Table 1). Weight gains are 34 and 15 per cent, respectively, for the two methods. In the former, the processor bears none of the weight loss as the frying step is carried out by the consumer. The par-fried product has a considerably lower weight gain and the processor has to bear the cost of the cooking oil and also become involved in an extra stage, ie par-frying.

Most emphasis was placed, therefore, on the unfried product for subsequent tests. Microbiological status was perfectly acceptable for this type of product, particularly as the mushrooms

Table 1
Breaded mushrooms — weight relative to 100g of fresh mushrooms

	Unfried product	Par-fried product
Initial	100	100
After batter + crumb	137	130
After frying	—	118*
After freezing	134	115

* Includes about 11g of "soaked" frying oil

are subsequently fried in oil prior to consumption. Colour and flavour data for the breaded mushrooms stored unfried at −18°C for 18 months showed that there was no change in terms of lightness and yellowness during the storage period. Initially it was feared that surface discolouration of the mushrooms under the crumb would manifest itself as a darkening and/or a browning of the crumb (the crumb used had a yellow/orange colour which changed to golden on deep frying). The flavour, colour and crumb integrity of the finish-fried product were excellent even after 18 months' storage.

Breaded mushrooms are a versatile product and a range of batters with different flavours and also crumbs of different colours and degrees of coarseness can be used. They are excellent where served as a hors d'oeuvres or as a vegetable. Earlier work on this product using other batters and procedures has been published (*Proc. IV Int. Congress Fd Sci. Technol.* (1974) **4:** 147-154).

Frozen mushrooms

A wide range of techniques for reducing shrinkage (loss of weight) in blanched frozen mushrooms has been investigated at Kinsealy in recent years. The most successful has been to vacuum treat the mushrooms with a one per cent aqueous solution of food grade xanthan gum ("Keltrol"), containing sodium metabisulphite, for 12 minutes prior to blanching and freezing. The data (Table 2) show the large reduction in blanching loss at the higher levels of xanthan treatment.

Xanthan gum also removed the leathery texture found in frozen mushrooms as indicated by the shear values (Table 2). It had no adverse effect on the mouth feel properties or flavour of the mushrooms as reported by five tasters. Increasing levels of sodium metabisulphite (SMBS) (0.1 to 0.4 per cent) in the xanthan gum solution also had a softening (enhancing) effect on the texture of the frozen mushrooms. The xanthan/SMBS system has, therefore, the triple effect of reducing weight loss during blanching, enhancing the texture of the frozen product, and maintaining whiteness in the mushrooms.

Other tests on frozen mushrooms at Kinsealy aimed at reducing weight loss and maintaining whiteness include "hot air" blanching (900°C) of mushrooms pre-soaked in ascorbic acid or SMBS solution, the use of SMBS as an alternative to blanching, and the cryogenic freezing (Freon) of unblanched mushrooms. While these treatments were partly effective, each also had a negative aspect in relation to mushroom quality or to ease of application of the particular process in question. Details of these tests have been published and are available on request.

Canned mushrooms

Weight loss occurs in canned mushrooms at the blanching and retorting stages. The combined loss in conventionally canned mushrooms is generally fairly constant, ie a low blanching loss results in a high retort loss and *vice versa.* The use of xanthan gum as a pre-blanching vacuum treatment has also been applied successfully to canned mushrooms. Recent Kinsealy data (Table 3) show than xanthan treatment (one per cent) gave lower blanching and total losses than the other treatments.

Its close rival the "3S" treatment (Table 3), gave less white mushrooms and is cumbersome to use in practice; the term "3S" refers to soak (water for 20 min), store (72 hours at 2-4°C),

MUSHROOM STRAINS

Results of tests on the suitability of different mushroom strains for canning were reported in 1980 (*Ir. J. Fd Sci. Technol.* **4:** 57-64). These were canned using the conventional (no xanthan) blanching and retorting procedure. Cream and off-white strains had the highest level of open and misshapen mushrooms prior to processing and a brown strain the lowest. Blanching losses ranged from 38 per cent for the cream strain to 23 per cent for the brown strain.

Values for shrinkage during blanching were similar for the five strains with a mean of 19 per cent loss in weight. Shrinkage during retorting ranged from 15 per cent for the off-white 2-strain to 11 per cent for the cream strain. The brown strain gave the highest yield of whole, closed, canned mushrooms at 55 per cent and the cream strain the lowest at 45 per cent. Corresponding yields of canned stems and pieces were 16 and 25 per cent, respectively. Total yield values for all strains were similar, ranging from 70 per cent to 71 per cent.

Table 2
Effect of different levels of xanthan gum on shrinkage and texture in blanched mushrooms

Level of xanthan gum (%)	Weight gain (%) after vacuum soaking	Blanch loss (%)*	Shear value (kN)
0 (water cooled)	60	11	0.79
0.25	60	8	0.81
0.50	60	7	0.64
0.75	62	4	0.67
1.00	59	2	0.66

* Based on weight prior to vacuum soaking.

Table 3
Shrinkage, colour and shear press values for mushrooms canned using xanthan gum treatments in comparison with the "3S" process and water treated controls

	Pre-blanching treatment				
Factor/test	Control	72 hour "3S" process	Vac. soak water	Vac. soak 0.5% xanthan gum	Vac. soak 1% xanthan gum
Weight gain (%)	0	30	49	53	45
Blanch loss (%)*	26	10	23	14	8
Retort loss (%)	13	12	12	13	13
Total loss (%)§	35	21	32	25	20
Whiteness (L)	54	67	73	72	70
Shear press value (kN)	0.81	0.80	0.76	0.80	0.65

* Based on fresh weight.
§ Comprises weight loss during blanching and retorting.

and then soak again (water for two hours) prior to blanching and canning the mushrooms. The "3S" process was reported originally by workers in the USA and results of tests on a range of modifications to it were reported from Kinsealy in 1982 (*Ir. J. Fd Sci. Technol.* (1982), **6**: 165-175).

Chilling mushrooms at 2°-4°C for up to three days had a progressive lowering effect on total weight loss during canning in the case of xanthan vacuum-treated and water vacuum-treated mushrooms but not for "3S" mushrooms. The chilling period had no adverse effect on the whiteness of xanthan-treated canned mushrooms but it did affect the "3S" samples. Based on these data the best results were obtained by chilling and then treating with xanthan gum solution prior to blanching and canning. The economics of xanthan treatment seem favourable even when taking the cost of the extra equipment for vacuum treatment into account.

Other treatments

Tests were carried out in 1983 on vacuum soaking mushrooms in solutions of skim-milk powder or starch ("Colflo 67") prior to blanching in order to study their effects on weight loss. The former had no effect but the latter did reduce blanching loss to 17 per cent compared with a value of 23 per cent for the control. However, the use of starch for reducing shrinkage in canned mushrooms was discontinued in view of the practical difficulties of soaking mushrooms under vacuum in a starch suspension and also in view of the more encouraging results obtained using xanthan gum.

Conclusion

Of the wide range of processing procedures for mushrooms investigated at Kinsealy in the last decade, breaded frozen mushrooms or the pre-treatment of mushrooms for freezing and canning with xanthan solution offer most potential in terms of weight conservation during processing and good product quality.

Acknowledgements

Aspects of this work were funded by Mr. P. Walsh of Walsh Mushrooms Ltd., Mr. R. Wilson of Monaghan Mushrooms Ltd., Mr. C. Butterly of Scotts Foods Manufacturing Ltd., and by the National Board for Science and Technology. The section on xanthan treatment/freezing of mushrooms was included as a contribution to the European COST 91 (Sub Group 3) programme dealing with freezing and thawing of foods.

Dr. Ronan Gormley is Head of the Food Science and Technology Department at Kinsealy Research Centre, Malahide Road, Dublin 17.