

GUIDANCE ON AVOIDING ODOUR FROM PACKAGING MATERIALS USED FOR FOODSTUFFS

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A complete list of British Standards, numbering over 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook. The BS Yearbook may be consulted in many public libraries and similar institutions.

This publication makes reference to the following British Standards:

- BS 881, 589. Nomenclature of commercial timbers, including sources of supply.
- BS 1133. Section 21. Transparent cellulose films, plastics films, metal foil and flexible laminates.
Section 22. Packaging in plastics containers.
- BS 2548. Wood wool for general packaging purposes.
- BS 3755. Methods of test for the assessment of odour from packaging materials used for foodstuffs.

The following BSI references relate to the work on this publication:
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CO-OPERATING ORGANIZATIONS

The Packaging Standards Committee, under whose supervision this publication was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Association of Steel Drum Manufacturers
 Board of Trade
 British Jute Trade Federal Council
 *British Paper and Board Makers' Association (Incorporated)
 *British Paper Bag Federation
 *British Paper Box Federation
 *British Plastics Federation
 British Tin Box Manufacturers' Federation
 *Chemical Industries Association
 Collapsible Tube Manufacturers' Association
 Crown Agents for Oversea Governments and Administrations
 Envelope Makers' and Manufacturing Stationers' Association
 *Fibreboard Packing Case Manufacturers' Association
 *Food Manufacturers' Federation (Incorporated)
 *Glass Manufacturers' Federation
 *Institute of Packaging
 Institute of Weights and Measures Administration
 Institution of Production Engineers
 Ministry of Technology
 Ministry of Transport
 National Carriers Ltd.
 *Packaging Films Manufacturers' Association
 Paintmakers Association of Great Britain
 *Pira, The Research Association for the Paper and Board Printing and Packaging Industries
 Society of Motor Manufacturers and Traders Limited
 Timber Container Confederation

The industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this publication:

Association of Board Makers
 British Aluminium Foil Rollers Association
 British Carton Association
 British Mechanical Engineering Confederation
 Cake & Biscuit Alliance Ltd.
 Cocoa, Chocolate and Confectionery Alliance
 Federation of Gelatine and Glue Manufacturers
 Food Machinery Association
 Ministry of Agriculture, Fisheries and Food
 Society of British Printing Ink Manufacturers
 Technical Section of the British Paper and Board Makers' Association

GUIDANCE ON AVOIDING ODOUR FROM PACKAGING MATERIALS USED FOR FOODSTUFFS

FOREWORD

The guidance given in this document was prepared at the request of the Institute of Packaging under the authority of the Packaging Standards Committee.

1. INTRODUCTION

1.1 GENERAL

Odour is an attribute of many materials which cannot be measured directly in terms of any physical or chemical parameters. It arises from the interaction of volatile compounds with sensitive receptors in man, but little is known about the nature of this interaction or about the train of events set in motion by it.

There are two routes by which odour-producing compounds can cause concern in the packaging of foodstuffs. They can either reach the nose directly, giving rise to objectionable odours from the package, or they can be taken up by the packaged food and produce an off flavour or a variation of the original flavour only apparent when the food is eaten.

In both instances the quantities of the material producing these undesired effects are extremely small and very often they are beyond the reach of the most refined analytical techniques. In general it is necessary, therefore, to assess the odour and the taint-producing qualities of materials by direct sensory tests, for which a standard procedure has been laid down in BS 3755*.

This document cannot possibly encompass the whole field of the subject in complete detail. It is essential that new packs or changes in old ones are the subject of consultation between the makers of the packaging materials concerned, the packaging suppliers and the food maker and packer. Wherever previous experience does not clearly establish the absence of a problem it is recommended that appropriate storage tests of the projected package be made.

The experiences quoted and the statements made in Sections 2 and 3 are specific to the circumstances concerned and also past history. Their intention is to sound a warning, not to lay down either methods or techniques for the packaging of any particular foodstuff. Technological advance is rapid in the packaging field and changes in the situation can arise almost overnight.

With these reservations, it is believed that this document will guide the uninitiated and remind the experienced that there is no better method of pre-

* BS 3755, 'Methods of test for the assessment of odour from packaging materials used for foodstuffs'.

venting odour problems in the packaging of food than frank discussion between supplier and user all down the line from raw material supplier to distributor.

1.2 HOW FOOD BECOMES TAINTED BY ODOUR TRANSFER AND OTHER MEANS

Every odorous substance has at least a very small proportion of its molecules in the vapour state.

If a food product is packaged in an odorous material and if there is an air space between the product and material then odorous molecules in the vapour state can dissolve in or be absorbed by the surface layers of the food. When so trapped they will diffuse slowly into the interior of a solid food or more rapidly into a semi-liquid product. When this occurs the normal equilibrium between 'solid' and 'vapour' molecules of the odorous substance is disturbed and tends to readjust itself by further evaporation of odour molecules into the vapour state. These, in their turn, will be absorbed into the food and the whole process repeats itself and continues at a rate largely determined by the temperature of the packaged food and the degree of saturation in its surface layers. In this way a degree of contamination of the food and a tainting which is much greater than might be anticipated by a slight smell in the packaging material, may develop.

If a product is packed in direct contact with a packaging material taint can also take place by direct absorption and/or solution of both odorous and non-odorous material from the packaging into the surface layers of the food.

Many odorous substances are readily absorbed by or dissolved in fatty and oily materials and because of this fat and oil-containing foods are especially susceptible to tainting. However, foods flavoured with essential oils will also readily absorb odours even if fatty materials are absent. Again, finely powered materials, because of their high ratio of surface area to volume, will generally be active in absorbing odorous material, so that virtually every type of food, particularly when enclosed in a container which is resistant to the passage of gases and vapours, will tend to absorb entrapped odours.

1.3 OTHER CAUSES OF OFF ODOUR AND TAINT IN FOOD

Off odours and taints sometimes occur with food products which are not attributable to odour from packaging materials and arise from other causes. They are sometimes attributed however, quite erroneously, to odour from the packaging material. Examples are:

(1) Packaging materials which are good barriers to water vapour will maintain humid conditions inside a pack containing a moist food, which then develops a musty smell which is kept in by the barriers around it. This sometimes occurs when a home pack is overwrapped with a moisture resistant barrier to convert it into an export pack.

(2) Packaging materials which are resistant to the passage of water vapour do not necessarily prevent the transfer of oxygen, and fatty food susceptible to oxygen can develop a rancid odour inside a barrier package due to oxidation of the food.

(3) Packaging materials will permit certain external odours (such as those from other commodities) to transfer into the package and the resulting food taint is then wrongly attributed to the packaging material.

(4) Packaged fruits are sometimes found to be tainted and this is probably due to tainting before packaging rather than to packaging odours, e.g. apples can take up taints from some solvents present in paint and bituminous preparations used to cover the walls of refrigerated stores. Such taint has erroneously been attributed to packaging material.

Well sealed film packages of fruit can develop anaerobic conditions inside and the respiration of the fruit then leads to its acquiring a taste of acetaldehyde formed within the tissue. This flavour is also often present in apples, which are otherwise normal in appearance, through exposure to anaerobic conditions which may later result in the flesh turning brown. Consequently, as fruits are not particularly liable to pick up odours or taints it is more likely that taint occurs before packaging or develops due to anaerobic conditions in the pack.

Vegetables behave in a similar manner, being much more likely to develop taints than to absorb them.

(5) The insertion of articles within a package to serve as 'give aways' to increase sales must also be carefully checked. A great proportion of such articles are manufactured from heavily printed materials, from moulded plastics or rubber, not necessarily produced with such uses in mind. If they are not checked for odour by the user, odour problems may result which may erroneously be attributed to the packaging material. It is essential when ordering such items to incorporate a clause about freedom from odour in the specification and to inform the supplier of the use which will be made of them.

2. PACKAGING MATERIALS AND CONTAINERS AS POTENTIAL SOURCES OF ODOUR

2.1 METAL

2.1.1 Tinplate containers. Tinplate by itself does not represent a source of odour. What is commonly designated as a 'metallic' odour or taint arises from volatile compounds developed by interaction of corroding materials with the metal. Corrosion has other undesirable consequences limiting the shelf life of the pack and for this reason has to be controlled. In practice such corrosion products do not give rise to odour or taint.

To prevent interaction between product and metal the tin plate is often protected by a lacquer applied either to the plate in sheet form or to the inside of

the container. The requirements of suitable lacquers are highly specialized, freedom from odour of the finished lacquer films being one of the first necessities.

There is no universal tinplate lacquer suitable for all products and particular lacquer systems have to be selected for specific purposes. Collaboration between the can maker and the packer is required, therefore, in all instances.

The considerations to be taken into account in selecting can lacquers are illustrated by the requirements for peas. During the heat sterilization process in the can, peas (in common with many other vegetables) release low molecular weight sulphur compounds. In an unlacquered can this causes unsightly staining. Use of an internal lacquer impervious to sulphur compounds leaves them unreacted in the headspace of a can and a strong odour is detected on opening. The problem can be avoided by incorporating a material into the lacquer film which reacts with the sulphides to form insoluble compounds.

For the outside decoration of cans, inks and varnishes are used which avoid transfer of odour and taint if set-off on to adjacent sheets occurs or by transfer through the air when empty cans are stored in cases. Trouble has been experienced by the use of unsuitable marking inks in a packers' plant for the external coding of ends. Transfer of these inks (from outside to inside) occurred on stacking the ends and the odour of the inks transferred to the product.

2.1.2 Aluminium containers. Everything that has been said generally about tinplate applies equally to aluminium. The metal itself cannot give rise directly to odour and such difficulties as may occur will originate from unsuitable lacquers or decorative systems. As with tinplate, co-operation between the packer and the can maker should avoid trouble.

2.1.3 Steel drums. A clean steel drum without an internal lacquer cannot impart an odour to a product packed in it and is completely impervious to odours. Steel drums are coated internally with lacquers and are stoved at temperatures sufficiently high to remove all solvents and to cure the resin present so that no significant odour remains.

There are, however, various components of drums that present potential odour hazards and a careful choice of these components is required if odour is to be kept to an absolute minimum.

(1) *Gaskets for the heads of open top full aperture drums*

(a) *Natural and synthetic rubber gaskets (pre-formed).* These gaskets are normally adhered to the head or cover of the container with a solvent based adhesive which may exude a solvent odour over a period of time. The gaskets themselves, depending upon the material used, can thus give off odours ranging from pungent with some natural rubbers to almost odourless with certain neoprenes.

(b) *Flowed-in rubber gaskets.* This form of gasket, initially a viscous

liquid, is applied to the head or cover and fully cured by stoving afterwards. No adhesive is used and the material—a rubber compound—is relatively odourless when cured and aerated.

(2) *Bung washers*. Normally made from synthetic rubbers or other plastics, these present little or no problem, since the area of the washer in contact with the contents of the package is negligible. The use of polythene washers should ensure no odour risk with very sensitive foods.

(3) *Seaming compounds*. Where compounds are applied to double seams during the seaming operation, it is possible to develop a faint ammonia odour. Proper control of the film weight prevents this.

2.1.4 Aluminium foil. Aluminium foil, whether for containers, bottle closures or wraps, cannot give rise directly to odour. Difficulties that may occur originate from surface contamination, unsuitable coatings or decorative systems, or where aluminium foil is used in combination with other materials such as paper or plastics. Odour may arise from the paper, the plastics or the adhesive used in bonding the materials to each other. Co-operation between packer, converter and foil roller will avoid serious defect. When used on high speed machinery aluminium foil requires lubrication. Complaint of odour from the lubricants employed are rare.

Aluminium foil is printed by flexography, rotogravure and occasionally lithography. It is also coloured by nitrocellulose and other lacquers. Odours may arise through incomplete drying (see 2.10).

2.1.4.1 Foil coatings. Coatings are applied to aluminium foil and foil laminates for a variety of purposes, including protection and to render the foil heat sealable. These coatings may be applied from solvent solutions, from aqueous emulsions and by hot melt coating or by extrusion (see 2.4.4, 2.4.5 and 2.10).

2.2 WOOD AND PLYWOOD FOR CASES, CRATES, BOXES, TRAYS, CASKS, ETC.

The foods that are commonly packed in wooden containers without further protection are generally not highly sensitive to taint. Some timbers possess characteristic odours, although many of those used in packaging are practically free from odour and problems may be avoided by proper choice of wood.

2.2.1 Solid wood

2.2.1.1 Wood species (see BS 881, 589*). In Great Britain most boxes, crates and trays to hold foods are normally made from softwoods because, in general, they are more suitable in their properties than hardwoods.

* BS 881, 589, 'Nomenclature of commercial timbers, including sources of supply'.

Of the common softwoods, the spruces (European spruce or whitewood and Sitka spruce), firs (*Abies* spp.), hemlock and podo (from East Africa) are practically free from odour and can safely be used for containers for most types of foodstuff.

The pines (Scots pine or redwood, Corsican pine, maritime pine, etc.) and to a lesser extent the larches and Douglas fir ('Columbian pine') are more resinous timbers and possess a characteristic resinous odour. While this does not prevent their use for ventilated crates and trays for certain types of food, these timbers should be avoided as far as possible in the manufacture of close boarded boxes intended for sensitive food products, particularly fatty foods.

All timbers described as 'cedars', whether or not they are true cedars (*Cedrus* spp.), possess a characteristic fragrant odour which may be picked up by many foods. 'Western red cedar' (*Thuja plicata*) is less odorous than most cedars, but damage to apples stored in boxes made of this timber has been reported. The cypresses (*Cupressus* sp.) possess a similar characteristic odour also.

The common European and North American hardwoods are substantially free from odour in the dry condition and are satisfactory from this point of view for packaging, though they are less widely used than softwoods for other reasons. Hardwoods of tropical origin are more varied and should generally be avoided as some of them possess distinct odours.

2.2.1.2 Moisture content of wood. Most timbers have a more pronounced odour in the undried condition than they do after drying. Thus, green oak often smells strongly of acetic acid, and the odour of resinous softwoods is much more noticeable before drying. The reason for this is that a large part of the volatile material is lost during the drying process. Seasoned wood for construction of packages will minimize any odour problems.

2.2.1.3 Microbiological contamination. Fungi or bacteria growing on wood could give undesirable odours. Apart from the musty smell commonly associated with mould growth, some organisms produce specific odours. Instances of contamination of foods by these are rare, but the possibility should be recognized. Since these organisms only grow on wet wood, the risk is negligible when dry seasoned wood is used.

'Woody' or 'musty' flavours in beer have been caused by species of *Actinomyces* growing in the wood of the cask while empty and not being removed during washing. On several occasions it has been found that casks made from Persian oak have imparted a sweet-scented odour to beer, which was traced to infection of the staves or heads of the casks by a wood-rotting fungus, *Stereum subpileatum*, the metabolic products of which have a penetrating, persistent odour. Such fungal infections can be killed by heating or steaming the wood at 71 °C for about 1 h.

2.2.2 Plywood. In plywood in addition to the wood itself the glue used in manufacture presents a potential source of odour. Most of the woods used in plywood manufacture are free from odour and, of the glues used, animal glue and casein glue are usually satisfactory. Ureaformaldehyde glues may contain traces of residual formaldehyde which, however, disperse fairly rapidly, and phenolformaldehyde glues contain small amounts of unreacted phenol which can persist. Plywood for packaging foodstuffs is therefore much less likely to be made with phenolformaldehyde than with other types of glue.

Plywood tea-chests are manufactured in the exporting country and are controlled by specification. The Indian Standard Specification (IS: 10-1964) requires the adhesive to be lactic casein, or any other glue which stands a test for water resistance and dry adhesion and does not impart any taint to the tea. The specification includes a list of permitted Indian timbers which may be used in manufacture. As a further precaution the chests are lined with aluminium foil, so tainting of the tea by the plywood is unlikely, but the foil may not cover the battens at the corners and it is important that these should be of a non-tainting species and free from fungal contamination.

Instances have occurred of taint to beer stored in casks made from laminated staves. The staves, faced with oak, had other timbers (e.g. birch) in the interior and were manufactured with a phenolformaldehyde resin. The taint was due to an impurity (diphenylene oxide) in the phenol. This unusual instance of contamination indicates the need for caution when using plywood or laminated wood products made with synthetic resin glues.

2.2.3 Wood wool. No records are available of odour arising from wood wool affecting foodstuffs packed in it. All wood wool used for packaging foodstuffs should comply with BS 2548*. This requires the wood wool to be manufactured from sound, well seasoned softwood of low resin content, free from knots and cross grains, and clean. As a further safeguard if the wood wool is to be in contact with odour sensitive foods, whitewood (spruce) should be used.

2.2.4 Wood shavings. Wood shavings are used for similar purposes to wood wool but are less easily controlled. Provided they are made from an acceptable species of wood they are unlikely to give rise to odour problems but often they are of mixed origin.

2.3 GLASS

Glass itself presents no problems in relation to odour. A clean glass container cannot impart any taste or odour to a product packed in it. Furthermore, glass is an impervious material and therefore presents a barrier between the product and any other source of odour in close proximity.

* BS 2548, 'Wood wool for general packaging purposes'.

Bottles freshly delivered from the annealing oven (lehr) are moreover sterile. If kept in open storage for long periods they may become contaminated by dirt, but this can be removed by normal bottle washing processes and is not usually a source of odour provided care is taken, particularly during the final rinsing.

A glass container is not however complete until it is sealed and care must be exercised in the choice of closure, particularly of the sealing wad.

2.3.1 Closures for glass containers

2.3.1.1 *Metal caps.* Possible sources of odour include the lacquer, coating or varnish used. Modern coatings are usually free from odour if stoved properly. Understoved coatings are unlikely as they are almost sure to give rise to other troubles which would cause rejection, such as difficulties in tooling and imperfect formation.

2.3.1.2 *Moulded caps (thermosetting and thermoplastic).* Possible sources of odour are the materials themselves, but these are usually well controlled. When phenolic caps are also used as drinking cups the moulding powder should be specified as of very low free phenol content.

Some thermoplastic caps (although free from odour themselves) may allow transmission of odour from external sources.

2.3.1.3 *Cap liners.* Possible sources of odour are the facing materials on cap liners. Normally odour causes no trouble but ceresin facings should not be used for sensitive products and alkyd resin coatings should not be used for mineral waters which may pick up faint odour from the alkyd.

Composition cork and pulp board cap liners themselves do not present an odour problem if used without facings for sealing non-hygroscopic powders and tablets, but if mould growth occurs it could cause taint.

Adhesives are used to stick the facings to the wads, the foil facings to their backing papers and the liners into the caps. These adhesives must dry out odourless.

Waxes used to coat foils and wads or provide temporary bonds for membrane seals should be selected to be odourless.

2.3.1.4 *Membrane adhesives.* These are used in certain closures to adhere a cap lining membrane to the neck of a glass container. The adhesive used should be odour free in both the wet and dry state, otherwise the food will be exposed to odour.

2.4 PAPER AND PAPERBOARD

2.4.1 General. The problem of preventing odour contamination of food products when paper or board is the potential source of odour is complicated, principally because as a general rule the level of odour from such material is low.