Microbial Growth in Soaps — Prevention, Control and Cure

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One of the most serious quality issues that can occur in the soap industry is that of microbiological contamination. The nature of the contamination is such that the disruption caused and the cost incurred to contain such occurrences can have serious business implications. The loss in creditability of company brands, the associated costs of recall from the market and distribution network, the negative publicity generated, and penalties imposed, if any, can be very harsh on the organisations overall business prospect.

Microbial growth generally occurs under high humidity conditions on soap tablets, wrappers, and in external packaging material. The nature of soap manufacture is such that that no manufacturer on earth can be completely immune from microbial outbreak. All companies must clearly recognise this fact and take sufficient steps to avoid this malice.

Microbial contamination causes discolouration that are easily visible to the naked eye. Discolouration, if extensive and severe, can extend from the soap surface to the wrapper and vice-versa. It can produce strong allergic reactions and pose a health hazard. Generally, microbial contamination develops slowly but spreads rapidly before it is discovered. It usually affects large tonnages widely spread over the product distribution network, making recalls necessary. Sometimes salvaging the contaminated material may not be always possible. The difficult and expensive method of incinerating the contaminated product then remains the only option left; dumping not being viable due to environmental pressures. Bacteria and moulds are the two major microbial contaminants occurring in soap and soap packaging materials.

Bacteria

Bacteria's are microscopic uni-nuclear cells that multiply very rapidly within short period to form a visible colony. Bacterial spots about 1-mm diameter on the soap surface are visible to the naked eye. They are generally coloured white, yellow, red, brown or black.

Mould

Moulds are the most common microbial contamination in soaps. Moulds produce extensive blackish discoloration on soap surface, stiffeners, wrapper, and the external soap packaging. Mould contamination is generally identified from the discoloration observed on the soap surface and the strong musty unpleasant odour. Moulds belong to the plant kingdom and consist of branched filaments or hyphae. The hyphae are collectively known as mycelium that can be easily seen with a naked eye as a fluffy mass.

Moulds can occur almost anywhere in the environment and reproduce by spores. They produce spores in large numbers, which get dispersed by wind, water insects and animals. Spores can remain dormant for long periods extending to years and germinate when conditions become favourable. The source of the commonly found soap mould *Aspergillus Versecolour Vuille* is water and atmosphere.

ENVIRONMENTAL FACTORS FAVOURABLE FOR MICROBIAL GROWTH

Moisture

Spores require a relative humidity of 60-70% or above for mould growth. As humidity increases, the rate of mould growth too increases. Interestingly, mould does not grow in dry environment, but once the metabolic process is triggered due to a presence of the required moisture, then it is sufficient to create a moist environment *in situ* for fuelling further growth.

Nutrients

A regular supply of organic nutrients is necessary for complete mould growth. If the supply is low or insufficient then growth is impacted.

Temperature & pH

The optimum pH for mould growth is between 3.5 and 5.5. The temperature most suitable is around 25°C. However mould growth does take place outside this specified range, but the growth rate is slow. Presence of nutrients such as fructose, glucose, mannitol, dextrin, starch, some times used in the soap formulation, help mould growth. Generally mould types that grow on soap are black in colour. However, if a rare species of mould growth takes place then the mould colony could be of a different colour depending on the pigment contained in it and typical for that species. Identifying the exact type of microbial growth is the most important aspect to control the outbreak.

NATURE OF MICROBES PRESENT IN THE PRODUCT

1. Moulds produce an unsightly stain on

the soap surface, resulting in an unpleasant mouldy odour.

2. Smell and visual observations are the best means to guide one in identifying mould growth.
3. Visual inspection of packaging, wrappers, stiffeners, glassine paper, and soap surface for any staining and fungal growth should be carried out as a regular routine at all godowns, warehouses.
4. Sales godown inspectors, warehouse in-charge, and all others in the distribution chain should be trained to look and identify microbial growth, both visually and olfactory.
5. Workers in the production areas and in the packaging section of the factory should consciously keep a watch for any indication of microbial growth as only their vigil can help in identifying the outbreak at its very early stage.

The moment an outbreak is identified, action to freeze and isolate the suspected soap stock should be initiated. Samples of the suspect batches should be examined by a qualified microbiologist to confirm the suspect presence of microbial contamination. Preventing microbial growth is essential and this can only be achieved if sufficient attention is paid to factory hygiene and warehouse cleanliness. In addition, strict adherence to the minimum specification required of various ingredients used in manufacturing is needed.

MAJOR SOURCES OF MICROBIAL CONTAMINATION IN SOAPS

Packaging materials:

- Bundle wrapper
- Cellophane paper
- Stiffeners
- Corrugated cardboard
- Glues & Pastes

Water-based pigment slurries, water-based dyes and colorants:

Fillers used in the manufacture:

- Natural products (e.g., Starch)
- Minerals
- Synthetic additives

Herbal extracts used as material for marketing claims.

Soap finishing plant areas:

- Soap silos (Especially if made of wood)
- Weathering chambers
- Stampers
- Chill generators and chilling units
- Water based lubricants.
- Soaps received from trade for reprocessing.

PACKAGING SECTION

Specific standard procedures for handling packaging raw material should be established so that microbial outbreak is prevented. It is important that an effective microbial inhibitor should be incorporated in the packaging. The level and type of the inhibitor should be specified and strictly added. Most mould inhibitors have a tendency to lose their potency and effect and this aspect should be taken into account when deciding the type and levels to be used.

Typical mould inhibitors used in packaging materials include:

- Methyl benzimidazol-2-ylcarbamate (Carbendazim)
- 2-(4-thiazolyl)-1H-Thiabendazole (TBZ, Thiabendazole)
- 3-Iodo-2-propynylbutyl carbamate (IPBC)
- Sodium pentachlorophenoxide (SPCP)
- Copper-8-hydroxyquinolinolate (Copper Oxide) – To be used only in outer cases or outer carton boxes

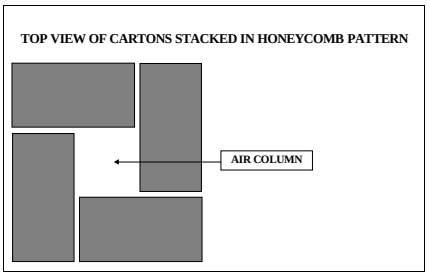
Packaging material specifications, especially the quality of paper and presence of mould inhibitor, largely influence microbial growth. Clay caseinate, carbohydrates and other organic materials found in packaging can encourage microbial growth. Inner wrapping of soap like cellophane, polyethylene (PE), polyvinyl chloride (PVC), and oriented polypropylene (OPP), stiffeners, should only be used if a microbial growth inhibiting fungicide is incorporated into the primary packing manufacture.

Spores, if present in packaging, can germinate to form wrapping mould colonies and spread to the soap surface. The high water vapour trapped inside the wrappers and outer cases helps all the same. Packaging materials must be used strictly following the FIFO 'First in first out', and should be checked for presence of mould inhibitors. It is also important to check whether the levels of mould inhibitor present is effective and are as specified for use in packaging. Manual handling of packaging materials should be minimised as possible. Good housekeeping procedures should not only be specified for packaging material suppliers, but also regularly monitored so that the materials supplied are clean without any microbial contamination. Farm products like straws, dried grass, old news paper scraps, etc., used to pack and transport virgin soap packaging to manufacturing locations should be strictly avoided.

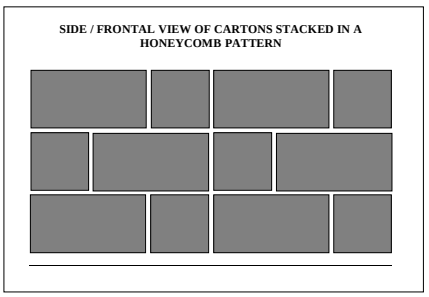
GODOWNS AND WAREHOUSES

Godowns and warehouses are highly prone to fungal and mould growth. It is therefore necessary that, warehouses are well ventilated to maintain ambient temperature and low humidity levels. To maintain good ventilation, it is preferable to have air vents at roof level, rather than at the walls. Forced circulation of air, by use of electrically driven system of fans, is preferred. Apart from maximum space optimisation, a clean surrounding and good hygiene is important in a warehouse. In case the warehouse is attached to a production site, it is necessary to have a manufacturing plan, so as not to accumulate stocks for a long time.

Personal care products stored for a long time have greater chances of becoming contaminated with mould and fungus. This risk is higher, particularly when the stocks are stored for more than a month, especially during the monsoon. Damage to the outer packaging increases mould and fungal growth and should be avoided. Boxes containing personal care products should be stored, at least 50-cm. away from walls and from adjacent stacks to ensure proper ventilation. Stacking in a honeycombed pattern on pallets with a minimum gap of 5-cm. between each box, ensures good ventilation, and prevents dampness arising through the warehouse flooring onto the pack.



FIFO operational philosophy must be adopted for products stored for a longer time then normal. Regular inspection and, if necessary, restacking, of the product boxes is to be carried out, to rule out the possibility of fungal or microbial growth. Not having pellets, the floor may be covered with a polythene sheet to make it impermeable to moisture from the warehouse flooring. Godown flooring should be made of stone or cement concrete, with the flooring at the entrance, a little higher than the rooms. This will prevent water from seeping inside the warehouse from the outside, especially during monsoon. Leaks in roofs or walls should be checked at regular intervals and repairs carried out in case of any defects. Warehouse should be cleaned regularly to destroy mould spores using a sanitizer like sodium hypochlorite. Pallets and flooring should be cleaned after the product lot is removed for despatch. Insecticides to control pests should be used to protect the stored packs and to prevent spread of mould spores in the warehouse. Proper care should be taken to maintain low humidity levels, as high humidity condition helps' mould growth. In cases where mould growth is foreseen, extra care is to be taken to stack products, in a manner that ensures thorough ventilation, so that air passage is not restricted in any way.



MANUFACTURING LOCATIONS

Good housekeeping and hygienic conditions are necessary to be kept throughout the factory premises. This is very important and should be followed in production areas. Mould spores can easily spread to larger areas of the production site, if they are unclean and dirty. Proper ventilation is essential and dust levels kept to the minimum. Plant equipments, mixers, mills and plodder/extruder, roofing and flooring should be cleaned regularly. Special care is to be taken to clean packing and wrapping machines by brushing and should not be omitted. 200-ppm available chlorine solution of sodium hypochlorite is most suitable for this purpose.

A minimum contact time of one hour should be maintained between the disinfectant and equipments/plant parts, before reuse, so that all microbes are made ineffective. Hypochlorite disinfectant should not be used along with any other disinfectant or mixed. Hypochlorite is an effective disinfectant. However, it has a tendency to corrode plant equipments, if not compatible. Compatibility should be thoroughly checked and all plant equipment parts dried after treatment. Containers that enter the production areas should be examined for microbial contamination to prevent introduction of microbes during processing. Open drainages should be replaced by a closed drainage system to eliminate favourable areas for microbial growth in manufacturing locations.

In case this is not immediately possible then they should be cleaned and disinfected regularly and all care should be taken to prevent water stagnation in the drainage channels. Similarly, leaks in water pipes should be rectified to prevent water dripping and making the area moist and prone to mould growth. Quality control and market rejected finished products that get returned to the production department for reprocessing should be thoroughly checked for microbes, before it is reprocessed with a fresh batch in a regular production cycle.

Soap noodles and chips should preferably be collected and stored in non-absorbent silos or bins. Metal bins, preferably stainless ones, should be preferred over wooden ones to minimise the risk of microbial growth. Existing wooden silos should be resin treated and replaced with metal ones at the earliest opportunity.

Soap chips having high moisture content, should be packed in PE bags or bags having a protective inner-lining of PE. Fibre bags collecting soap fines should be washed and reused or replaced at regular intervals. Wash water used for this purpose should have 2-ppm available chlorine. Mixers, mills, plodder/extruder, cutters all must be cleaned and sanitised regularly. Condensate water should not be allowed to build up around mills and plodder barrels and should be clean dried intermittently. Soap droppings that get collected in trays below

the mills and plodder should be returned to the soap making process and not allowed to build up.

Stampers are another high risk area and sufficient care should be taken to keep the stamper free from water accumulation and soap mush. Water condensates that stagnate in the tray can lead to contamination of the chilling pipes and soap dies. If the tray surfaces are difficult to clean and maintain it should be modified so that regular cleaning of the same is possible. Chill dies, push rods, stamper casing should be thoroughly cleaned and sanitised daily. It is advisable to spray the inside of the casing and the chilling pipes with a fungicidal solution of either Metasol/Carbendazim every fortnight, as a preventive measure.

Chill generators or chilling systems and weathering chambers are also major areas that can be a source of microbial contamination and should not be overlooked. Water in the chill water reservoir is continuously reused. It should be periodically changed and protected against microbial contamination. The water used should be free from contamination and have 2-ppm available chlorine at all times.

Sodium hypochlorite is the most effective wide spectrum anti microbial available for chlorination. The piping for the chill water distribution to the manufacturing and packaging location is a very good support structure for microbial growth. Adequate insulation on the chilling system should be given to minimise ice build up. The insulation should be preferably having aluminium over-wrapping for easy, efficient cleaning and maintenance. Chilled water generators and water reservoirs should be preferably built outside the manufacturing and packing sections of the factory. Weathering chambers should be regularly monitored for mould growth. Regular cleaning and sanitation of the weathering chambers is also necessary. Conveyor belts used in the processing section should be maintained and cleaned regularly.

STAMPER DIE LUBRICANTS

Use of lubricants is best avoided, but if unavoidable then boiled water should be used for making the same. Concentrated salt water lubricant should be prepared and exhausted every day. Bulk preparation of water-based lubricants is not advised. Brine, when used as a lubricant, should not be diluted by topping up with water and used for extended periods. Water used for making the lubricant should be treated water having 2-ppm available chlorine. Mineral oil is also a preferred lubricant, however glycerine solution a popular lubricant, is a good source of food for mould growth and is best avoided.

GLUES

Glues used in sealing the pack are a good source of microbial contamination. It is advisable to avoid glues as a rule. Polymer based products now available for sticking, hot melt sealing, or heat sealing is preferable.

DYES & COLOUR PIGMENT SLURRY

Aqueous solution of colour dyes, water dispersible pigment slurries, optical brighteners, can all introduce bacterial contaminants in soap. Colour pigment pastes & slurries should have a preservative added to prevent bacterial growth. 0.2% of 40% formaldehyde solution is a good preservative. Instead of formaldehyde, Proxel (1,2-benzisothiazolin-3-one) at 100-200 ppm active can also be used. Both stock solutions and bulk solutions should be monitored for microbial contamination by regular testing. Contaminated dyes should be discarded immediately.

All transfer and storage and mixing vessels and accessory implements should be preferably made of stainless steel and should be kept clean and stored dry when not in use. Hopper feeds of slurry making vessels should be cleaned regularly as those are potential sites for microbial growth. Water used for making the slurry should be microbe-free treated water having 2-ppm available chlorine.

MINERAL ADDITIVES

Mineral fillers like clay, talcum powder used in soap making may vary in microbial population. The source of contamination may be through direct faecal residues from animal sources and soil, or indirectly from contaminated water.

It is essential that fillers treated either by dry heat, steam, ethylene oxide or gamma irradiation and free from microbes is used in the manufacture. Herein, it is also important that the efficacy of the procedures should be monitored routinely and residual gas or its by-products are effectively controlled for reducing the total microbial population to levels approved as safe.

HERBAL PLANT EXTRACTS, STARCH, ETC.

Plant extracts used in the formulation should have been manufactured by following good manufacturing practice, and superior hygiene levels. Sometimes in lieu of hygiene, excessive preservatives and anti-oxidants to prevent microbial growth are used by suppliers and this can compromise the safety of the formulated product, due to excess chemicals being present and, in addition, unwanted remains of the killed microbes.

The microbial status of the natural plant extract thus becomes a criterion, of paramount importance and should not be overlooked.

CONCLUSIONS

All efforts should be taken to prevent microbial outbreak. However, if any organisation is unfortunate to experience or even suspect an incident then it should take immediate steps to contain and prevent this malady from spreading by using all the available resources.

1. A team consisting of trained experts should be constituted to identify the source of microbial contamination.
2. The team should immediately determine the nature and extent of suspected microbial contamination.
3. The contaminated material should be isolated forthwith to prevent further spreading.
4. The suspected materials should be tested microbiologically by an expert to confirm the type of contamination.
5. Trained personnel should be deputed to monitor, soap, packaging, and raw materials.
6. Inhalation of mould spores can lead to respiratory problems. All personnel involved in handling contaminated products should be adequately protected with protective clothing, coats, masks, gloves, hats, and other personal protective equipments.
7. All areas prone to microbial contamination should be immediately cleaned and sanitation procedures carried out.
8. In extreme cases, fumigation of the entire plant and surrounding buildings may also be carried out.
9. Continuous monitoring of the manufacturing process systems should be done and continued till such time that the contamination is completely eradicated.
10. Contaminated packing materials should be incinerated at an isolated spot away from the manufacturing locations.
11. Contaminated soaps should not be kept in dry form as it can lead to mould spore build up. It should be salvaged by reboiling in the crutcher at the earliest, to eliminate all traces of microbial contamination. In cases where the contamination is severe, and reprocessing in difficult then the product is incinerated and destroyed.

Microbial outbreak, big or small, should never be underestimated. If warning signs are noted, remedial action should be taken immediately, as once the outbreaks occurs it is difficult to control or eradicate as they multiply very rapidly as in most cases.

Prevention is better than control and/or cure.