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HACCP FOR SKIM MILK POWDER

This bulletin includes technical information, latest development on products, systems, techniques etc. reported in journals, companies' leaflets, books and based on studies and experience. The technical information would be on different areas of plant operation in different issues. It is hoped that the information contained herein, if employed in the factory, will help in making dairy plant operations more efficient.

Your contributions and suggestions will make the bulletin more useful and are welcomed.

The theme of information in this issue is HACCP for Skim Milk Powder. It may be understood that the information given here is by no means complete.

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1. INTRODUCTION

The importance of quality management and safe food production is being realized by more and more dairy organizations. The cooperative dairies have now started incorporating hazard analysis critical control point (HACCP) principles into their processing systems. HACCP is a preventive system of control based on applying an organized approach to food production system.

The importance and the principles of HACCP, and an HACCP system for pasteurized milk were presented in the 11th (November-December 1997) and 12th (January-February 1998) issues of the 'Technews', respectively. To help the dairy organizations prepare their HACCPs, we present the HACCP system for skim milk powder (SMP) in this issue. Although, in the present example, the focus is primarily on product safety aspects, it can include other process steps and quality aspects as well, if required.

The HACCP plan for SMP is presented in items 2 to 5. The detailed and elaborate process required to arrive at the results is not presented here, only the results are presented.

The conditions of storing and handling of post-pasteurized foods must not be such that microbes can contaminate, grow or form toxins in the food prior drying, for example in

balance tanks or concentrators. Good manufacturing practice (GMP) guidelines must be established, together with recommended microbiological protocols.

The drying is not *per se* lethal to all micro-organisms and many may survive. Depending upon the severity of the process the more resistant organisms are the most likely survivors, e.g. bacterial spores, yeasts, moulds and thermophilic bacteria. While pasteurization destroys salmonellae in liquid milk, higher temperatures are required for destruction in milk concentrates. Although certain conditions of heat and moisture reduce the chances of survival during drying, total destruction is not achieved. Spray drying kills substantial number of salmonellae in skim milk, but it does not yield salmonellae-free powder. Nevertheless, the source of salmonellae occasionally found in dried milk mostly is incidental contamination via the large volumes of air in drying and cooling operations. Pathogens of most concern in milk powders are *Brucella* sp., *Salmonellae* sp., *Listeria monocytogenes*, *Escherichia coli*, *Shigella* sp., *Staphylococcus aureus* and *Yersinia enterocolitica*.

Indeed, there have been incidences of disease outbreaks associated with milk powders, such as in U.S.A in 1981 there were 239 cases reported and in the U.K. in 1985 there were 48 cases reported with the death of 1 person.

Therefore, utmost emphasis needs to be given for vigilance in hygiene and in process parameters at all stages of manufacture if the occurrence of pathogens is to be minimized.

2. TERMS OF REFERENCE

Manufacturing process of SMP includes steps from milk reception to product storage (Fig 1). However, in the HACCP for Pasteurized Milk (Technews, issue No. 12) all the steps

from milk reception to pasteurized milk storage have been covered, therefore, they are not repeated here. The HACCP plan presented here includes steps after pasteurized milk storage to product storage only, and considers health hazards. Microbiological, chemical and physical hazards are identified.

The product should be safe to consume up till the 'use by' date, taking into account the storage temperature and humidity.

3. DESCRIPTION OF THE PRODUCT

Table 1 describes the product.

Table 1 Description of skim milk powder

| Product Description : Skim Milk Powder | |
|--|---|
| Facility | The dairy factory produces a variety of dairy products including skim milk powder (SMP) for sale. The factory is located on the state highway 10 km south of the town. |
| The product | The product is partially agglomerated skim milk powder in 25 kg. bags, and 1 kg. and 1/2 kg. retail packs (polyethylene pouches). The product is stored at ambient temperature, preferably lower than 30°C, and relative humidity not higher than 70%. The keeping quality of the end product under these storage conditions would be not less than 9 months. The product can be despatched in covered trucks to its destination. |

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Table 1 Contd.....

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|--|
| The package |
| <p>Bags for bulk pack are multi-wall paper sacks with inner polyethylene liners of minimum 75 microns thickness. The outer two plies of the sack are made from a high wet strength crepe kraft paper and are joined by polyethylene. The inner four plies consist of natural kraft paper.</p> <p>The filled bags are machine sewn with cotton and filler cord is used to prevent the stitching from pulling through the bag.</p> <p>Consumer packs are multilayer plastic pouches which are automatically heat sealed.</p> <p>All packages are marked with the batch number and date of manufacture.</p> |
| Manufacture |
| <p>Good quality raw milk is cooled, stored, preheated to 45°C, separated to 0.05-0.1% fat, the skimmed milk pasteurized at 76°C for 15 seconds, and cooled to 4°C. The pasteurized skimmed milk is then heated to 90°C for 1 minute to impart it medium heat treatment, condensed to 48% total solids in a 4 -effect evaporator and dried in a two-stage spray dryer to 3% moisture. The powder which is at lesser than 30°C is packed in bags or retail packs, and stored in powder store rooms.</p> |
| Intended use |
| <p>The product is to be used by other dairies in the manufacture of dairy products by recombination, such as market milk; by food processors as an ingredient in milk chocolate, some sugar confectionery, ice cream, desserts and a variety of hot and cold beverages; and by consumer as hot milk drink by reconstitution. For reconstitution, it is well stirred in warm water. The reconstituted milk should be pasteurized before use.</p> |

4. FLOW DIAGRAM FOR MANUFACTURE OF SMP

Fig 1 presents the simplified flow diagram for the manufacture of SMP.

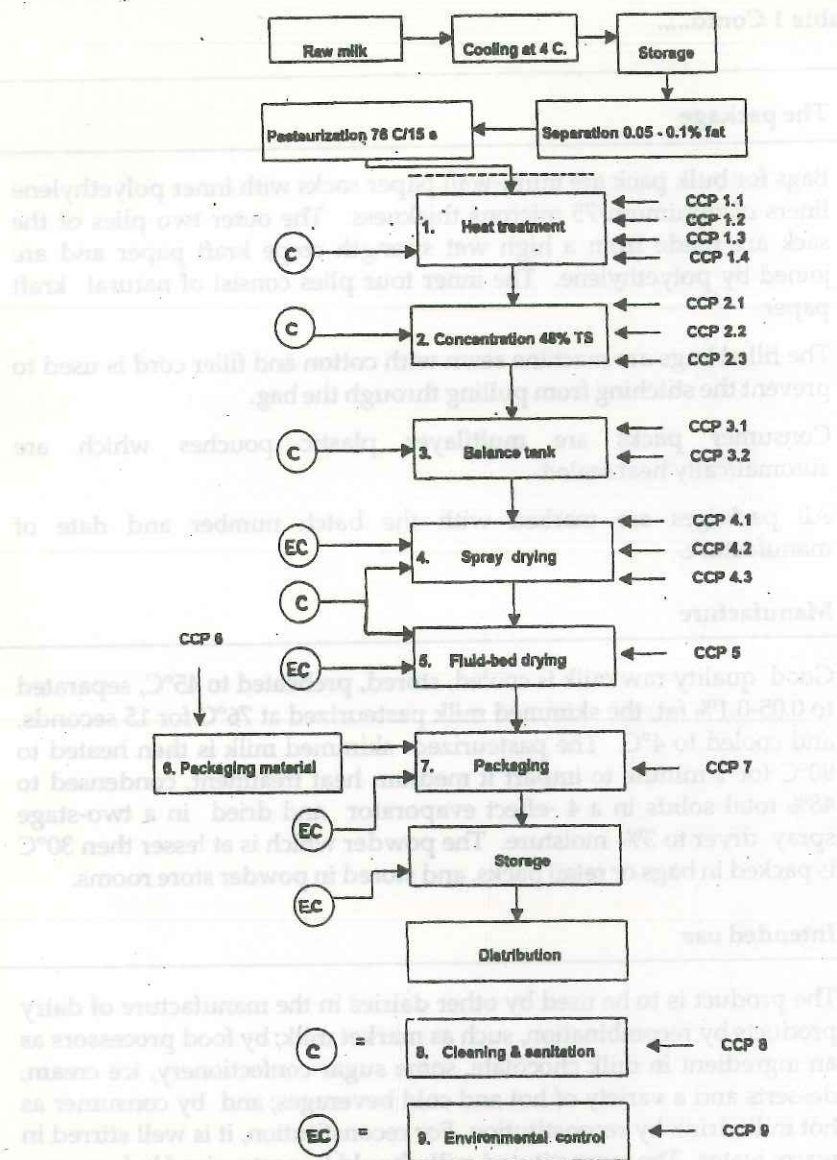


Fig. 1. Flow diagram for production of SMP

5. HACCP CHART FOR SMP

The HACCP chart for skim milk powder is given in Table 2.

Table 2 HACCP Chart for skim milk powder

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|----------------------|---|--|---------|--|---|--|------------------------|---|-------------------------------|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. Preheat treatment | a. Pathogens & saprophytic micro-organisms - growth | Proper temperature and time control. Flow control assurance | 1.1 | Temperature & time | Not less than 90°C and 1 minute. | High heater temperature chart visually every hour. Flow rate. | Evaporator operator | Check steam pressure. | High heater temperature chart | Examination of plant records by section-in-charge |
| | | Restricting running to 20 h Ensure no mixing with untreated milk takes place. | 1.2 | Temperature device calibration | Temperature device to be within $\pm 0.5^\circ\text{C}$ | Calibrating the temp. instruments every 6 months | Maintenance supervisor | Temperature instrument to be repaired or replaced and re-calibrated before use. | Calibration record. | Examination of calibration records by QA Manager every 6 months. |
| | b. Micro-biological contamination | Ensure proper cleaning of the equipment | 1.3 | Cleaning & sanitation | As per conformed cleaning & sanitation procedures | Ensure that the pre-heaters and associated lines have been cleaned and sanitized before use. | Evaporator operator | Reclean and sanitize as necessary. | Cleaning & sanitation record. | Examination of cleaning records by section-in-charge daily & QA manager periodically. |
| | c. Enzyme lipase | Proper temp. time control | 1.4 | As for CCP 1.1 | As for CCP 1.1 | As for CCP 1.1 | As for CCP 1.1 | As for CCP 1.1 | As for CCP 1.1 | As for CCP 1.1 |
| 2. Concentration | a. Microbial contamination build-up | Proper sanitation & GMPs. Evaporator operation under optimal conditions. | 2.1 | Cleaning & sanitation of evaporator, pumps, pipelines & other system components. | As per conformed cleaning & sanitation procedures. Cleaning once in 20 hours. | Where long runs are necessary, operate evaporator at temperatures above max. growth temp. of thermophilic micro-organisms. | Evaporator operator | Re-clean | Cleaning & sanitation record. | Inspection of plant weekly by in-charge to ensure cleaning. Periodic specialist examination & maintenance of plant by manufacturers. |

Table 2 HACCP Chart for skim milk powder (Contd.)

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|-----------------------|---|--|---------|------------------------------------|---|--|---------------------|--|--|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 3. Balance tank, dual | b. Contamination with cleaning residues. | Evaporator equipped with appropriate instruments (for temp, vacuum). Instruments properly maintained | 2.2 | Proper operation of the evaporator | All operating parameters as approved. | Cleaning routines to be correctly implemented. Trained staff to be employed at all times. Visual inspection of tubes, valves, gaskets, jets, sprays after each cleaning for blockage & wear. Visuals on temp, pressure gauges, plant operation records | Evaporator operator | Check operating parameters and adjust as required. Recycle till okay | Evaporator plant record | Examination of plant records daily by in-charge powder section. |
| | | Proper maintenance of pump seals, flash vapour ducts, gaskets | | | | | | | | |
| | | Good manufacturing practices (see step 9.) | 2.3 | Instruments calibration | As for CCP 1.2 | As for CCP 1.2 | As for CCP 1.2 | As for CCP 1.2 | As for CCP 1.2 | Examination of plant records by in-charge daily, & by QA Manager weekly. |
| 3. Balance tank, dual | a. Environmental contamination of concentrate with bacteria | Tanks are kept with covers in place during operation | 3.1 | Balance tank condition | Covers in place on the tank during operation. | Visual during operation | Evaporator operator | Replace cover | Evaporator operation record, GMP records | Examination of plant records & GMP records by the section in-charge. |
| | | | | | | | | | | |

Table 2 HACCP Chart for skim milk powder (Contd.)

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|--------------------------|--|--|---------|--------------------------|---|---|---------------------|--|-----------------------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | b. Excessive build up of bacteria (S. aureus) & toxin production, in case of extended plant run. | Ensure continuous and regular flow of concentrate to allow shortest residence time. Use of dual balance tank, regularly cleaned during run | 3.2 | Shortest residence time. | Continuous flow - Each balance tank to be cleaned every 6 h. | Plant records, visual during operation | Evaporator operator | Examine the cause and take action in consultation with the in-charge | Plant operation records | Examination of plant records weekly by the section-in-charge |
| 4. Spray dryer operation | a. Microbiological contamination | Precautions against contamination from raw milk, to heated milk, concentrate or powder. Precautions against cross contamination between the wet side of the plant & the powder side, like locating air inlet away from exhaust air outlet. Dryer equipped with suitable instruments (inlet air temp., outlet air temp.), instruments maintained properly GMPs (See also step 9). | 4.1 | Feed Control | No mixing of raw milk. | Precautions against contamination from raw milk to heated milk, concentrate or powder to be monitored on a continuous basis. GMP records. | Evaporator operator | Re-pasteurize the mixed milk | Evaporator operation record | Examination of process records daily by section in-charge. Dust samples from dryer fluid bed, cyclone and silo, to give early warning of plant contamination, by QA Manager. Periodic specialist examination & maintenance of plant by manufacturer to detect cracks in dryer inner wall. |
| | | | 4.2 | Cleaning & sanitation | Refer to cleaning & sanitation procedures. Chamber & cyclones wet cleaned once a week. Atomizer manually cleaned twice in a production run. Dry cleaning after each run, of chamber, ducts, cyclones rotary valves etc. | | | | | |

Table 2 HACCP Chart for skim milk powder (Contd.)

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|-----------------|---------------------------------------|---|---------|------------------------|--|--|----------------|---|--|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | Precautions against inward leaking of air. Regular inspection of dryer chambers for stress cracks & appropriate repair & maintenance schedules. To ensure no sudden increase in feed rate. Exhaust stack covered when not in use. Cleaning according to conformed procedures. Trained staff at all times. | 4.2 | Cleaning & sanitation | Dryer exhaust wet cleaned daily. | | | | | |
| | b. Physical contamination (dust etc.) | Cleaning & changing filters of main drying air & fines return air as appropriately specified | 4.3 | Air filters | Cleaning/ replacing filters when pressure drop across it reaches at pre-set value. | Visual inspection at start-up & shut-down daily. | Dryer operator | Re-clean or replace filter, as necessary. | Dryer (air heater and fines return) operation record | Examination of plant records & visual inspection weekly by plant in-charge. |

Table 2 HACCP Chart for skim milk powder (Contd.)

| Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|------------------------------|---|--|---------|------------------------|---|---|-------------------------|---|--------------------------|--|
| 1. Process Step | | | | | | | | | | |
| 5. Fluid bed dryer operation | a. Microbial contamination through air | Air filters cleaned & changed as per conformed schedules & procedures. Exhaust stack to be covered when not in use. GMPs (see step 9.) Proper cleaning of duct work, cyclones, rotary valves. Ensure no cracked rubberware. | 4 5 | Air quality | Intact filter in place. | Visual inspection at start-up & shut-down daily. | Dryer operator | Reclean or replace air filters, as necessary | Dryer operation records. | Examination of plant records & visual inspection by plant in-charge. |
| | b. Physical contamination (dust etc.) through air | Air filters cleaned & changed as required. | | | | | | | | |
| 6. Packaging materials | Physical/microbial contamination source | As per specification. Storage & handling of packaging materials according to conformed procedures. | 6 | Storage & handling | Area to be clean & tidy. Each batch inspected for damage etc. before use. | Ensure clean storage environment. Ensure dirty material is rejected. Audit supplier's QA. | QA & purchase managers. | Reject suspected packaging material, change supplier. | Packaging records | Examination of records by QA Manager regularly. |

Table 2 HACCP Chart for skim milk powder (Contd.)

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|---|---|--|----------------|---|---|--|-------------------------------|---|---------------------------------------|--|
| 7. Packaging | a. Environmental contamination b. Small piece of component falling into pack | Same as those of step 5. Good housekeeping and GMPs. Regular PM of equipment | 7.1 7.2 | Clean environment Proper operation & PM of equipment | As per CCP 9. All component tightened always | As per CCP 9. Check equipment condition at start-up | As per CCP 9. Operator | As per CCP 9. Tighten component in m/c. properly | As per CCP 9. Packaging record | As per CCP 9. Examination of packaging records and PM records by Section-in-charge regularly. |
| 8. All process steps involving product in contact with production equipment (pre-heater, evaporator, balance tanks, dryers, pipe-work, cyclones) cleaning | Microbial/toxin contamination due to poor cleaning. | Effective cleaning procedures. | 8 | Cleaning parameters | Approved cleaning procedures, no residues | Visual inspection, temp, solution concentration, time, frequency etc. as approved. Before start-up of every batch. | Evaporator & dryer operators | Reclean | Cleaning records | Examination of cleaning & plant operation records by QA Manager & plant in-charge daily. |

Table 2 HACCP Chart for skim milk powder (Contd.)

| 1. Process Step | Potential Hazard | Preventive Measure | CCP No. | Critical Control Point | Critical Limits | Monitoring Procedure & Frequency | Responsibility | Corrective Action | Record | Verification |
|--|--|--|---------|------------------------|---|---|--------------------------------------|--|---------------------------------|--|
| 1. Environment control in powder manufacturing, packaging and surrounding areas. | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 9. Environmental control in powder manufacturing, packaging and surrounding areas. | a. Environmental contamination with micro-organisms through air, deposits of powder. | Barrier hygiene to avoid contamination of areas producing/handling powder. Minimization of dust and powder deposits in dryer and other handling areas. Maintenance of dry conditions in dryer & other areas with application of dry cleaning techniques. Proper maintenance of the building to prevent contamination from external sources such as rain water, pest infestation etc. | 9 | Clean environment | Clean air, no cracks in dryer insulation & wall; no powder deposits on dryer installation, building walls, roof, floor etc. | Microbiological tests (standard plate count, coliform test & Salmonella test). Visual inspection of dryer installation, walls etc. regularly. | Plant incharge, sanitation incharge. | Repair dryer insulation; clean dryer wall, building of powder deposits & other dirt. | Sanitation records, GMP records | Inspection to assess levels of GMP and good house-keeping atleast weekly. Environmental sampling to give early warning of plant contamination, by QA Manager. Examining GMP records & physical inspection of cleanliness at least monthly by QA Manager. |