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DRAFT TANZANIA STANDARD

Code of practice for the prevention and reduction of inorganic tin contamination in canned foods

TANZANIA BUREAU OF STANDARDS

0 FOREWORD

Tin is relatively less toxic than mercury, cadmium and lead. The principal concern in relation to tin in food is the possibility of high levels potentially present in canned food in incorrectly manufactured tins, where tin present in the can has leached into the food. This has been shown to occur in the case of acidic foodstuffs such as canned tomatoes, and consumption of the affected foodstuff has resulted in gastrointestinal irritation and upsets due to the acute toxic effects of tin. These short-term effects may occur in some individuals at concentrations above 200 mg/kg. Only limited data are available on the toxicological effects of inorganic tin present in canned food, resulting from the dissolution of the tin coating.

This code is therefore aiming to guide the manufacturers, producers, distributors as well as consumers to prevent and reduce the inorganic tin contamination in canned foods.

In the preparation of this code of practice the assistance was drawn from CAC/RCP 60-2005 code of practice for the prevention and reduction of inorganic tin contamination in canned foods.

1 SCOPE
This code of practice recommends the good practice for the prevention and reduction of solely migration of inorganic tin from the internally plain (i.e. not lacquered) tin coating of tinplate cans in canned foods. Compliance with this code does not confer immunity from relevant statutory and legal requirements

This code of practice is applicable to thermally processed canned human foods (including fruit and vegetable juices) which are packed into plain tinplate cans. It is considered that this description covers both:
i) Hot fill and hold products; and,
ii) Hot or cold fill and retort products.

This code of practice is not intended to apply to tin exposure from any other source and is specific to inorganic tin. Also dry goods and 100% oil products are not included, because they do not experience tin migration.

2 TERMS AND DEFINITIONS
For the purposes of this document, the following terms and definitions apply.

2.1 Annealing
heating process used in tinplate manufacture to soften the steel strip after cold rolling and to impart the required hardness; the process can either be continuous (continuous annealing or CA) or in batches (batch annealing or BA).

2.2 Beads, Beading
corrugations rolled into can walls to give added strength to the can body

2.3 Closer
machine used to seal an end onto a can

2.4 Closing under vacuum
applying a vacuum to the closing chamber of the can closer, whilst sealing the end

2.5 Corrosion
chemical action of dissolving the surface of a metal (eg. tin in food medium)

2.6 Corrosion accelerator
chemical species with the ability to accept electrons, which will increase the rate of a corrosion reaction

2.7 Corrosion mechanism
specific chemistry of any corrosion reaction; especially for tinplate when 2 metals (tin and iron) are coupled and where one or both has the potential to dissolve

2.8 DR Tinplate
'double reduced' tinplate where a second rolling is used to reduce steel thickness in order to produce a thinner but stronger product

2.9 Electrolyte
substance which dissociates into ions when dissolved in a suitable medium; hence a tin rich electrolyte is used in tinplate manufacture (see Electro-Tinning); the food in contact with an internally plain can may also be described as an electrolyte

2.10 Electrolyte Tinplate
low carbon mild steel strip coated on both top and bottom surfaces with an electrolytic deposition of tin; the deposited tin exists as an alloyed and free tin and has a passivated surface as well as a coating of oil.

2.11 Electro-Tinning
act of plating tin from a tin rich electrolyte onto a continuous steel strip to produce electrolytic tinplate

2.12 Embossing
use of a die to stamp a product code or manufacturing date into a can end

2.13 Filler
machine used to automatically fill a can with the desired weight or volume of food

2.14 Fill Temperature
temperature at which the food is filled into the can

2.15 Food Acids
organic acids, naturally occurring in foods, especially in fruits and vegetables; also used to impart flavour and to modify the pH of foods

2.16 Headspace
space left in the top of the can after filling and end sealing, in order to allow for product expansion during thermal processing

2.17 Hot Fill and Hold
process where a high acid food product (usually juice or liquid) is filled at high temperature, the end sealed and cans held for a period of time before cooling; commercial sterility is achieved without retort processing

2.18 Inject Coding
use of an ink jet to print a product code or manufacturing date on the can end

2.19 Internal Corrosion
corrosion occurring within a food can (see Corrosion)

2.20 Lacquers
inert organic coatings used to give additional protection to tinplate; usually applied in liquid form and 'cured' at high temperatures

2.21 Pack Testing
storage and regular sampling of canned foods under controlled temperature conditions to determine internal corrosion characteristics and potential shelf life

2.22 pH
measure of acidity

2.23 Plain Cans
cans made from plain tinplate

2.24 Plain Tinplate
bright tinplate without any additional lacquer coating

2.25 Process Time
calculated time at a particular temperature (process temperature) for which a specific can size and food product need to be heated in order to achieve commercial sterility

2.26 Product Line
maximum level or height of the product in the can; the headspace is above the product line

2.27 Reducing Environment
conditions expected inside a plain processed food can, whereby the contents are protected from oxidative reactions such as colour change

2.28 Shelf Life
the term or period during which canned foods stored at recommended conditions remains suitable for consumptions.

2.29 Sidestripe
thin band of lacquer designed to protect the weld of a can body from corrosion

2.30 Stock Rotation
method of ensuring the oldest canned products are identified, removed first from warehouse storage and are first onto the retailers shelf

2.31 Thermal Processing
use of any heat process to ensure the commercial sterility of filled cans

2.32 Tin Coating Mass
mass of tin, expressed in g/m^2, which is applied to each side of the steel base; standard coating masses generally range from 2.8 to 11.2g/m2 in increments of 2.8g/m^2; the internal tin coating mass of plain cans is usually either 8.4 or 11.2g/m^2

3. RECOMMENDED PRACTICES TO MINIMISE TIN UPTAKE BY FOODS PACKED INTO PLAIN TINPLATE CANS

3.1 General

3.1.1 There are many factors which may influence the level of product tin uptake in plain tinplate cans. Some are very minor and others, usually specific to the chemistry of the processed food, may have a significant effect on internal can corrosion and product tin dissolution. The recommendations contained below are based on an attempt to identify all of these factors, no matter how minor, and to suggest specific areas where monitoring or other controls would be beneficial.

3.1.2 In summary the factors which have been identified can be grouped as follows:
i) choice of tin coating mass and passivation level;
ii) damage to tin coating or passivation;
iii) type of food product, pH and acid content;
iv) presence of corrosion accelerators, such as nitrates, in the raw food ingredients;
v) presence of sulphur compounds in the food;
vi) presence of oxygen within the sealed can;
vii) process times and temperatures;
viii) storage times and temperatures; and,
ix) storage humidity.

3.2 Packaging manufacturer

3.2.1 Tinplate supplier

3.2.1.1 Tinplate customers should state the end use when ordering tinplate. The tinplate supplier should have sufficient expertise to ensure that specifications for the tinplate are appropriate to the stated end use and notify the customer should there be any concerns (e.g. with regard to the passivation level or the requested tin coating mass).

3.2.1.2 The tinplate manufacturer should have quality procedures in place to ensure that every tinplate order conforms to the required standard. Incorrect tin coating masses or passivation levels could result in abnormal corrosion and increased product tin levels. Low oil levels may lead to abrasive damage to the tin coating during transport and can manufacture.

3.2.2 Can maker

3.2.2.1 Can makers should approve tinplate suppliers on the basis that each supplier has demonstrated compliance to agreed standards and ordering requirements.

3.2.2.2 The can maker should have sufficient expertise to ensure that the customer’s ordering requirements (i.e. passivation and tin coating mass) are appropriate for the end use and should notify the customer of any concerns.

3.2.2.3 The can maker should assist the customer in determining the correct can specification for any new food product or recipe change. Such changes should be tested to ensure that product tin uptakes are not excessive.

3.2.2.4 Machine settings for processes where metal working occurs (e.g. beading) should be such as to minimise damage to the tin coating.

3.2.2.5 If a sidestripe is applied to 3 piece cans then excessive heat should be avoided when curing the stripe.

3.3 The canner

3.3.1 Raw Materials

3.3.1.1 The canner should work closely with the can supplier to ensure an appropriately specified can is supplied for any given application. Procedures should be in place to ensure that cans are supplied to specification.

3.3.1.2 The canner should consult with the can maker to determine the correct specification can for any new product or any recipe change of an existing product. It is extremely important that sufficient pack testing is conducted to gain a thorough knowledge of the corrosion mechanism, likely product tin uptakes and overall suitability of the can specification for the product.

3.3.1.3 Canners should be knowledgeable about the shelf life of all their products with respect to likely tin uptakes. It should be noted that fruits and vegetables in particular may have a significant variation in their chemistry, dependent on variety, maturity, time, or place or conditions of harvest, soil chemistry and agricultural practices. These are difficult for the canner to control and may ultimately impact on the level of tin uptake by the product.

3.3.1.4 Quality procedures should be in place to ensure that product batches conform to recipe specification.

3.3.1.5 Particular attention should be paid to the pH of the food and the addition of food acids. It should be recognised that corrosion is pH dependent and that too large drop in pH may give a significant change in corrosive behaviour and tin uptake. Different food acids (e.g. citric, malic, fumaric and acetic) behave in different ways with respect to internal corrosion and any ingredient change from one type of acid to another should be thoroughly tested. Acetic acid is particularly aggressive towards tin.

3.3.1.6 The presence of a chemical species with the ability to accept electrons will increase the rate of the corrosion reaction. Nitrate is a corrosion accelerator and its presence, even at low levels (1 mg of NO_3- will yield nearly 8 mg of Sn2+) causes rapid de-tinning. In a 400 g can, 10 mg of NO_3- will rapidly react to give approximately 80 mg of Sn2+ or, in other words, a product tin concentration of 200 ppm. In about one year 100 ppm of nitrate will completely de-tin a No. 303 can with an inside coating weight of 11.2 g/m^2. Nitrates originate from overzealous use of fertilizers and some fruits and vegetables can accumulate high levels (e.g. tomatoes and pineapples). It is essential, when nitrates are likely to be a problem that the canned food manufacturer and his suppliers have a system in place to ensure fruits, vegetables and other ingredients are acceptable for use in canning.

3.3.1.7 Sulphur residues have also been known to cause corrosion problems in plain tinplate cans. These residues can be of agricultural origin or may have resulted from bleaching or preserving agents used in some ingredients. The canned food manufacturer and his suppliers should again carry out any necessary testing and make sure that the raw materials are fit for purpose.

3.3.1.8 Some foods, especially protein rich meat and fish and, to a lesser extent, vegetables (e.g. peas, beans, corn etc.) contain naturally occurring sulphur compounds. These can react with a plain tinplate surface to give a purple-black stain of tin sulphide. Although the stain is harmless, it may serve to change the passivation of the tinplate surface, which, in turn, could alter the rate of tin uptake. Degree of sulphide staining is also influenced by pH, process time and temperature and the presence of certain cations. Al3+ and Fe3+, Fe2+ ions, found in some treated potable water; act as catalysts for the breakdown of naturally occurring sulphur compounds. Subsequently the presence of these ions increases the rate and severity of sulphide staining. Clearly the canner must have an intimate knowledge of his product; the likely variations that could occur in raw materials and process; and the range of effects that these variations could produce within the can. That knowledge should be used to set controls where necessary and to determine consistent supply.

3.3.1.9 All raw materials from all suppliers should be well documented especially when a supplier is changed or a raw material is obtained from another source or location. In the unlikely event that unexpectedly high product tin levels occur, documentation makes it easier to track back to any specific changes and to take appropriate action.

3.3.1.10 Water quality should be monitored as some water supplies may contain corrosion accelerators such as nitrates.

3.3.2 Processing

3.3.2.1 The canned food manufacturer should take all necessary steps to eliminate oxygen from within the can prior to closing and to ensure an adequate can vacuum. Oxygen is a corrosion accelerator and its presence in a can after closing can lead to early tin dissolution, especially from the headspace area. Oxygen can be present in the interstices of the product and steam exhausting plus a high fill temperature will help its removal. Minimising headspace, whilst still allowing for product expansion, also helps eliminate oxygen. Another control method is closing under vacuum. Steam injection to the headspace must be consistent and controlled. Line stops and delays between filler and closer should be avoided.

3.3.2.2 The primary method used for removing oxygen is closing under vacuum and seam exhausting.

3.3.2.3 Chemical reactions, such as corrosion, are accelerated by increasing temperature. Canners should avoid excessive processing times at high temperatures that may have an effect on advancing tin uptake.

3.3.2.4 Inadequate cooling and drying should be avoided because this means, for a large mass of cans, that they will remain at an elevated temperature for a considerable period of time. Cans should be cooled to 35–40 °C. Cans cooled to a lower temperature may not dry adequately leading to external rusting. Cans that are not adequately cooled can be subject to contamination by thermophilic bacteria or products may suffer a loss in quality.

3.3.3 Finished goods storage

3.3.3.1 Internal can corrosion, like any chemical reaction, is temperature dependent. In general, for every 10 °C rise in temperature the reaction rate will double. The expected level of tin uptake from a can stored at high temperature (i.e. 40 °C) would be significantly higher than from a can stored at lower temperature (i.e. 10 °C) for the same period of time. Canned food manufacturers should consider the location of their finished goods storage areas when determining maximum storage times. For example: - what is the likely maximum temperature; are some areas heated more by the sun; how many days per annum at relatively high temperatures etc.

3.3.3.2 Stock control is required to ensure finished canned goods from earlier production dates are used first.

3.3.3.3 Warehousing be done under conditions where the temperature can be controlled. Large swings in temperature can lead to condensation of moisture on the exterior of cans which can lead to rusting.

3.3.4 Other considerations
Can damage should be minimised as this can lead to local areas of de-tinning. For this reason, it is preferable to use ink jet coding rather than embossing.

3.4 Transport and warehousing
3.4.1 Please refer to sub clause 3.2.3.2 and 3.2.3.3 in sub clause 3.2.3 Finished Goods Storage.

3.4.2 Temperatures encountered during transport need to be considered if the canned goods are likely to remain at these temperatures for any length of time (i.e. during shipping). If possible, it is preferable to export stock from a more recent production date if high temperatures are likely to be encountered during shipping or at the final destination.

3.5 Retailer
The retailer should maintain correct stock rotation and good handling practices to ensure that shelves are stocked with cans in production date sequence and to avoid can damage.

3.6 Consumer
3.6.1 The consumer should choose a storage location for canned foods that is not subject to excessive heat. Cupboards should not be close to ovens or heaters and should preferably not be in direct sunlight.

3.6.2 Unused food or juice left in plain tinplate cans may rapidly accumulate tin in the presence of air. It should be transferred immediately to a clean plastic or glass container and stored in the refrigerator.