codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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Agenda Item 15 (c)

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD ADDITIVES AND CONTAMINANTS

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PROPOSED DRAFT MAXIMUM LEVELS FOR TIN - COMMENTS AT STEP 3

The following comments have been received from: Australia, Poland, and Sudan.

AUSTRALIA:

The 35th Session of the Committee decided to return the proposed draft maximum levels for tin (250 mg/kg in canned foods other than beverages and 200 mg/kg in canned beverages) to Step 3 because no consensus could be reached on the proposed draft MLs.

Australia submitted comments on this item for the 34th and 35th CCFAC. Australia also developed a Discussion Paper on Tin for the 35th CCFAC which was accepted by the Committee with little change. The Committee decided at the 35th CCFAC to begin elaboration on a Draft Code of Practice for the Prevention and Reduction of Tin in Food and Food Products under the leadership of Australia.

Australia's comments are reiterated at this time. Australia has examined the proposed MLs for tin in foodstuffs and agrees that MLs should be set. At the 35th CCFAC, there was discussion on the JECFA assessment on the toxicity of tin, with clarification from the FAO Joint Secretary for JECFA and the representative from WHO, that there was no acute reference dose for tin and that very limited data (one case) indicated that concentrations of 150 mg/kg tin in canned beverages and 250 mg/kg in other canned foods might produce reversible gastric irritation in a limited number of sensitive subjects only.

The Australian position on the draft MLs for tin has not changed. Australia supports the draft MLs and does not support lower MLs proposed by some member countries, since the basis for lowered levels is not substantiated on safety grounds and lower levels would result in disruptions to international trade.

Australia believes that the proposed draft MLs should be maintained (250 mg/kg in canned foods other than beverages and 200 mg/kg in canned beverages) and supports the Committee decision to ask JECFA to evaluate new data once it becomes available to determine an acute reference dose. Australia also supports the elaboration of the Code of Practice for the Prevention and Reduction of Tin in Food and Food Products. Together, these two activities might in future allow MLs for tin to be revisited and changed if appropriate".

POLAND:

According to Polish regulation maximum tin level for canned foods is 100 mg/kg, whereas for canned foods intended for infants and young children (up to the age of three years) it cannot exceed 10 mg/kg. In view of that we consider proposed maximum levels too high.

SUDAN:

SURVEY

The Quality of White Cheese in Brine

Manufactured in the Sudan

Summary:

The quality of white cheese in brine packaged in metal container was investigated for presence of the chemical contaminant "Tin" which might affect the safety of this widely common used food. It was found that migration of metal contaminants and non proper hygiene found in some samples have affected the quality and safety of this product.

This study was conducted by the National Chemical Laboratories, Federal Ministry of Health (FMOH) in collaboration with the World Health Organization (WHO), through the Food Safety Project.

Objectives of the study:

Most of the products of white cheese in brine locally produced are manufactured of raw milk and canned in metallic containers (tins) of 10kgs weight. The containers are made of tin-plated iron sheets, usually consists of three pieces, one curved around to form the body, plus top and bottom pieces. Lead metal solder is generally used to fix, at least, the top piece. Therefore the quality of the product need to be investigated for chemical and microbiological contamination in order to ensure safety and fitness for human consumption i.e. level of hygiene and GMP application.

The survey was conducted to study the quality of white cheese in brine packed in metallic containers, with respect to 'Tin' chemical contamination. Therefore, the cheese samples were collected from Khartoum state and investigated through laboratory analysis for tin, iron (rust) and lead contamination, in addition to related general characteristics; appearance, pH and sodium chloride (salt) content. Microbiological investigation was carried out to identify the level of hygiene applied in the manufacture process.

Standard methods were used for the laboratory analysis of the collected cheese samples and the obtained results were compared with Codex and/or international standards.

Introduction:

Tin (Sn):

The 35th Session (March 2003) of Codex Committee on Food Additives and Contamination advanced the proposed draft maximum levels for tin (200 mg/kg in liquid canned foods "beverages" and 250 mg/kg in solid canned foods "non-beverages") to the Commission for adoption at Steps 5 "sent back to step 3".

JECFA recommended that the provisional tolerable weekly intake (PTWI) of 14 mg/kg b.w. be maintained. JECFA assessed the acute toxicity of tin, but data were insufficient for establishing an acute reference dose. The limited human data available indicate that concentrations of 150 mg/kg in canned beverages and 250 mg/kg in other canned foods may produce acute manifestations of gastric irritation in certain individuals (WHO Technical Report Series No. 776,1989).

The level of 250 ppm for Tin set by many countries as a safe upper limit in canned foods is not based on toxicological evidence of safety but on the levels of Tin found in canned foods under normal conditions of processing and storage.

Sources of Exposure***:***

Food, especially canned food, represents the major route of human exposure to tin. Tin occurs in most foods, however, levels are generally less than 1ppm in unprocessed foods (Schroeder et al, 1964). Higher concentrations of tin are found in canned foods from dissolution of the tinplate to form inorganic tin compounds or complexes (Schafer and Fembert, 1984). The concentration of tin in canned foods depends on a number of factors, including, the type and acidity of the food, time and temperature of storage and the presence of air in can headspace (Greger, 1987). Oxidising agents such as nitrates, iron and copper salts accelerate dissolution of tin, while sugars and colloids such as gelatine retard detinning.

Cans are often lacquered to reduce corrosion and prevent detinning. Tin concentrations in foodstuffs in unlacquered cans often exceed 100ppm while food stored in lacquered cans have tin levels generally below 25ppm (Jorhem and Slorach, 1987; WHO 1989). Storage of food in opened unlacquered cans results in substantial increases in the tin levels in the food.

Physical and Chemical Properties:

Tin is a soft, white silvery metal that is insoluble in water. Tin metal is used to make cans for food, beverages and aerosols. It is present in brass, bronze, pewter, and some soldering materials.

Tin is a metal which can combine with other chemicals to form compounds, and when combined with chemicals such as chloride, sulphur, or oxygen, it is referred to as inorganic tin compound.

Tin can also combine with carbon-containing materials to form organo-tin compounds. These are used in making plastics, food packages, plastic pipes, pesticides, paints, wood preservations, and rodent repellents.

Tin forms two series of compounds, and may present in oxidation states of +2 or +4, i.e., the stannous compounds of bivalent tin, and the stannic compounds of quadrivalent tin. The most important inorganic compounds of tin are tin oxides, chlorides, fluorides and halogenated sodium stannates and stannites. Although little is known of the form in which tin occurs in food, attempts have been made to characterize the chemical form of tin canned foodstuffs. Total tin in acidic foods can be transformed to many different chemical forms, but mainly remain in the form of inorganic complexes (Winship,1988). Oxidation, hydrolysis and complex formations are three main processes of transformation of tin in food.

Metabolism and Kinetics:

Tin is poorly absorbed in animals and humans (Hiles, 1974; Furchner and Drake,1976; WHO, 1982). The presence of citric acid in canned foods can increase the rate of absorption of tin. Experiments in rats revealed that in the absence of citric acid 2.85% of tin was absorbed from the gastrointestinal tract, while in the presence of citric acid 23.34 % of tin was absorbed (Kojima et,1982).

Tin is widely distributed in tissues, especially in bone, liver, kidney and spleen (WHO,1982). Animals and humans accumulate more tin in the bone than in soft tissues (Greger, 1987).

Toxicity:

In summary, the main acute effect from excessive oral consumption of tin compounds of about 200ppm in food is acute gastric irritation, with wide variation in sensitivities between individuals (JECFA, 26th meeting, 1982). The clinical signs following acute ingestion were vomiting, diarhoea, fatigue, and headaches.

In summary, from the available animals studies conduced in rats and mice, there is no evidence to suggest that inorganic tin compounds have carcinogenic potential.

Effect of Tin on bone strength:

Studies suggested that excess tin in the diet may interfere with normal bone formation and/or maintenance. In conclusion, the data suggest that there may be a tin-calcium interaction leading to leaching of calcium from the bones at 1mg/kgbw/day (35th CCFAC).

Interaction with specific dietary components:

From previous studies, tin is known to interact with a number of essential trace elements in the body.

Limited evidence indicates that excessive intake of tin interferes with levels of essential micronutrients in the body, potentially resulting in deficiency and its systemic consequences. Repeat-dose studies indicate that iron levels in particular are affected, tin-iron interaction could occur leading to iron deficiency (anemia) and poor growth in affected animals, also zinc, copper, calcium and possibly selenium levels appear to be affected but at high doses.

Tin Content of Food:

The intake of tin by different sub-population groups depends on the amount and type of canned foods consumed and its tin level. Intakes can vary widely between sub-population groups.

The uptake of tin by foods depends also on whether the cans are lacquered or not. The risk of contamination of food by tin is significantly reduced by lacquering. The lacquer protects the surface and tin dissolution occurs only around a scratch or through a pore. The contact area is small therefore corrosion is slow. Problems arise when the lacquer film lifts from the metal surface.

Canned foods accumulate more tin when stored for several months and corrosion accelerated at temperatures of about 40ºC. Tin uptake will increase with time and most products exhibit first order reaction rates where the rate of dissolution double for every 10˚C rise in temperature.

Materials and Methods:

(94) samples of white cheese in brine were bought from the local market, Khartoum State, in the same way done by the consumer either as weighed pieces or in the original containers (tins of 10kg wt.), attached by them the data collected for the questionnaire.

Table (1) shows the sources of the collected samples and the data collected for the questionnaire.

The samples were laboratory analyzed for pH, sodium chloride (salt), iron (rust), tin, lead and microbiological examination (staph. Aureus, E.coli, coliform and salmonella bacteria). The results of analysis are shown in Table (2).

Determination of Tin in White Cheese in Brine:(AOAC,15th Ed.)

Tin was determined in the cheese samples by atomic absorption spectrometric "AAS" method in which samples were digested with nitric acid and hydrochloric acid and diluted with aqueous potassium chloride.

Equipment and Reagents :

(1) Hydrochloric acid (analar grade)

(2) Nitric acid (analar grade)

(3) Potassium chloride (analar grade)

(4) Distilled water

(5) Sensitive balance

(6) Oven

(7) Hot plate

(8) Atomic absorption spectrophotometer, with tin lamp (235.5 nm)

(9) Volumetric flasks

(10) Conical flasks

(11) Pipettes

(12) Filtration funnels

(13) Filter paper No. 4

The detailed procedure was as follows: -

(1) Accurately (± 0.01g) (5-10) grams of the cheese was weighed in a conical flask after complete mixing of the sample.

(2) The sample was dried in an oven at120ºC.

(3) 30 ml of concentrated nitric acid was added to the flask.

(4) The flask containing the sample and nitric acid was heated gently on hot plate to initiate digestion avoiding excessive frothing.

(5) The digest was gently boiled until (3-6 ml) volume remained.

(6) 25 ml concentrated hydrochloric acid was added and was heated gently for approximately 15 minutes, until bumping from evolution of chlorine stopped.

(7) Heating was increased and boiling was continued until(10-15 ml) volume remained.

(8) 40 ml of distilled water was added and the content of the flask was swirled and poured into 100 ml volumetric flask, after being rinsed once by 10 ml of water.

(9) 1.0 ml of potassium chloride solution was added to the contents of the volumetric flask, which was prepared by dissolving 1.91g of potassium chloride and diluted to 100 ml with distilled water.

(10) The volumetric flask was cooled and diluted to volume with distilled water, additional distilled water was added to the flask to compensate approximately for volume of the fat in the sample.

(11) The volumetric flask content was mixed well and 50 ml of was filtered in polyethylene sample bottle using filter paper No.4 and filtration funnel.

(12) The sample in the polyethylene bottle was readily fed into the atomic absorption spectrophotometer.

(13) The details of the instrument and the instrumental procedure was as follows:

(A) Instrument: Atomic absorption (AAS) model GBC 932 plus consisting of:

1- Hollow cathode lamp as a source of electromagnetic radiation

2- Monochromator

3- Nebuliser

4- Spray chamber

5- Burner

6- Compressor for air supply

7- Acetylene gas cylinder

8- Soft ware program to control whole analysis process

(B) The acetylene and air supplies were opened and automatically mixed in the ratio of (2:8) respectively, and the instrument was programmed to the type of element under analysis (Sn), number of samples, wave length (235.5 nm for Sn), and labels

(C) Sn – lamp was mounted into the instrument, and the burner was ignited to create a suitable flame of air-acetylene.

(D) The lamp was switched on and the sample was fed into the flame through sample capillary tube and was atomized in the flame, and absorbed the Sn- spectral line from the lamp. The absorbed portion of the spectral line was directly proportional to the concentration of the sample (Beer – lamperts law).

(E) Standard calibration curve for "Tin" was constructed in the range of (0.0 – 55 µg Sn/ml). Then "Absorbance" was read for cheese samples, the standard graph was used to calculate tin concentrations in the cheese samples and expressed as mg Sn/kg of the cheese weight. Samples of higher tin content were diluted to the concentrations range of the graph. (The results are shown in Table 2)

<u>Results:</u>

Table 2 shows the results of analysis of the cheese samples for Tin (Sn) and pH..

Table 2.

Serial No	Tin Content mg/Kg	pH
1	13	2.7
2	52	1.6
3	44	2.8
4	43	4.5
5	136	3.4
6	269	4.5
7	101	4.6
8	69	4.2
9	127	4.3
10	15	3.7
11	169	3.55
12	128	3.49
13	112	1.22
14	154	1.94
15	55	4.68
16	82	2.34
17	78	3.39
18	46	3.03
19	19	2.58
20	128	2.88
21	220	3.71
2	104	3.18
23	97	3.07
24	38	2.8
25	15	2.9
26	51	2.3
27	74	5.0
28	250	3.0
29	77	3.2
30	49	3.4
31	196	5.0
32	17	3.2
Serial No	Tin Content mg/Kg	pH
33	152	3.6
34	249	2.5
35	124	2.0
36	108	4.6
37	296	3.3
38	18	2.6
39	103	2.4
40	12	5.0
41	178	3.2
42	231	2.6
43	43	2.0
44	257	3.4
45	167	4.1
46	158	2.9
47	156	3.7

48	131	4.7
49	133	3.4
50	209	4.3
51	150	5.5
52	164	3.2
53	85	4.2
54	94	4.8
55	157	2.8
56	76	3.7
57	ND	3.7
58	ND	3.0
59	84	3.5
60	200	5.1
61	166	4.6
62	319	4.2
63	112	5.2
64	2.5	4.2
65	281	5.1
66	231	5.1
67	265	3.2
68	205	4.4
69	268	3.9
70	ND	5.6
71	179	4.3
72	405	4.4
Serial No	Tin Content mg/Kg	pH
73	210	4.6
74	213	3.3
75	234	4.6
76	118	3.8
77	295	3.5
78	196	3.5
79	222	5.4
80	236	5.4
81	286	3.3
82	97	3.5
83	161	3.2
84	195	4.3
85	168	4.9
86	129	3.7
87	145	5.0
88	189	4.5
89	202	3.0
90	169	3.6
91	387	5.0
92	ND	2.22
93	ND	2.90
94	ND	2.3

ND = Not Detected

Discussions and Conclusion:

(94) Samples of white cheese were collected from different areas around the capital of Khartoum , distributed over the three main cities of the state, (34) samples from Khartoum city, (31) samples from Omdurman city and (29) samples from Khartoum North city .

The Sudanese white cheese in brine is produced locally at the areas of rich milk supply. These samples were from Elduwaim (83 samples), Gezira area (5 samples) and others (rest of the samples). The cheese is generally made of raw milk, rennet and salt (sodium chloride), then packaged in metallic tinplated iron sheet containers (some producers use plastic containers for packaging of cheese products "not included in this study".

Samples were collected in plastic bags as weighed pieces, and a number of samples were collected in their original containers (tins of 10kg).

For laboratory investigation, each sample was given a serial number, mixed and homogenized. A representative part was taken and analyzed for tin content according to the detailed experimental procedures cited in the experimental section using AAS method and for pH.

The shelf life of most of the samples was six months, and for few was three months.

From the experimental results, it was found that all cheese samples were acidic, the values of the pH were in the range of (3.6 to 4.4), and the samples were of acceptable taste and odour.

Most of the samples were found to contain iron in varying unacceptable high amounts.

The results of analysis of cheese samples showed that Tin (Sn) was found in 90 samples, in the range of (12 to 405 ppm) with a mean value of (148.2ppm), and was not detected in few samples. The results of data analysis showed that (30%) of the samples were found to contain Tin in amounts of less than (100ppm), (70%) of the samples were less than 200ppm, (88%) were less than (250ppm) and (12%) contained Tin in amounts higher than (250ppm) which is the maximum limit for Tin in solid foods (non-beverages foods) proposed by the Codex Committee on Food Additives and Contaminants submitted to the Codex Alimentarius Commission for adoption at step 5 (June 2003).

In conclusion, the practice of packaging "White Sudanese Cheese in brine" in metallic Tin plated Iron sheet containers is not safe and imparts a great risk to the health of the consumer due to consuming of cheese containing variable levels of the Tin contaminant due to migration of dissolved Tin from the un-lacquered Tin-plated iron sheet containers into the contents of the products. The rust "ferric form of Iron" formed at the inner surface of the containers due oxidation of the exposed iron sheet dissolves in the acid medium and contaminate the product, which might activate the dissolution of Tin.

Recommendations:

- The containers (tin –plated iron sheet tins) should not be used more than once for cheese packaging, i.e the re-use of metal containers must be stopped.

- All the requirements necessary for proper labeling must be fulfilled including production date and shelf life (expiry date).

- An extra packaging material of H.D. polyethylene bag should be used to fill the contents in as packaging material inside the metal container to work as a barrier between the contents and the metallic container in order to protect the product against migration of metallic contaminants from the container, Tin (Sn), iron (rust) and lead (Pb).

- Application of HACCP system throughout the chain of cheese making process should be encouraged.

- Risk management application should be introduced to ensure safety of cheese making process.

- Specifications for "white cheese in brine" should be set. Codex standards could be used as a reference (copy is attached).

- The Tin and/or Lead concentrations in a single can may lead to negative health effects, therefore continuous laboratory investigations should be carried out in order to ensure complying with standards and application of safety requirements.

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