

UTILIZATION OF CHROMIUM-PLATED STEEL CANS IN CANNEDMEAT PRODUCTION

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Comparative studies were carried out on three kinds of chromium-plated steel drawn cans and on tinplate ones i.e. on bare cans, cans internally coated with the epoxyphenolic lacquer and on cans internally protected with the aluminium pigmented epoxyphenolic lacquer. The mentioned cans were used in production of canned cured minced pork, canned cured pork chops, canned cured beef chops and canned sour cabbage with pork chops.

Packaging tests, performed in 4-year period, followed by analytical analyses, showed that adequately lacquered chromium-plated steel drawn cans can successfully be used in meat industry regarding the corrosion shelf-life of canned meat products.

VERWENDUNGSMÖGLICHKEIT DER VERCHROMTEN FEINSTBLECHDOSEN  
IN DER FLEISCHKONSERVEN-PRODUKTION

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Komparative Prüfungen auf drei Sorten der verchromten Feinstblechdosen und an verzinnnten Feinstblechdosen d.h. an blanken Dosen, an von innen mit Epoxyphenolfilm überzogenen Dosen und an von innen mit Aluminium pigmentierten Epoxyphenollack geschützten Dosen durchgeführt. Die angeführten Dosen wurden in der Produktion von konservierten gepöckelten Schweinestücke, konservierten gepöckelten Rindstücke und von konservierten Sauerkraut mit Schweinestücke angewendet.

Fleischverpackungsprüfungen, in 4-jähriger Zeitspanne durchgeführt, nachgeprüft durch analytische Bestimmungen, haben erwiesen dass die tiefgezogene verchromte Feinstblechdosen, angemessen lackiert, können in der Fleischindustrie, mit Hinsicht auf die Korrosionslagerfähigkeit der Fleischkonserven, vortrefflich angewendet werden.

UTILISATION DES BOÎTES EN ACIER CHROMÉ DANS  
LA PRODUCTION DES CONSERVES DE VIANDE

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Des recherches comparatives ont été faites sur trois sortes des boîtes embouties en acier chromé et sur les boîtes embouties en fer blanc, c'est à dire sur les boîtes nues protégées à l'intérieur par le laque epoxyphenolique et sur les boîtes recouvertes à l'intérieur par laque epoxyphenolique aluminium pigmenté. Les dites boîtes ont été utilisées dans la production des conserves de porc haché saumuré, des conserves de porc en morceaux saumuré, des conserves de boeuf en morceaux saumuré et des conserves du choucrout aux morceaux de porc.

Les essais des conserves, faits dans la durée de quatre ans, suivis des determinations analytiques, ont montré que les boîtes en acier chromé, convenablement laquées, peuvent être utilisées avec succès dans l'industrie de viande à l'égard de la stabilité des conserves de viande en stockage en vue de la corrosion.

ПРИГОДНОСТЬ УПОТРЕБЛЕНИИ ЖЕСТЯНОК ИЗ ХРОМИРОВАННОЙ СТАЛЬНОЙ ЖЕСТИ В ПРОИЗВОДСТВЕ МЯСНЫХ КОНСЕРВОВ

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Произведены сравнительные исследования на трех видах таянутых жестянок из хромированной стальной жести и из белой жести, т.е. на неварнированных жестянках, жестянках, чьи внутренние поверхности защищены эпокси-фенольным лаком и на жестянках, защищенных на внутренних поверхностях алюминий-пигментированным эпокси-фенольным лаком. Упомянутые жестянки были употреблены в производстве консервов засоленного измельченного свиного мяса в кусках, консервов засоленного говяжьего мяса в кусках и консервов квашеной капусты с кусками свиного мяса.

Исследования консервов в течение четырехлетнего складирования, сопровождавшиеся аналитическими определениями, показали, что соответствующим образом лакированные таянутые жестянки из хромированной стальной жести могут успешно применяться в мясной промышленности, имея в виду коррозионную сохранность консервов.

## PACKAGING FRESH AND CURED MEAT

## UTILIZATION OF CHROMIUM-PLATED STEEL CANS IN CANNED MEAT PRODUCTION

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About sixty per cent of world tinplate production is used in food canning. In recent years, can manufacturers and food industry are faced with the tremendous increase of tinplate prices and simultaneously with the disbalance in supply and demand of the tinplate at the world market. It promoted the interest in the more serious research of available substitute materials for hermetical food containers. One of such metals is chromium-plated low carbon steel. First, it was produced in Japan. Its prices are between tinplate prices and blackplate ones. At the market, Japanese chromium-plated steels can be found under different trade marks: "Cansuper" - Fuji Iron and Steel Company, "Hi-Top" - Toyo Kohan Company and "Supercosat" - Yawata Steel Company. The mentioned products differ among each other by a protective coating being either metal chromium or chromium oxides or a combination of chromium and chromium oxides. Some European countries and U.S.A. have already produced chromium plated steels under Japanese licences.

According to literature data, chromium plated steels, having  $5-20 \mu\text{g}/\text{m}^2$  protective films, are suitable materials for drawn can manufacture on condition they are lacquered on both sides. It was demonstrated that lacquers, like phenolic and epoxyphenolic ones, used for the tinplate can protection, can successfully be used for chromium-plated steel. The adhesion and resistance to cracking of lacquer film on the chromium-plated steel are higher than on the tinplate. Results of packing tests with different kinds of canned products in chromium-plated steel cans were generally good regarding internal and

atmospheric corrosions. However, some undesirable changes derived from internal corrosion were also registered e.g., in the cases of canned carrots and canned sour cucumbers. Besides the cited advantages, chromium-plated steels are resistant to staining. The imperfection of that material is the impossibility to be soldered. So chromium plated steels can be used for drawn cans or for combined cans - chromium-plated steel ends and tinplate bodies. Chromium content and its valency ( $3^+$ ) found in canned foods after a long-term storage show that chromium plated-steel cans are not dangerous from the toxic view point (2, 3, 6, 7, 8).

Literature data dealing with meat products in chromium-plated steel cans are very poor and differences in canned meat technology and in kinds of meat products are great. Therefore, the aim of our work was to test comparatively some quality components, being in relation of the internal corrosion, of four characteristic sterilised meat products in "Cansuper" cans and the same ones in tinplate cans during the four year storage.

## Materials and Methods

In the experiments the following sterilised canned meats were used: cured minced pork, cured pork chops, cured beef chops and sour cabbage with pork. The mentioned foods were packed in drawn cans ( $\emptyset 73 \pm 28 \text{ mm}$ ) of "Cansuper", having the  $0.04 \mu$  thick chromium coating, and of electrolytic tinplates - E1 and E2 (manufacturer: "Rasselstein" - West Germany). Regarding the additional internal protection, three kinds of cans were used: plain cans, cans protected with unpigmented epoxyphenolic lacquer -  $5 \text{ g}/\text{m}^2$  thickness, and cans with the aluminium pigmented epoxyphenolic coating -  $7 \text{ g}/\text{m}^2$  thickness (lacquer manufacturer: "Herbol" - West Germany).

Canned meats were kept four years at room temperature and tested after 1, 6, 12, 24 and 48 months. Meat products in plain cans were only tested for 12 months.

Each test group consisted of 10 samples.

The visual examination of cans and the organoleptic testing of meat products were carried out by three experts.

The adhesion of the lacquer coating was determined by the "Selotape" method (4).

The porosity and scratches of the lacquer coating were evaluated by the copper sulphate method and porosity and scratches of protective metal coatings by the sulphur dioxide and the thiocyanate tests (4).

Quantitative analyses of iron, tin (5) and chromium (1) were done by the spectrophotometric methods.

## Results and Discussion

By the visual examination of non-used cans and by testing the scratches of internal protective coatings, it was determined that the cans of all test groups had approximately the same degree of mechanical damages. However, by the thiocyanate test, there were found differences in the degree of porosity of protective coatings (Table I). The results point to the interesting fact that on one hand, plain "Cansuper" cans are of remarkably higher porosity of protective coatings than tinplate cans, and on the other hand, the lacquered "Cansuper" is shown to be the more effective protection of steel base compared with the lacquered electrolytic tinplates. The interpretation of such a fact can be found in the possibility of the chemical interaction between the chromium coating and the lacquer one in the course of lacquer film stoving (3, 8). The other demonstrated property of the chromium-plated steel film has that the same quality of unpigmented epoxyphenolic electrolytic tinplates contrary to the results for pigmented epoxyphenolic lacquer.

The results of the visual examination of internal changes of cans during four-year storage of canned meats are

presented in the Figure 1.

On the basis of internal changes of cans, it may be concluded that none of examined plain cans was suitable for packing tested meat products. The undesirable internal changes of canned meats in those test groups had so intensively developed in the course of 12 month storage that it was no use to take them further in the experiments. For can changes in the form of black spots, shown in the Figure 1, the determining is the characteristic of the secondary phenomenon and for the "Cansuper" cans, the formation of black spots is followed by the widening of pores and scratches without appearance of bare areas. Comparing can changes of four tested products in the course of four year storage, it may be concluded that more intensive changes were in canned sour cabbage with pork while among other tested products there were no significant differences.

By the visual examination of the surfaces of can contents, the highest degree and the highest frequency of undesirable colour changes were found in test groups where plain cans were used. The changes were mostly in the form of numerous black spots. The same appearance was found in products in the lacquered cans except in sour cabbage with pork, but in the significantly lower degree, and in the later stages of canned meat storage. Besides that, in the case of canned minced pork and canned pork chops, yellow to yellowish-brown product surface discolourations were found, more frequently in tinplate cans than in "Cansuper" ones.

Regarding off-flavours of tested canned meats, it may be stated that products with larger quantities of corrosion deposits had metal flavour.

A sample of the 24-month stored pork chops in the lacquered "Cansuper" can and three samples of the same product after 48-month storage were interesting because of the unusual appearance of crystals on the internal can surfaces and on the can content surfaces (Figure 2). On opening, the crystals had white colour that, exposed to the air, grew darker and darker passing



## PACKAGING FRESH AND CURED MEAT

through different shades of green colour. By the qualitative analysis, it was demonstrated that the crystals were anorganic iron compounds. Iron content in the above products was 130-170 ppm. It should be pointed out that the four samples with crystals had off-flavour and undesirable meat tenderness.

On the basis of the quantitative metal determination in the meat products (Figure 3), it may be seen that the chromium content in products in "Cansuper" cans is approximate to chromium quantities of the products in tinplate ones. However, iron content is remarkably higher in "Cansuper" cans than in tinplate ones especially in the canned cabbage with pork. The cause of such a state can be interpreted by the electrochemical view point. While chromium coating of "Cansuper" cans, in the case of canned foods, is noble to steel, tin is a sacrificial coating. Besides that, it is known that the degree of porosity of sacrificial coatings, contrary to the noble coatings, is not of great importance for corrodability of the metal base.

## Conclusions

Results of experiments show that:

1. It is possible to use lacquered drawn chromium-plated steel cans in tested canned meat production.
2. Epoxyphenolic lacquers are suitable protection for drawn chromium plated steel cans. The use of pigmented epoxyphenolic lacquer, in the case of "Cansuper" cans, is not recommended for two reasons: 1. it is useless to apply pigmented lacquer coating as chromium plated steel is shown to be significantly resistant to staining; 2. pigmented lacquer coatings on "Cansuper" cans have lower adhesion and chemical resistance than unpigmented epoxyphenolic lacquers.
3. Chromium-plated steel cans are safe with relevance to chromium pick-up by tested can contents. Regarding chromium content in tested meat products, it may be said that "Cansuper" cans did not differ from tinplate ones.

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Table I: Results of thiocyanate test on non-used cans

Type of internal can coating	"Cansuper" mg Fe/dm <sup>2</sup>	E1 electrolytic tinplate mg Fe/dm <sup>2</sup>	E2 electrolytic tinplate mg Fe/dm <sup>2</sup>
Plain	1,80	1,37	1,36
Unpigmented epoxyphenolic lacquer	0,010	0,017	0,016
Aluminium pigmented epoxyphenolic lacquer	0,0086	0,0086	0,0086

Fig.1. Collective scores for visible undesirable internal changes of cans during 4-Year storage of canned meats

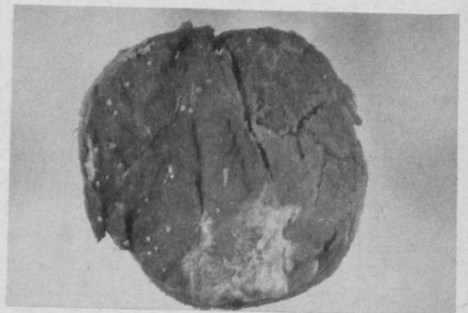
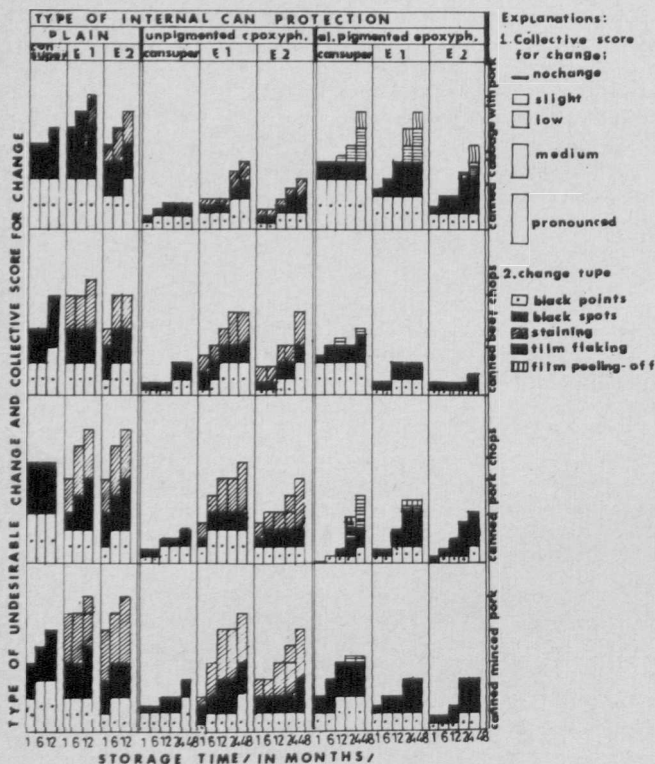


FIG.3. METAL CONTENT IN 48 MONTH STORED CANNED MEATS

