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## THE MERCURY CONTENT OF PREAMALGAMATED DENTAL AMALGAM ALLOYS

by

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### INTRODUCTION

Preamalgamation of alloys is used in order to facilitate the initial reaction with mercury. This method has long been a somewhat controversial subject among amalgam experts. The exact method of mercury incorporation is a secret of the manufacturers; hence the true amount of initial mercury is not known (e.g. *Gilmore*, 1967; *Jørgensen*, 1967). Prevailing alloy specifications (A.D.A. and F.D.I.) state in the paragraph on compositions (3.2) that the mercury content shall be less than 3 per cent (*Guide to Dental Materials*, 1968).

In addition to the speed of amalgamation, a smooth plasticity of the amalgam mix and the best possible adaptation of the set amalgam to the walls of a prepared cavity are both appreciated qualities. Preamalgamation ensures a good plasticity and adds to the other desirable qualities of a set dental amalgam.

The first comprehensive study to demonstrate differences in physical properties between amalgams made from 'standard' and preamalgamated alloys has been recently published (*Forsten*, 1969). Mercury analyses were not made, however.

This paper concerns preamalgamated alloys marketed in Finland in spring 1969. The aim was to determine their initial mercury content.

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## MATERIAL AND METHOD

Table I.  
*The preamalgamated alloy brands studied*

Amalgam alloy brands	Alloy/Mercury ratio	Manufacturer
1. Argos	1 : 1	AB Svenska Dental Instrument
2. Argos non zinc	5 : 6	AB Svenska Dental Instrument
3. Sterling	1 : 1	OY Dentaldepot AB
4. Abedent	1 : 1	Bååths Dentalindustri
5. New Abedent	5 : 6	Bååths Dentalindustri
6. ANA 68	1 : 1	AB Nordiska Affineriet
7. ANA 68 non zinc	1 : 1	AB Nordiska Affineriet
8. Svedia	1 : 1	Svedia Dental-Industri AB
9. Svedia non zinc	1 : 1	Svedia Dental-Industri AB
10. Royal	1 : 1	Amalgamolaget AB

The alloy/mercury ratio had been stated for each sample. For two samples of different composition, ratio 5/6 was recommended. The 1:1 ratio is usual for preamalgamated alloys.

From each sample, 0.5 gm was weighed with  $\pm 0.1$  mg accuracy and dissolved in nitric acid (1:3). For separation of the insoluble metastannic acid formed by this process, the solutions were evaporated to dryness on a water-bath. The residues were dissolved in dilute nitric acid (1 per cent), the metastannic acid was removed by filtering and thoroughly washed with dilute nitric acid (1 per cent). The washings were combined with the main solution, which then was diluted to 100 ml in a volumetric flask. The mercury content of the solutions thus prepared was then determined with a Perkin-Elmer Model 303 automatic absorption spectrophotometer, using an air-acetylene flame, mercury discharge lamp, wavelength 254 Å and slit setting 3, which corresponds to 0.3 mm. The instrument was calibrated using mercury nitrate solutions of known concentrations. According to recent information (Perkin-Elmer Co., 1968), the only interfering element in mercury determinations by atomic absorption technique is cobalt, which was absent in these determinations. Every determination was run twice.

## RESULTS

Table II gives the results as means of the parallel determinations, expressed in per cent Hg.

Table II.  
*Mercury determinations of ten commercial dental amalgam alloy brands*

Sample No.	1	2	3	4	5	6	7	8	9	10
Hg per cent	1.34	4.91	2.88	1.88	0.26	1.36	1.50	1.33	1.54	2.92

As is seen from these figures, the mercury contents were greatly different, ranging from 0.26 to 4.91 per cent. The mercury content of one sample exceeded the specification limit of 3 per cent. Two samples were just below 3 and one slightly below 2 per cent. Five samples were grouped around 1.4 per cent.

Three alloy brands were tested in equivalent pairs with and without zinc content. In one of them the amount of mercury was more than triple in the zincfree modification, while in the rest the mercury values in the type without zinc were slightly more than ten per cent higher.

One of the two samples approaching the specified 3 per cent limit of mercury content was analyzed ten times. The accuracy of the automatic analyzing method was thus determined.

Table III gives the results obtained when sample No. 10 was analyzed ten times, using the technique described. As can be seen from the value of the variation coefficient 0.60, the reproducibility can be considered satisfactory.

The mean value of mercury content of the ten studied alloy brands was 2.90 per cent, the variance 0.0307, standard deviation 0.175, and variation coefficient 0.60.

Table III.  
*Ten parallel mercury determinations of sample No. 10*

Analysis No.	1	2	3	4	5	6	7	8	9	10
Hg per cent	2.88	2.90	2.90	2.90	2.92	2.92	2.92	2.92	2.88	2.88

## DISCUSSION

The alloy samples now studied were all collected on the same day from the dealers. All of them were commercially available in Finland and they were claimed to be preamalgamated alloys.

The results revealed wide variation in the initial mercury content of the alloys, ranging from 0.26 to 4.91 per cent. Hardly any consistent trend could be seen in this respect.

The accuracy of Hg determination by automatic atomic absorption spectrophotometer is claimed to be 10 p.p.m., which equals to 0.001 per cent.

The results obtained by the method described were stated with three significant digits, which implies an accuracy of one hundredth of one per cent. However, the last digit should be taken with some reservation. This is also seen from the Table III, showing the variation in greater detail.

A test, involving determination of the mercury content in different layers in a container, revealed a difference in the order of 0.02 per cent. This source of error arised from the fact that the mercury is not homogenously distributed in the alloys. This may be explained by uneven distribution of small and large particles in the container (*Rantanen*, 1969). Continued studies, involving the determination of mercury in small and large particles of one and the same alloy sample, would seem to be indicated.

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#### SUMMARY

The author reports on the initial mercury content of ten commercial dental amalgam brands, all declared as preamalgamated alloys with the recommended alloy/mercury ratio 1:1 or 5:6. The method of the analysis was automatic atomic absorption spectrophotometry. One sample contained more than the specified three per cent upper limit of initial mercury. The results of the analyses are given, and the reliability of the method is analyzed.

#### RÉSUMÉ

TENEUR EN MERCURE DES ALLIAGES PRÉAMALGAMÉS POUR AMALGAMES DENTAIRES

L'auteur rend compte d'une étude sur la teneur initiale en mercure de 10 produits du commerce pour amalgames dentaires, tous déclarés comme alliages préamalgamés et recommandant la proportion alliage-mercure de 1:1 ou de 5:6. La méthode choisie pour l'analyse était la spectrophotométrie automatique d'absorption atomique. Un des échantillons contenait plus

que les 3 % de mercure initial constituant la limite supérieure spécifiée. Les résultats des analyses sont présentés et la confiance à apporter à la méthode employée est analysée.

## ZUSAMMENFASSUNG

ÜBER DEN QUECKSILBERGEGHALT DER PRAEAMALGAMIERTEN ZAHNAMALGAMFEILUNGEN

Der Verfasser bestimmte den Quecksilbergehalt von zehn verschiedenen auf dem Markt erscheinenden praeamalгамиerten Zahnamalgamfeilungen. Alle Amalgamsorten waren als praeamalгамиert angegeben und ihr Mischungsverhältnis 1:1 bzw. 5:6 (Alloy/Hg).

Das Analysierungsverfahren war eine automatische Atomabsorptionsspektrofotometrie. Eine Probe enthielt einen Quecksilbergehalt, der über dem Standardgrenzgehalt, welcher 3 % beträgt, lag. Die Analyseresultate und die Resultate über die Genauigkeit der Methode werden in Tabellen angegeben.

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