ENHANCING THE LEVEL OF FOOD HYGIENE IN COBOTS: JOINT COVER CONSIDERATIONS

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Introduction

The European as well a national food legislation consists of (Wirtanen et al., 2023) both horizontal and vertical measures. The collaborative robots (cobots) used in open food processing must be hygienic because otherwise they will contaminate the products processed. The framework for equipment food safety – both microbial and chemical – is given in the various regulations. In addition, rules on materials and articles intended to come into contact with food are given in the material regulation. Design requirements for food equipment are given in the machine directive. It is important to always use an updated, consolidated version of the legislation.

Hygiene challenges in open food processes

In the food industry (Salo et al., 2006), the first step is to identify hygiene problems in the equipment used. It is important to use rapid, practical methods in the detection so that the equipment can be cleaned before use in the real process. Training is needed to refresh the personnel about food safety and hygiene issues in the food processing. In testing the surface hygiene in food processing areas aerobic bacteria e.g., coliforms and fungi e.g., yeasts and moulds should be monitored to check the cleaning result. Specific microbial test methods can be added according to microbial risks of the products produced. When setting surface hygiene limits, product spoilage sensitivity should be considered. The more prone the product is to spoilage the stricter limits should be used. The focus of hygiene control should of course be on the food contact surfaces.

Background to the test series

These test series were based on earlier thesis conducted at Seinäjoki University of Applied Sciences (Haapala, 2023; Korkiamäki & Samppala, 2023). The thesis by Haapala encompassed three different test sets, where in the first set, surface materials were soiled once with cheese sauce, allowed to dry, washed, and subjected to culturing using petrifilm (3M Science Applied to Life, Labema), allergen testing (Reveal® 3-D Total Milk Test, Labema), and protein testing (Clean Card Pro, Kiilto). In the second set, surface materials were soiled for three days without intermediate rinsing, and on the fourth day, tests were conducted on the surfaces with dried cheese sauce residues. Subsequently, the soiled surface materials were washed with process detergent, and previously mentioned tests were conducted. The third set served as a control, where materials were not soiled, and the clean surface materials were tested as above mentioned.

Test set with cheese sauce

In the four-day test series, aluminium, and stainless-steel plates, as well as plastic joint covers (Universal Robots, n.d.) in the collaborative robot, were stained by cheese sauce. The material samples were named as A1–3 (aluminium), T1–3 (stainless steel), and N1–3 (joint covers). Reveal® 3-D Total Milk Test was used as the allergen test for casein and whey. Luminometry was used to reveal adenosine triphosphate (ATP) (Net-Foodlab Oy, n.d.) residue on surfaces and Orion Clean Card Pro test for protein residue. When taking sample from materials, it was paid attention in angles and corners of joint covers.

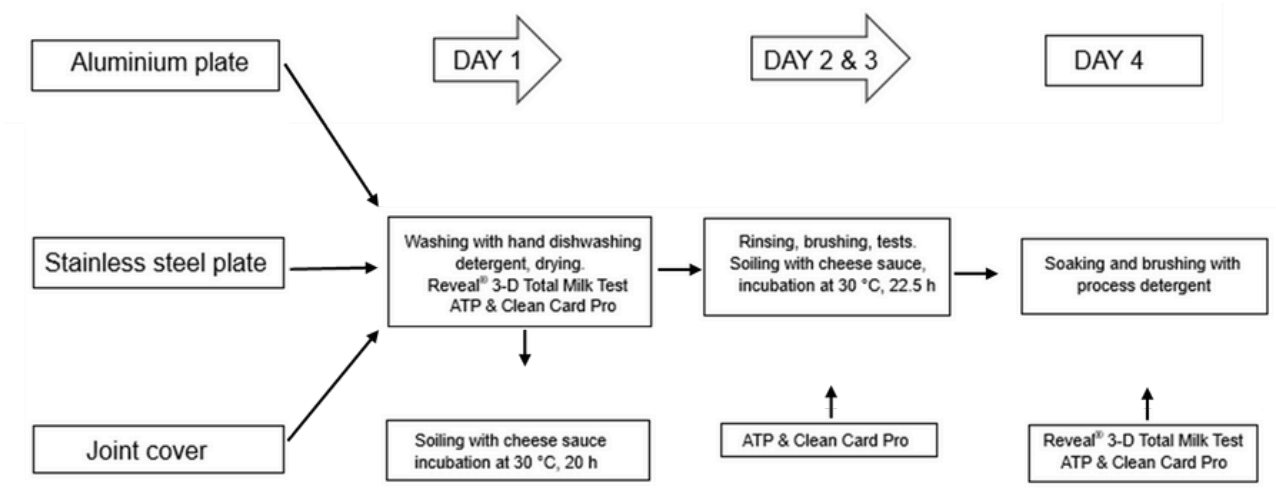

Figure 1 Process chart of test set with cheese sauce. (Lotta Haapala & Gun Wirtanen, CC BY-ND).

In Figure 1 the test procedure is given. On the first day, surface materials (A1–3, T1–3, N1–3) were washed with hand dishwashing detergent. And Reveal® 3-D Total Milk Test, ATP, and Clean Card Pro tests were performed on clean materials. Thereafter, the surfaces were soiled with cheese sauce and the soiled materials were dried in an incubator at 30°C for 1.5 hours. After drying, the surfaces were cleaned (rinsed and brushed) with warm water for 30 s and dried with hand towels. After rinsing and drying, ATP and Clean Card Pro tests were performed on the surface materials. The surface materials were soiled again and placed in the incubator to dry for 20 hours.

On the second and third days the soiled test materials were dried in the incubator at 30°C for 20–22.5 hours. After incubation materials were rinsed and brushed with warm water for 30 s. Protein residue tests (ATP, Clean Card Pro) were performed on the surface materials. The surface was soiled again by cheese sauce, and the soiled surface materials were placed in the incubator.

On the fourth day, the soiled test materials that had been drying in the incubator at 30°C for 22.5 hours were soaked in process detergent for 5 minutes and brushed with process detergent for 30 seconds. After soaking and washing Reveal® 3-D Total Milk Test, ATP, and Clean Card Pro tests were performed on the surfaces.

Results and conclusions of the test set with cheese sauce

The Clean Card Pro results are shown in Figure 2. The results of the analysis (Reveal® 3-D Total Milk Test, ATP, and the Orion Clean Card Pro rapid test) are presented in Table 1. The results in Table 1 show that soiled surfaces should be cleaned immediately after use.

Rinsing and brushing after drying is not sufficient. The surface requires proper cleaning. If the product is allowed to dry, allergens cannot properly be eliminated from the surfaces even with soaking and washing using process detergent. On the fourth day, milk protein residues were found after proper cleaning (Table 1). On all soiled surfaces residues appeared.

Figure 2. The Clean Card Pro results after cleaning. The results of the strips are interpreted according to the colour change (1-4). Result 4 indicates that the surface is very dirty. (Lotta Haapala, CC BY-ND).

Table 1. The results of the cleaning tests have been summarised in this table. Clean Card Pro results are marked with points 1-4 and explained in Figure 2. (Lotta Haapala, CC BY-ND).

Material	Reveal 3-D Total Milk Allergen		ATP		Clean Card Pro	
	Day 1	Day 4	Day 2	Day 4	Day 2	Day 4
A1	neg	pos	60	3	●●●	●●
A2	neg	pos	3	11	●●●	●●●
A3	neg	pos	55	0	●●●●	●●●
T1	neg	pos	1	77	●●	●●●
T2	neg	pos	71	5	●●●	●●●
T3	neg	pos	248	0	●●●	●●●
N1	neg	pos	6	4	●●	●●
N2	neg	pos	349	676	●●●	●●
N3	neg	pos	2	1	●●	●●

ATP results varied much (Table 1). During the test series, it was noticed (Figure 3) that the material in one joint cover (N2) was slightly different from the others (N1). The cover N2 had a different colour shade and it felt rougher (N1). Furthermore, after washing the surface N2 felt greasy. More dried cheese sauce adhered to the joint cover also after water soaking, brushing, and washing with process detergent. The features (e.g. smoothness) of the material used in the joint covers can vary from batch to batch. This must be considered in industry when planning equipment to ensure the cleanability.

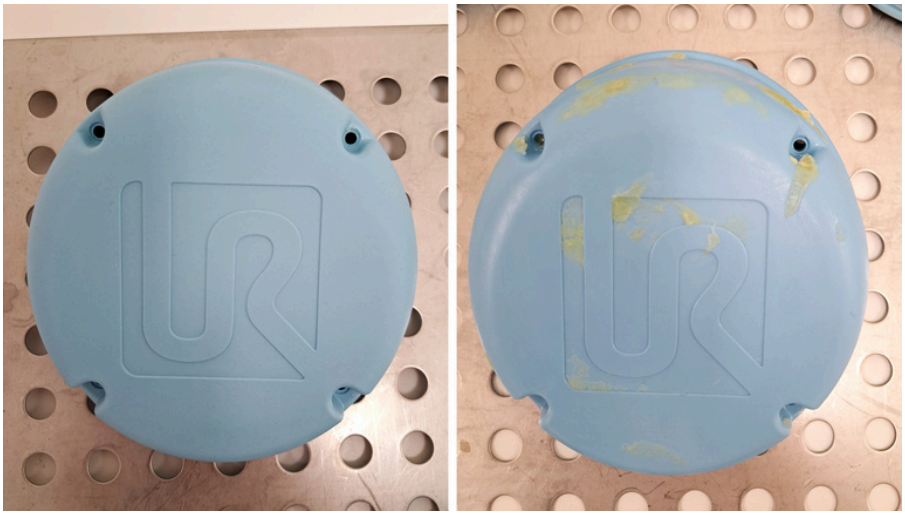

Figure 3. Difference between joint covers (N1 left, N2 right) used in cobots. These pictures show differences after washing with industrial detergent. (Lotta Haapala, CC BY-ND)

The importance of effective cleaning was observed also in the video on allergen assessment (Nikumatti, S.; Rekiaro, J. 2023) filmed at Seinäjoki University of Applied Sciences. In this video the cleaning of milk residues was tested from a stainless-steel plate surface. The work showed that after 10 minutes of drying, the milk does not properly wash off. Proper washing with detergent is needed to clean both allergens and microbes.
This test set with cheese sauce emphasises the importance of timely cleaning and points out the effects of delayed cleaning in allergen management. As a conclusion it can be stated that effective surface cleaning is paramount for control of both allergens and microbes on all surfaces used in open food processing.

Acknowledgement
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