JOURNAL of AGRICULTURE
agrijournal@hotmail.com
ISSN: 2636-8757
https://dergipark.org.tr/tr/pub/ja

DOI: 10.46876/ja.839181

Review / Derleme

Swab Analysis, Its Importance and Applications in Personnel Hygiene and Business Sanitation Monitoring

Menekşe BULUT[1]*, Melek ZOR[2]

ABSTRACT

Swab analysis is of paramount importance especially in the detection of microorganisms taken from surfaces as well as identification, counting and description of these microorganisms and hygiene monitoring. Responsible personnel, food contact tools and equipment play role in the contamination of food with bacteria. It can be identified by swab analysis whether foods, food production equipment, personnel and environment have bacteria or not. Swab samples are of great importance in taking any cross-fertilization under control. While performing analyses, correct selection of swab analysis method should be attached importance as correct swab analysis method selection influence the sensitivity of the results of analyses.

Keywords: Swab analysis, Hygiene and sanitation, Swab method

Swab Analizi, Personel Hijyeni ile İşletme Sanitasyonu Takibinde Önemi ve Uygulamaları

ÖZET

Swab analizi, özellikle yüzeylerden toplanan mikroorganizma tespitinde, bu mikroorganizmaların tespit edilmesi, sayılması ve tanımlanmasında, hijyen takibinde büyük önem taşımaktadır. Sorumlu personel, gıdalarla temas eden alet ve ekipmanlar, gıdalara bakterilerin bulaşmasında rol almaktadır. Özellikle gıdaların, gıda üretim ekipmanlarının, personelin ve ortamın bakteri taşıyıp taşımadığı swab analizi ile belirlenebilmektedir. Herhangi bir çapraz üremenin kontrol edilmesinde swab örnekleri büyük önem arz etmektedir. Analizler yapılırken, swab analiz metodunun doğru seçilmesi dikkate alınması gereken bir konudur. Çünkü swab analizinde metotların doğru seçilmesi, analiz sonuçlarının hassasiyetini etkilemektedir.

Anahtar Kelimeler: Swab analizi, Hijyen ve sanitasyon, Swab metodu

[1*]Menekşe BULUT (Orcid ID: 0000-0003-3902-6403) Department of Food Engineering,, Facult of Engineering, Igdir University, 76000, Igdir , Turkey

[2]Melek ZOR (Orcid ID: 0000-0002-5795-218X), Department of Gastronomy and Culinary Arts, School of Tourism and Hotel Management, Agri İbrahim Cecen University, 04100 Agri, Turkey

*Sorumlu Yazar/Corresponding Author: Menekşe BULUT, e-mail: gidabenefse@gmail.com

Makale Geliş Tarihi (Received): 11-12-2020 Makale Kabul Tarihi (Accepted): 21-01-2021

INTRODUCTION

Detection, counting and identification of pathogenic microorganisms collected from surfaces is the essential in hygiene monitoring, environmental sampling and bio-threat assessment across diverse fields of applications. For rapid and sensitive detection of bacteria and viruses, molecular analysis methods such as real-time PCR are commonly applied. To ensure optimal limits of detection, the initial sample collection must be highly efficient and reproducible. Cotton swabs have traditionally been recommended for microbial surface sampling as well as sampling of human biological traces (Jansson et al., 2020).

Swab and swab analysis methods

Swab consists of a flock layer with long support body structure for collection and transfer of biological material samples and defined by a large number of fibres attached and placed at the end (Triva, 2019). In Figure 1, a sterile disposable swab sample is given.

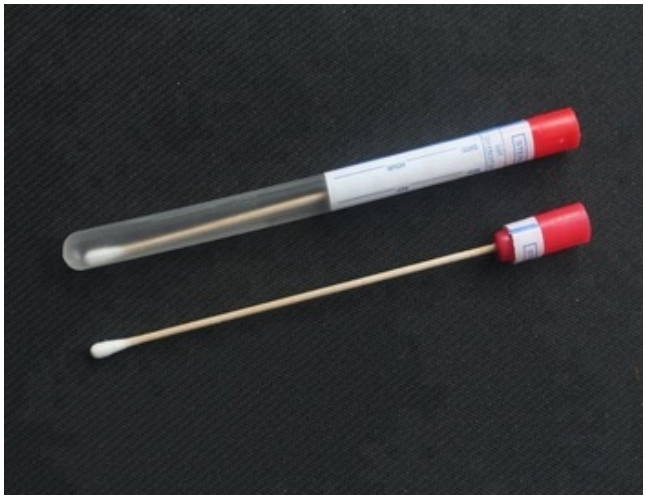

Figure 1. Sterile disposable swab (Anonymous, 2021a)

Today, it has been determined that traditionally used swab materials affect swab efficiency. Swab material selection may depend on the nature of the target organism, change in time after accumulation on the surface (namely, wet or dry sample). It is generally accepted that swabs of the same material show equal performance in sampling. In addition, another issue originates from the differences in recovery between swabs of the same material (Jansson et al., 2020).

In the study carried out by Jansson et al. (2020) in which they evaluated sampling efficiencies for 15 different swabs made of cotton (5), flocked nylon (3) and foam (7), they reported that cotton swabs and small foam swabs were advantageous for sampling from non-absorbent surfaces while foam swabs were advantageous for sampling from all surfaces, and wood areas tested, and foam sticks should be preferred when collecting viruses, regardless of the surface material. It was reported that foam swabs are generally advantageous on absorbent surfaces, such as wood (Figure 2), and recoveries under optimal were obtained for all surfaces tested by nylon flocked swabs. It was emphasized in the same study that there was also a high difference in recovery efficiencies between different swabs of the same material, and it was important to evaluate specific swabs for the intended use before application. (Jansson et al., 2020).

Figure 2. Foam tip swab and sponge swab (Anonymous, 2021b)

For sampling with swabs, the swab tip is first swept once on the surface in a slalom-like pattern (black arrow heads). Next, the swab is swept perpendicularly for a second time on the surface to the first sweeping direction (grey arrow heads) and sampling is performed (Figure 3).

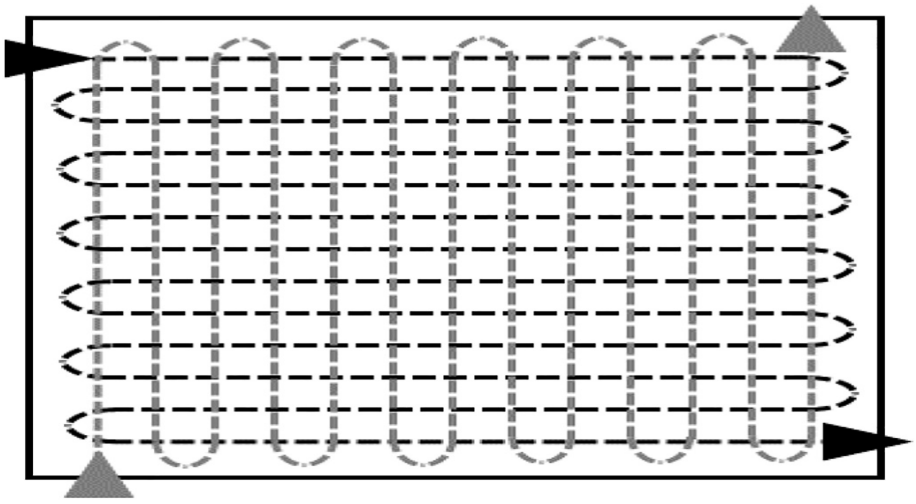

Figure 3. Sampling procedure by swab (Jansson et al., 2020).

After making sampling operation by sterile swabs, swab is put into a tube containing sterile physiological saline water or peptone water and transferred to laboratory quickly at +4 °C, and finally examination is conducted after appropriate dilutions are made according to the microorganism to be detected. (Öz and Özgen Arun, 2019). Vortexing operation is carried out before dilution so that the samples on swab are mixed with the peptone water thoroughly (Ünal and Özmen-Togay, 2017).

Adenosine triphosphate (ATP) bioluminescence method, which is performed with swabs, except for the traditional use of swab sticks, enables the total surface cleanliness, including the presence of organic residue and microbial contamination, to be tested quickly by providing results within minutes. ATP bioluminescence is considered a highly effective biosensor providing a sensitive, non-destructive and real-time testing (Larson et al., 2003; CaPuto et al., 2011; Chollet and Ribault, 2012). The ATP bioluminescence detection test is based on the fact that ATP is an important source of biological energy found in various microbes and therefore reflects the presence of living microbes (Luo et al., 2009). Quantitative measurements of ATP bioluminescence have

been applied to biological and environmental systems for years (Căpriţă and Căpriţă, 2005). Thanks to these, the use of ATP bioluminescence method is getting widespread as a monitoring method at HACCP (Hazard Analysis and Critical Control Point). ATP measurement technique can be used successfully without any technical staff in order to train food processors and cleaning personnel on personal issues or kitchen hygiene, and to minimise possible errors that personnel may cause during applications. Morever, ATP bioluminescence method must be used after being integrated with microbiological tests as part of a compatible surface cleanliness monitoring system as it does not have similar functions with quantification of the microbial load on food contact surfaces (Aycicek et al., 2006).

ATP is one of the building stones with significant functions in energy transfer reactions of all cells (Ünlütürk and Turantaş, 1999). ATP bioluminescence method is indeed based on the formation of bioluminescence light as a result of the reaction of oxygen and luciferin enzyme in the presence of ATP (İpek, 2017). ATP hygiene monitoring system detects ATP in all animal, plant origin cells, mould and yeast cells. (Erkoç, 2019). In ATP bioluminescence method, the devices called luminometers and specially developed, are used. The sample, received from a parallel of 100 cm^2 surfaces, was placed in the swab compartment of the device by using the special swabs of the device. After the cover is closed, the reading is started and the relative light unit (RLU) value, read on the screen at the end of the time of measurement, is recorded (İpek, 2017; Öz and Özgen Arun, 2019). In Figure 4, sampling, placement of swab into the device and reading are demonstrated.

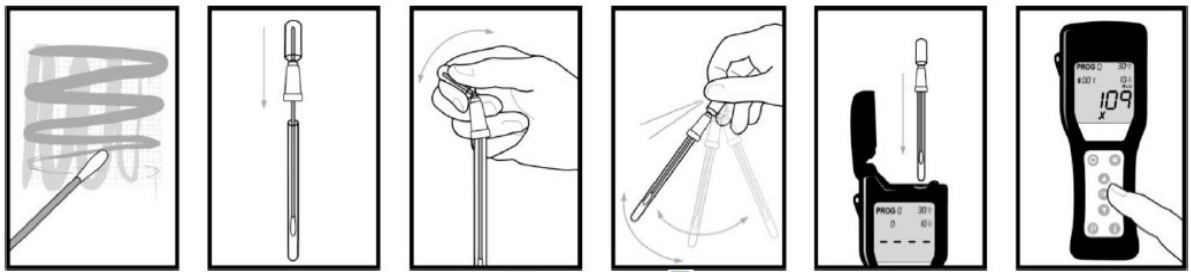

Figure 4. Basis of adenosine triphosphate (ATP) bioluminescence method (Anonymous, 2020)

In their study comparing the results of ATP bioluminescence and traditional hygiene determination methods in order to identify surface cleanliness in a hospital kitchen, Ayçiçek et al. (2006) found that there were more dirty surfaces than clean surfaces according to the ATP measurement results of steel meat processing bench, marble oven bench, wood meat processing bench, oven handle and tap head. In addition, the microbiological swab technique results for steel vegetable preparation bench, plastic meat processing bench, portable meat chopping table, portable vegetable chips tray, meat grinder, crushing machine, gastronome, meat and vegetable knives concluded that the number of clean surfaces was higher than dirty surfaces. In a similar, Öz and Özgen Arun (2019) performed tests on surfaces experimentally contaminated with different microorganisms by utilising ATP bioluminescence method and classical swab method in parallel. Moreover, it was stated that the most reliable results were obtained from the surfaces contaminated with *Salmonella.* İpek (2017) used ATP bioluminescence and standard swab method in the ezine cheese production line to specify the effectiveness of feasibility of disinfection with new disinfectant formulas. As a result of the study, common Bacillus spp. impurities were determined in process areas (36.75%), Enterobacteriaceae (25.64%) and Pseudomonas (23.93%) species.

The use of ATP bioluminescence technique is not also recommended in hygiene and sanitation practices at premises where dry cleaning methods are applied and the products, such as milk powder and flour are produced as product residues cannot be completely removed. The use of ATP bioluminescence technique is not recommended in hygiene and sanitation practices due to the adsorption possibility of sea-borne light-emitting bacteria in food premises that process fish and fish products. Ünlütürk and Turantaş (1999) urge that bioluminescence feature is found in lightning bugs, marine bacterium, some marine species and freshwater fish in the nature.

Use of swab methods in personnel hygiene and business sanitation monitoring

Hygiene is defined to be a science covering knowledge and applications required for the protection of health at every stage of human life and for ensuring the sustainability of the environment and human health. Personnel hygiene is described as keeping the body clean and all protective measures taken against the factors causing diseases. Personnel hygiene and health of individuals working in food premises affect food safety directly. For this reason, the personnel working in food premises must know and implement personnel hygiene rules and must have basic knowledge level regarding sanitation and kitchen at every stage where food is brought to our kitchen (Gürpınar et al., 2020).

Personnel hygiene is of paramount importance in ensuring ideal hygiene conditions at food premises, and the personnel working at food premises are one of the most important contamination causes. This type of personal illness, carelessness and negligence, is infecting and infecting other personality and plays the most important role in cross-contamination (Nerín et al., 2016). When evaluating individuals in terms of personal hygiene, there are differences between microbial loads on hands. In addition, there are natural differences due to skin flora, age, gender and geographical regions where lived in, physical and biological features of the skin area (Gürpınar et al., 2020).

Fields of administration

In the study carried out by Fida and Ağaoğlu (2004), in which they specified 20 restaurants as pilot in the region of Ağrı and examined these restaurants in terms of tool-equipment, environmental and personnel hygiene, they used the cotton swab method in taking samples from tool-equipment and other surfaces. As a result of the microbiological analyses, the samples received from the hands of the cook, working at the restaurants controlled, resulted in the primary sources of contamination, and general hygienic conditions of the restaurants examined in this study were not good.

In a thin sheet of dough plant, hands of personnel working in production and packaging were examined in terms of coliform bacteria and *Staphylococcus aureus* by utilising the swab-rubbing technique. Swabs soaked in sterile physiological saline were brought into contact with a surface of 5x5 cm for 20 seconds on the right-hand palm of the personnel, and the swabs were brought to the laboratory. Examination was made on suitable media for microorganisms. Accordingly, the number of coliform bacteria and *S. aureus* on the hand samples of the personnel working at the thin sheet of dough rolling section of all three facilities were found to be higher than the hand samples of the packaging personnel (Arda and Aydın, 2011). In the study (Dümenet al., 2019), 5 located in different geographical regions of Turkey and operates as a franchise under the same brand name 100 bakery business, has visited over 12 months. Visit him, he received a total of 6 swabs from a business, 3 from food contact surfaces and 3 from tools and equipment used in food production and sales. These swab samples were then examined regarding the parameters of total mesophilic aerobic

bacteria, coliform bacteria, *Escherichia coli* and *S. aureus*. The results showed that while the Marmara region had the lowest microbiological load, the Central Anatolia Region had the highest microbiological load.

Aydoğan (2016) identified Astrovirus (AsV), Norovirus (NoV) and Rotavirus (RoV), which are ranked among the most important factors of viral gastroenteritis cases, in the swab samples taken from the hands (palm, upper hand, fingers and fingernails) of 47 personnel working in the production department of 5 different milk and dairy products in Burdur City Center and Bucak District. At the end of the study, AsV, NoV and RoV virus antigens were not found in examined hand swab samples.

Swab samples were taken by sterile swab sticks from bench, cutting board, refrigerator handle, tap, dry storage shelf and serving spoons in 32 different meal preparation departments providing feeding programs to primary and secondary schools in Mpumalanga, Africa. In these swab samples, aerobic colony count, *Escherichia coli* O157:H7, *Salmonella*, *S. aureus* and *Listeria monocytogenes* identifications were performed. When the results were assessed in accordance with South African Government Regulation 962, it was found that bench top and dry storage areas had the worst results and that most of the food contact surfaces had insufficient hygiene conditions (Sibanyoni and Tabit, 2019).

Erkoç (2019) carried out a total viable bacteria count by taking swabs from vegetable and all surfaces, equipment and hand of personnel that vegetable contacted for each stage of vegetable until they are bought by consumers. For total bacteria count, culture was received from the vegetable to be tested under sterile conditions by touching the cotton tip of the swab, and then a measurement with a luminometer was performed. When evaluated regarding the total number of viable bacteria, the highest number of bacteria was found in the carrot vegetable during the service stage.

Various diseases may occur due to the transfer of microorganisms from the surfaces contaminated with pathogenic microorganisms to the body by hands. In this regard, in the study conducted in the province of İzmir, a total of 100 samples were taken from shopping carts in 20 different markets, and total viable count and *E. coli* analyses were performed. The total viable count on push arms of the shopping carts was determined to be in the range of 0,82-4,88 log kob/10 cm^2. No coliform and *E. coli* was detected. Therefore, it was reported that high number of microorganisms on the shopping carts may pose a risk for public health, and proper cleaning and disinfection operations should be specified and applied for shopping carts (Gündüz et al., 2019).

Tümer (2014) argued that he specified the effectiveness of the steam disinfection device used in surface cleaning and disinfection in kitchens that provide catering services by counting the breeding colonies after receiving microbial swab samples from different parts of kitchen surfaces, such as meat bench, vegetable cutting, floor, door handle and napkin box and 25 cm^2 area by damp rod for colony counting (*E. Coli* and *Acinitobacter Baumanni*) before and after the procedure. It was reported that when comparing microbial colony count after steam cleaning-disinfection, a significant decrease was achieved excluding meat bench. No difference was found on meat bench regarding colony examination before and after the cleaning.

In order to determine the qualification of hygiene training at cafeterias, Adenosine Triphosphate Bioluminescence Test (ATPBT) was performed by receiving samples from kitchen surfaces, kitchen tools and hand surfaces of personnel by means of swab before and after training periods. After providing a hygiene training, a decrease was observed in median values of ATPBT

scores regarding the surfaces of work benches, dining tables and tool-equipment. Knowledge level of the personnel should be increased to prevent foodborne diseases (FBD). In addition to these, this knowledge should also be put into practice. It was reported that the hygiene awareness of the personnel would be increased more by the measurability of the effectiveness of hygiene training and practices (Dere, 2018).

In the study in which ten different areas of cheese making rooms of 16 factories, including five food contact surfaces and five non-food contact surfaces, were sampled before and after food safety or sanitation training, samples were taken by swab for microbiological analyses. The designated area was sampled with the swab using two perpendicular sequences of "S" strokes, followed by a third diagonal streak, always with rotation of the swab to ensure contact of all parts of the swab surface. It was reported that these swabs were used in ATP bioluminescence method and microbiological examination. Surfaces and drainages were determined to be the areas with the highest microbial load at the end of analyses. It was also expressed that *Listeria* spp. was identified in 5 samples before training and in 3 samples after training at all factories, and no more than one sampling site was found to be positive at any factory, and the same sampling area was identified to be positive only at one factory both before and after training (Machado and Cutter, 2016).

In yoghurt production, samples were received from hands of personnel and surfaces by swab method for HACCP practices, and the steps of raw milk, pasteurization, yeasting, filtering and storage process were labelled to be critical control points (Karabıyık, 2006). 2 different swab samples were received from an area bounded by a sterile frame with an internal area of 15 cm^2 in order to sample the cutting boards and knife handles in food processing areas at university canteens. In the first swab, sterile cotton swabs to be used for counting of total coliform *E. coli*, *Enterobactericeae*, *S. aureus* and sulphite-reducing anaerobic bacteria were soaked with maximum recovery dilution agent containing 0.05% Sodium thiosulfate and then were applied on the surfaces of knives and cutting boards for 3 times in 3 directions. In addition, the second swab was taken directly into sterile tubes containing 10 ml half fraser broth and used for the pre-enrichment phase (Pamuk et al., 2018).

Aksu et al. (2017) reported that they used sterile swabs, which were moistened by sterile 1/4 Ringer's solution before sampling and then wiped on specified surfaces and finally transferred to a test tube containing sterile 10 mL 1/4 Ringer's solution, when taking samples from the food contact surfaces of hypermarkets for microbiological analysis. For taking samples from the hands of the personnel working at the food section and contacting with food, the sterile swab sticks moistened with 1/4 Ringer's solution were wiped on the 10 cm^2 area of the hands of personnel in perpendicular direction for 20 seconds. In the study investigated the number of *E. coli* and *S. aureus* on the hand samples and the number of total aerobic mesophilic bacteria (TMVB) and coliform bacteria on the samples taken from food contact surfaces, it was indicated that food hygiene, good manufacturing practices and HACCP system had to be followed in the food preparation and sales sections of the hypermarkets (Aksu et al., 2017).

In the study carried out by Yalçın (2018) in which Total Mesophilic Viable Bacteria (TMCB) and Enterobacteriaceae number of carcasses before and after cooling was specified by taking samples from a total surface of 400 cm^2 by sponge swab technique, it was concluded that there were mistakes related to hygiene during the cutting process in the slaughterhouse according to the values determined before cooling while the values specified after cooling suggested that there was a contamination caused by cold storage room, personnel and/or tool-equipment. It was also identified

in the same study that *Salmonella* spp., which should not be detected on lamb carcasses according to the Turkish Food Codex Microbiological Criteria Communiqué, was found on 3 carcasses before cooling and on a different carcass after cooling.

In another study, total aerobic mesophilic viable bacteria, coliform and fecal coliform bacteria, *S. aureus* and mould-yeast were counted, respectively by utilising the swab samples taken from the hands and clothes of the personnel working in hospital kitchens, which were considered to be contamination source during the preparation of food in hospital kitchens (Ünal and Özmen Togay, 2017). In the study in which a food poisoning occurred at a hospital cafeteria was examined, *B. cereus* reproduction was identified in the samples of bread board, robot switch button and oven opening lever and *B. cereus* was specified to be the cause of the epidemic as a result of microbiological analysis of swab samples taken from the kitchen environment. The contamination occurred during the consumption of salad with cross-contamination since the raw vegetables used in the salad were not washed adequately or the preparation areas and materials in the kitchen were not cleaned sufficiently (Terzi et al., 2018).

In another study to which 50 students enrolled in the department of Gastronomy and Culinary Arts participated, it was reported that the swab samples were received from hand before hand washing and after proper hand washing, and swab examinations were performed on Plate Count Agar (PCA) medium to count total aerobic bacteria. The study concluded that there was a decrease of 99% and above in the initial load of 41 students, 85-75% in 4 students, and 50% and below in 5 students. It was also argued that the awareness of these students, who would work at food and beverage services business, was raised regarding that they were the sources of cross-contamination and having information and implementing correct hand washing techniques (Gürpınar et al., 2020).

In the study performed by Kocatepe et al. (2011), in which they took samples by cotton swab method from three different fishing benches for microbiological control (from the shelf on which silver hake would be sold when fishing benches were clean in the morning and on the evening when the benches were not cleaned), they reported that they obtained the best results from the bench with nine sections, smooth floor, rounded corners, bottom cooling and sufficient slope for water drainage and made of stainless steel.

Hareket (2019) stated that samples were taken from extraction unit, extraction tank, filling tank and three filling units, used in the manufacturing of orange juice, before and after CIP in order to examine regarding the yeast, total mesophilic aerobic bacteria (TMAB) and lactic acid bacteria (LAB) parameters, and then yeasts in the environment were identified by molecular methods according to the findings obtained, and finally the microflora of the yeasts that were effective on the shelf life and quality of orange juices and spoil the freshly squeezed orange juice in the production and filling lines were determined.

CONCLUSION

Correct selection of tools and equipment to be used for healthy food production in the production area and hygienically valuable. At this point, various methods are used to detect personnel hygiene and business sanitation. It is important that the tools and equipment chosen for healthy food production in the production area are selected correctly and used hygienically. Swab method is a practical analysis method used in the detection of microorganisms regarding personnel hygiene and sanitation, surface control, environments and food. In our study, the application of swab method, which is one of the practical and widely used methods in the detection of

microorganisms related to personnel hygiene and sanitation, surface control, environments and food, has been discussed. At the same time, the traditional use of swab and ATP bioluminescence method were examined in detail in our study. In general, the use of ATP bioluminescence technique is recommended to give fast and reliable results, but it is not recommended for hygiene and sanitation use of ATP bioluminescence technique, except for product residues, in enterprises where drycleaning methods are applied, such as milk powder and flour. At this point, new swab analysis methods should be developed by taking these problems into consideration. In the swab analysis, it was emphasized that the swab material also affects the analysis sensitivity and the appropriate swab material should be used for appropriate analysis.

Briefly, with the swab method for the determination of personnel hygiene and facility sanitation, Total coliform bacteria, total mesophilic aerobic bacteria (TMAB), sulphite-reducing anaerobic bacteria, lactic acid bacteria (LAB), *Escherichia coli*, *Staphylococcus aureus*, aerobic colony count, *Escherichia coli* O157 : H7, *Salmonella*, *Listeria monocytogenes*, Acinitobacter Baumanni, Enterobactericeae, *B*. *cereus*, Astrovirus (AsV), Norovirus (NoV) and Rotavirus (RoV) have been detected in the literature review.

REFERENCES

Anonymous (2021a). *https://thedailychronicle.in/tag/global-medical-swab-market-analysis/.*(10.01.2021)

Anonymous (2021b). *https://www.kemitekskimya.com.tr/Product/Detail/17996/sunger-swab#.YAKeKl4zbIV*. (16.01.2021)

Anonymous. (2020). *https://www.kemitekskimya.com.tr/Product/Detail/20548/ultrasnap-surface atp#.YAKf2F4zbIV,* (13.03.2020).

Arda, Ş., Aydın, A. (2011). A study on the relationship of thin sheet of dough microbiological quality between quality of raw material and some hygiene parameters. *Journal of Faculty of Veterinary Medicine, Istanbul University. 37*(2), 135-147.

Aksu, F.Y., Altunatmaz, S.S., Uran, H., Altıner, D.D. (2017). The level of hand hygiene of sales staff and microbiological properties of food contact surfaces in the hypermarkets. *Journal of Faculty of Veterinary Medicine, Erciyes University*, *14*(1), 17-23.

Aycicek, H., Oguz, U., Karci, K. (2006). Comparison of results of ATP bioluminescence and traditional hygiene swabbing methods for the determination of surface cleanliness at a hospital kitchen. *International Journal of Hygiene and Environmental Health, 209*(2), 203-206.

Aydoğan, H. (2016). Investigation of Astrovirus, Norovirus and Rotavirus among employees of dairy plants. M.Sc. Thesis in *Mehmet Akif Ersoy University Graduate School of Natural and Applied Sciences Department of Food Engineering*, Burdur, Turkey, 46 p.

Căpriţă, A., & Căpriţă, R. (2005). Applications of biochemiluminescence in quality assurance of food products. *Agroalimentary Processes and Technologies*, *11*(1), 161-172.

CaPuto, P., FErri, E. N., Girotti, S., Gozzi, S., & SaraCiNo, P. (2011). Application of luminescent ATP rapid checks at ready-to-eat foods producing plant. *Czech Journal of Food Sciences*, *29*(4), 382-390.

Chollet, R., Ribault, S. (2012). Use of ATP bioluminescence for rapid detection and enumeration of contaminants: the milliflex rapid microbiology detection and enumeration system. *In Bioluminescence-Recent Advances in Oceanic Measurements and Laboratory Applications*. IntechOpen.

Dere, H. (2018). The influence of hygiene education on the hygiene status of foodhandlers in catering systems. Post Graduate Thesis. *Başkent University, Institute of Health Sciences, Nutrition and Dietetics*. 91 p.

Dümen, E., Çetin, Ö., Sezgin, F.H. (2009). Unlu mamül işletmelerinde temas yüzeylerinin ve aletlerin mikrobiyolojik kirliliğinin araştırılması. *Türk Mikrobiyoloji Cemiyeti Dergisi*, *39*(3-4), 108-114.

Erkoç, Ö. (2019). Microbiological Assessment of Some Raw Eaten Salad Vegetables. *Hacettepe University, Graduate School of Health Sciences*, Nutritional Sciences Master's Degree Thesis, Ankara, Turkey, 60 p.

Fidan, F., Ağaoğlu, S. (2004). The Investigation of Hygiene Status of Restaurants in Ağrı Region. T*he Journal of The Faculty of Veterinary Medicine University of Yuzuncu Yil, 15*(1-2), 107-114.

Gündüz, G.T., Akgül, Ö., Demir, Ş.B. (2019). Investigation of Microbiological Status of Shopping Carts. *Turkish Journal of Agriculture- Food Science and Technology*, 7(8), 1132-1137.

Gürpınar, S., Ağan C., Özer Ç. (2020). Gastronomi Ve Mutfak Sanatlari Öğrencilerinin El Hijyen Uygulamalari: İstinye Üniversitesi Örneği, *Turizm Ekonomi ve İşletme Araştırmaları Dergisi*, *2*(1), 5-17.

Hareket, S.A. (2019). Study on determination of yeast causing deterioration in orange juice production line. MSc Thesis. *Cukurova University, Institute of Science Department of Food Engineering*. Adana, Turkey, 63 p.

İpek, D. (2017). Applicability of Ezine cheese process lines disinfection by new disinfectant formulas: antibiofilm-antiquorum sensing agents. *Doctoral Dissertation in Food Science, Çanakkale Onsekiz Mart University Graduate School of Natural and Applied Sciences*. Çanakkale, Turkey. 166 p.

Jansson, L., Akel, Y., Eriksson, R., Lavander, M., Hedman, J. (2020). Impact of swab material on microbial surface sampling. *Journal of Microbiological Methods*, 176, 106006.

Karabıyık, S. (2006). Defining the microbylogical critic control points in manufacturing of strained yoghurt. MSc Thesis. *Selçuk Üniversity Graduate School of Naturel and Applied Siences Department of Food Engineering*, Konya, Turkey, 63 p.

Kocatepe, D., Taşkaya, G., Kaya, Y., Turan, H., Erkoyuncu, İ. (2011). Farklı balıkçı tezgâhlarının mikrobiyolojik yönden incelenmesi. *Research Journal of Biology Sciences, 4*(2), 73-77.

Larson, E. L., Aiello, A. E., Gomez-Duarte, C., Lin, S. X., Lee, L., Della-Latta, P., & Lindhardt, C. (2003). Bioluminescence ATP monitoring as a surrogate marker for microbial load on hands and surfaces in the home. *Food microbiology, 20*(6), 735-739.

Luo, J., Liu, X., Tian, Q., Yue, W., Zeng, J., Chen, G., & Cai, X. (2009). Disposable bioluminescence-based biosensor for detection of bacterial count in food. *Analytical biochemistry, 394*(1), 1-6.

Machado, R.A., Cutter, C.N. (2017). Sanitation indicators as a tool to evaluate a food safety and sanitation training program for farmstead cheese processors. *Food Control, 78*, 264-269.

Nerín, C., Aznar, M., Carrizo, D. (2016). Food contamination during food process. *Trends in Food Science & Technology*,*48,* 63-68.

Sibanyoni, J.J., Tabit, F.T. (2019). An assessment of the hygiene status and incidence of foodborne pathogens on food contact surfaces in the food preparation facilities of schools. *Food Control, 98*, 94-99.

Triva, D. (2019). *U.S. Patent No. 10,517,575*. Washington, DC: U.S. Patent and Trademark Office.

Tümer, G. (2014). Buharlı Dezenfeksiyon Cihazının Mutfak Yüzeylerinin Temizliği ve Sanitasyonu Üzerine Etkinliğinin Değerlendirilmesi. *Beslenme ve Diyet Dergisi, 42*(1), 37-42.

Ünal, M. M., Özmen Toğay, S. (2017). Determination of hygienic condition in surface samples and hygiene awareness of working personnel of hospital kitchens in Istanbul. *Turkish Bulletin of Hygiene and Experimental Biology*, *74*(4), 307-320.

Ünlütürk, A., Turantaş, F. (1999). Gıda Mikrobiyolojisi. İkinci Baskı, Mengi Tan Basımevi, İzmir. 598 s.

Öz, P., & Arun, Ö. Ö. (2019). Evaluating the performance of ATP bioluminescence method by comparison with classical cultural method. *Food and Health*, *5*(2), 77-82.

Pamuk, Ş., Erdoğan, M., Yıldırım, Y., Hızlısoy, H., Serhat, A. L., Sepin, Ö. (2018). Üniversite kampüs kantinlerindeki gıdaların mikrobiyolojik kalitesinin ve gıda çalışanlarının el hijyen durumlarının değerlendirilmesi. *Kocatepe Veteriner Dergisi,* 11(4), 363-373.

Terzı, Ö., Özdemır, Ş., Selçuk, M. Y. (2018). Bir Hastane Yemekhanesinde Yaşanan Gıda Zehirlenmesinin İncelenmesi. *Türk Hijyen Ve Deneysel Biyoloji Dergisi*, 280.

Yalçın, Y. (2018). Determination of the effect of cooling on the microbiological quality of lamb carcasses. *Adnan Menderes University, Institute Of Health Sciences, Department Of Food Hygiene And Technology Master's Thesis*, 56 p.