Novel Natural Disinfectants for Contaminated Cosmetic Application Tools

Amera M. Al-Rawi[1], * Shababa A. Bahjat[1], May A. A. Al-Allaf[2]
Department of Biology, College of Science[1], Environmental Research Center[2], Mosul University/Iraq. Correspondence author
E mail: umnashwa@yahoo.com

Abstract

Background: Makeup can get contaminated by inadequate preservative capacities, poor handling procedures during manufacturing and in use contamination. Makeup application tools like tweezers, scissors, and a variety of brushes and sponges are also a potential breeding ground for bacteria. Bacterial growth can occur when these tools are shared or used for a prolonged period of time without washing.

Aim: The present study attempted to find a novel, effective, economic and easy to use natural disinfectants that can be effective in inhibiting bacterial contaminants from cosmetic application tools.

Materials and Methods: A total of 35 multiuse tools (10 brushes and 15 face sponges) were collected from University Girls' Dormitory/ University of Mosul. Two concentrations (1,5, and 10%) of Aluminum potassium sulfate (alum) and sodium bicarbonate (baking soda) were evaluated for the first time for antimicrobial activity.

Results: Microbial analysis showed that brushes harbored more bacterial contamination than sponges. The most prevalent pathogenic bacteria were found to belong to the genera *Staphylococcus, Bacillus, Proteus, Klebsiella* and other lactose and non-lactose fermenters. Results showed that both compounds were effective in inhibiting growth of all bacterial isolates over a 24 hr. treatment period especially at higher concentrations (10%).

Conclusion: This study demonstrated the feasibility of alum used in debridement removing activity and a disinfecting agent based on antimicrobial activity against facultative anaerobic bacterial isolates which are best representing sponge and brush contaminants An advantage of $NaHCO_3$ and alum over other antimicrobial agents is its safety, availability , ease and low cost.

Key words: Alum, Sodium bicarbonate, disinfection, cosmetic application tools

Introduction

Makeup can get contaminated by inadequate preservative capacities, poor handling procedures during manufacturing and in use contamination. Cosmeticians use a variety of beauty accessories like tweezers, scissors, and a variety of brushes and sponges for makeup application and for skin care treatments. Makeup application tools are also a potential breeding ground for bacteria. Bacterial growth on powder brushes and foundation sponges can occur when these tools are shared or used for a prolonged period of time without washing.[1] Many women even share makeup and applicators with friends and their family, increasing their chances of facial infection. Skin pathogenicity due to repetitive use of salon tools has gained tremendous intimidation over the past several years [2].

The rich texture of cosmetic creams are mainly due to moisture content, presence of essential minerals and growth factors, which provides a broad spectrum of inorganic and organic compounds and a suitable environment for the growth of microorganisms **[3].** Small natural or synthetic sponges and brushes are common tools used in daily hygiene or applying and removing make-up. Microbiological studies performed on natural and synthetic sponges assessed them as reservoirs and vehicles in the transmission of such potential pathogenic

species [4]. In addition to that and which many young women are unaware of; repeated use of same brush to apply facial makeup causes spread of microbial contamination. These microorganisms and debris from the skin are transferred to cosmetic products, where they may eventually be capable of reproducing. Once established, the organisms are then transferred back to the user or users via the applicator. Much of the concern is related to the fact that many applicator formats and mechanisms can provide the ideal environment for the capture, retention, and proliferation of microorganisms.

Depending on the applicator composition, structure, and configuration, the risk factors associated with intended use can be considerably influenced. Applicators that can physically trap and retain moisture, sebum, skin cells, dirt, and microorganisms create the greatest problems and have the greatest probability of contributing to significant, high –risk contamination transfer. Sponges trap cellular debris contaminated products while providing the perfect environment for microbial survival and growth. Natural sponges may provide additional organic nutrients to the mix that could serve to further exacerbate the problem. Frequency of product application also plays a major role in the risk potential associated with tools **[5].** The major cause of contamination of saloon tools is repetitive usage on all costumers without considering the hygienic conditions [6].

Natural products have been used for centuries in treating human diseases and they contain components of therapeutic value. Natural products are environmentally safer, easily provided, and cheap [7]. Alum (Aluminum potassium sulfate): the crystallized double sulfate with the formula $KAl(SO4)_2.12H_2O$, are generally odorless, colorless crystalline solids that turn white in air, which is used as an astringent and antiseptic in various food preparation processes such as pickling and fermentation and as a flocculants for water purification. Other names of this mineral medicine include Alumen, Bai Fan, Ku Fan, Alumen mineral, alum herb, aluminum potassium sulfate, aluminum sulfate, alum powder, powdered alum, Alunite and white alum. Food and Drug Administration (FDAs) over the counter advisory panel has recommended alum as category I active ingredient in mouthwashes [8]. Natural alum stone is a translucent crystalline colorless stone, used topically to perform antibacterial and astringent action [9].

Sodium bicarbonate is a white, odorless, crystalline powder. It decomposes when heated over50^{o}C and therefore a melting and boiling point cannot be determined. Sodium bicarbonate is an inorganic salt and therefore the vapors pressure can be considered negligible. Its water solubility is 96 g/l at 20^{o}C. Grades with different average particle size diameters (d50) are placed on the market. The average particle size diameter of the different sodium bicarbonate grades can range between 15 and 300 µm. Sodium Bicarbonate has long been known and is widely used. The salt has many related names such as baking soda, bread soda, cooking soda, and bicarbonate of soda. It has anti-caries and abrasive properties [10].Sodium bicarbonate with its high pH, disinfectant and antiseptic properties, is commonly prescribed for oral rinses to reduce periodontal pathogens by killing off acid-loving bacteria while alkalinizing the mouth [11].

The present study attempted to assess the role of sponges and brushes as reservoirs and vehicles in the transmission of potentially pathogenic bacterial species. In addition to that, an attempt to utilize two novel natural remedies for disinfecting these tools was made. Alum and sodium bicarbonate with 3 different concentrations were evaluated for elimination of bacterial contaminants in cosmetic application tools.

Materials and Methods

Sampling

A total of 25 multiuse face sponges and brushes were collected from the College Girl's Dormitory /University of Mosul.

Media

Mannitol salt agar, Nutrient agar, Blood and MacConkey agar were used for the detection of *S. aureus, Pseudomonas aeruginosa*, and gram negative enterobacteria. Media were prepared according to manufacturer's details. A serial dilution for each sample was spread on respective media plates and incubated at 37°C for 18 hrs (overnight).

Evaluation of alum and sodium bicarbonate antibacterial effect

A sample of a multiuse face sponge and brush was used to evaluate the potential of alum and sodium bicarbonate as an effective over the counter novel disinfection method that is simple, effective and economical. The sample (face sponge) was aseptically cut into 4 parts. Each part was placed in 50 ml of Tryptic soy agar in each of four flasks. Brush samples were used as a whole (were not divided) and treated in a similarly. The first flask was left without treatment (control) and was soaked for 2 hrs. The second, third and fourth flasks were supplied with 1, 5, and 10 % weight/volume alum (powder) respectively (Figure 1).

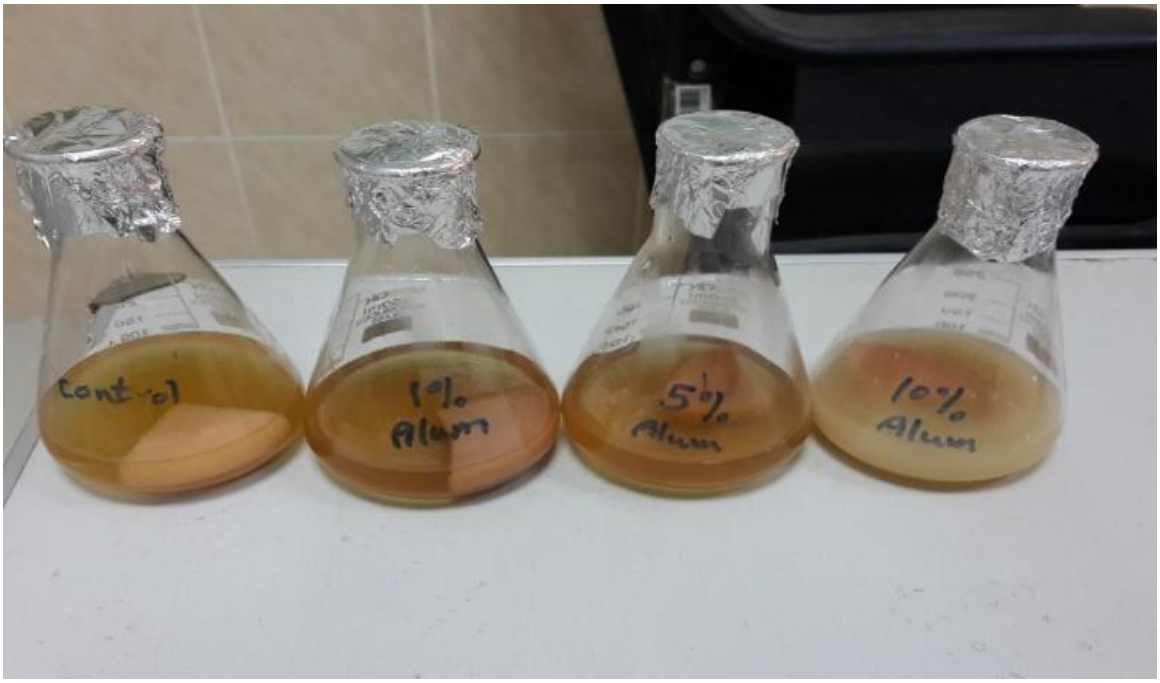


Figure (1) : Evaluation of different concentrations of alum in TSB in disinfecting sponge bacterial contaminants

Serial dilutions of all flasks were made and spread on four types of media; Nutrient, MacConkey , Blood and Mannitol Salt agar . All plates were incubated aerobically for 24 hrs. at 37ºC. The same process was repeated for Sodium bicarbonate. Visual growth density was examined as a measure of antibacterial effect. Bacterial isolates were identified by gram stain and biochemical conventional methods.

Results and Discussion

Contamination retention and contamination transfer are two of the most significant risk factors associated with cosmetic product applicators (tools). The function of tools is to facilitate the transfer of product from the primary cosmetic to the targeted area. These targeted areas often include face, neck, eyebrows…etc. Tools designed for use in sensitive areas around the eye and mouth are of most concern since they may have the greatest potential vulnerability to microbial contamination during use.[12].

Microbiological contamination of 15 cosmetic face sponges and 10 cosmetic brushes (multiuse by college dormitory students) were evaluated. The result of this first part of the investigation is reported in Figure 2.

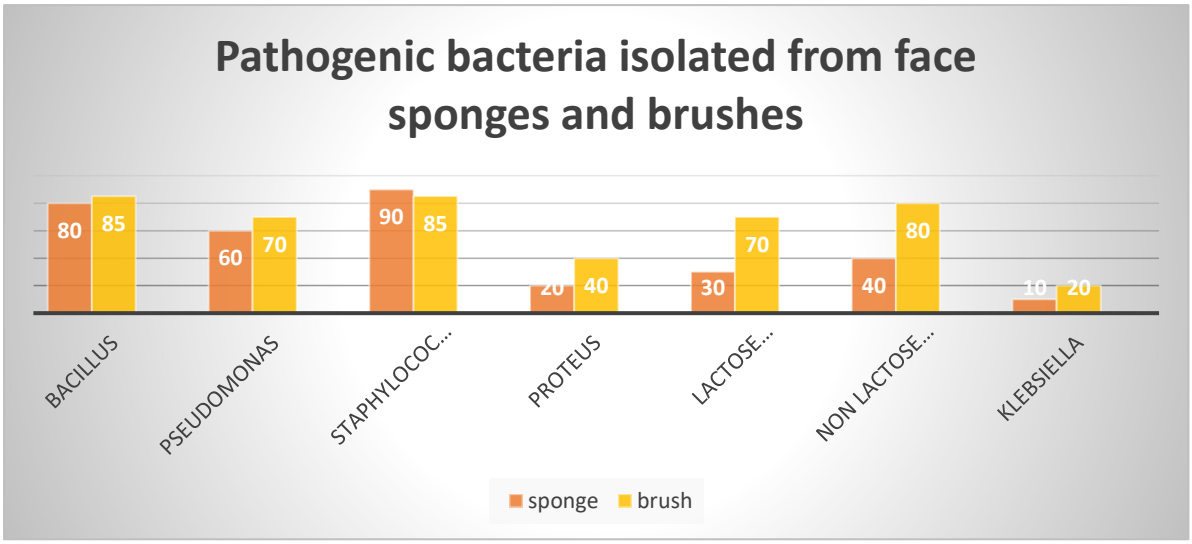


Figure (2): **Percentage of potentially pathogenic bacteria isolated from cosmetic tools.**

As shown, cosmetic face brushes harbored a higher percentage of contamination as compared with sponges which agrees with others [6]. This could be due to the larger surface area of the brush and pathogens are reported to adhere to the poly ethylene oxide PEO brush coatings very well [13]. Bacterial growth on powder brushes and foundation sponges can occur when these tools are shared among friends or used for a prolonged period of time without washing.

In the present study, the most frequently isolated bacterial contaminants were *Staphylococcus aureus* and *Bacillus spp. S. aureus* was isolated from 90 and 85 % of brushes and sponges and are among the most important bacteria that cause pus forming diseases such as boils, carbuncles, folliculitis, impetigo contagiosa, and scalded skin syndrome [14].

Other bacteria such as *Micrococcus and Bacillus* come from household dust and dirty surfaces. Figure 2 shows a high percentage of *Bacillus* from 85 and 80% of brushes and sponges respectively. These spore-formers are difficult to kill [15]. Preservatives which are added to cosmetic products control only the vegetative form of bacillus species, but do not kill their spores [16].

Bacterial species of environmental origin, belonging to the Enterobacteriaceae, like *Pseudomonas*, and gram negative lactose non- fermenting rods were also isolated and were considered opportunistic pathogens [17]. Unclean fingers or makeup brushes can spread anything from herpes to pink eye. Mwambete and Simon, [18] confirmed that the most frequently isolated and identified microbial cosmetic contaminants were attributable to Proteus *mirabilis*, *Staphylococcus aureus*, and *Bacillus*, consequently this may explain their presence in cosmetic tools.

By adapting the proper preventive precautions such as disinfection and proper washing of these tools, the microbial contamination can be controlled. Accordingly, the current study attempted to find a simple, economic natural product that can be effective in disinfecting cosmetic tools . Different concentrations of alum and sodium bicarbonate solutions were prepared (1,5,10%). This study demonstrated the feasibility of alum used in debridement removing activity and a disinfecting agent based on antimicrobial activity against facultative anaerobic bacterial isolates which are best representing sponge and brush contaminants.

A gradual decrease in bacterial growth was noted with the increase in concentration of alum and sodium bicarbonate. Complete inhibition of bacterial growth was established in the 10% concentration (figure 3). In this study, no attempt was made to test all associated organisms, because cosmetic contamination are poly microbial, the antimicrobial sensitivity testing of all associated organisms is difficult and produce a great deal of confusing data. [8]. The mechanism behind alum is that it can effectively prevent the propagation of bacteria by its ability to strongly coagulate proteins. Clinically it is widely used for the treatment of a variety of diseases, such as chronic otitis media, *Pseudomonas aeruginosa* infection in burn wounds, canker sores, acne, cold sores, etc. It has a broad spectrum of antimicrobial activity and shows varying degrees of inhibitory effect on many Gram-positive cocci and negative bacteria, some anaerobic bacteria, dermatophytes, and *Candida albicans*. Finally, it has an obvious inhibition on *Pseudomonas aeruginosa, Escherichia coli, and Staphylococcus aureus* [19]. Bestoon [8] also demonstrated that the degree of cleanliness obtained with alum solution (concerning debris and smear layer), was highly satisfactory.

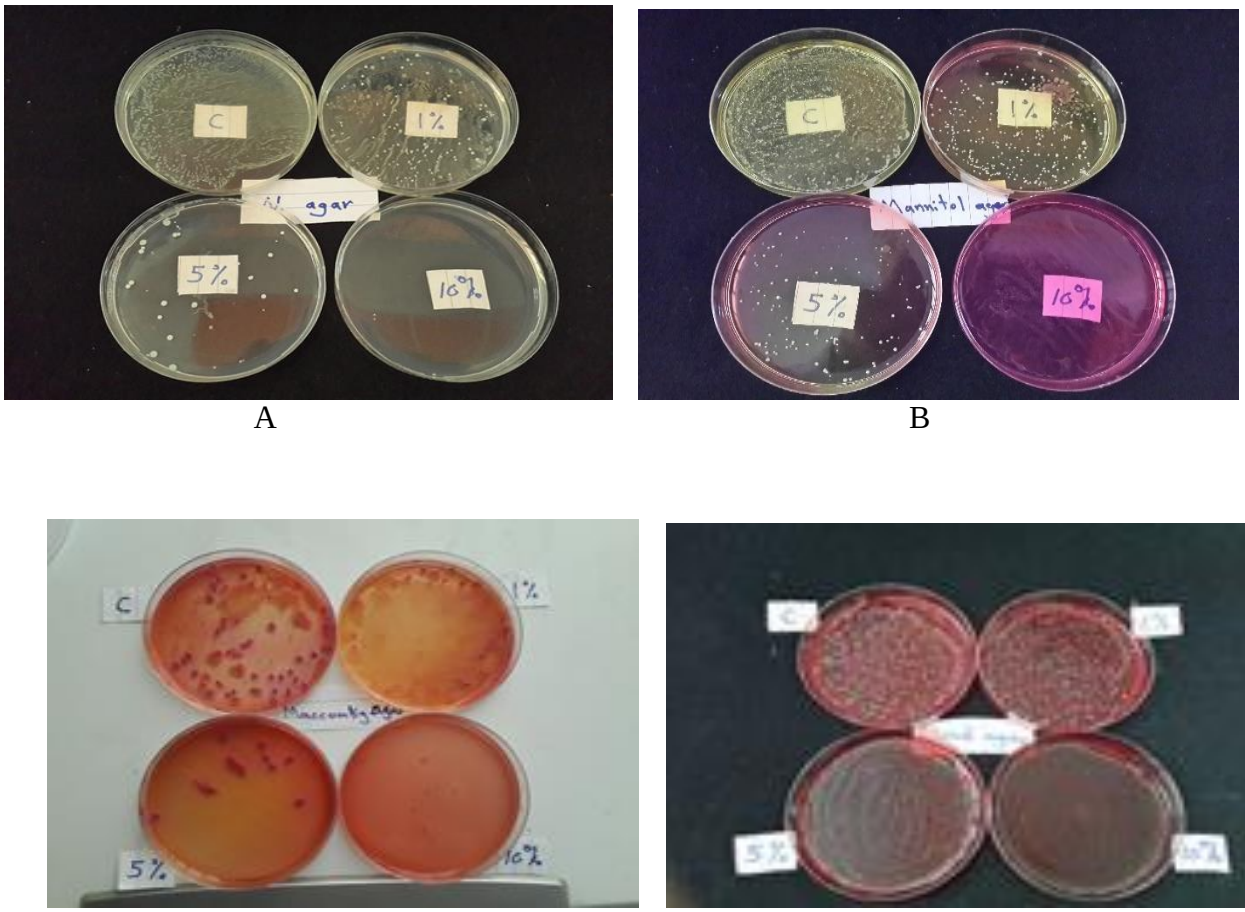
A study of Dutta [20] reported the bactericidal activity of potash alum when added to water, against various epidemic causing enteric pathogens like *Vibrio cholerae* 01, *V. cholerae* 0139 and *Shigella dysenteriae* 1 by lowering the pH of water from 6.0 to 4.0 [20]. A study of Al Ani, [21] showed that one of the many benefits of alum is the antibacterial effect on *Pseudomonas aeruginosa*.

Because previous studies [9,22] have shown that high concentrations of sodium bicarbonate inhibit or slow bacterial growth, it was hypothesized that the results of this study would mirror these findings. Results of the current study showed a pronounced effect in eliminating gram negative and gram positive bacteria on nutrient and MacConkey agar at a concentration of 10%(fig 4). This correlates with the fact that one of the main global applications for (5%) sodium bicarbonate is in detergents and other household cleaning products [23].

Another study suggested that sodium bicarbonate could be potentially used to eliminate *E. coli* contamination in oysters [24]**.** Gawande *et al.* [25] concluded that environmentally friendly and biologically safe compounds such as Sodium bicarbonate was effective in inhibiting as well as dispersing biofilms in dental unit water line-associated bacteria and yeast**.**

Also, NaHCO3, has particular significance in dentistry because of its ever-growing use in dentifrices and mouth rinses. It is appealing for its safety, low cost, low abrasivity, water solubility, acid buffering properties, and in high concentrations, antibacterial properties. Because of its alkalinity, or buffering capacity, sodium bicarbonate has the ability to neutralize acids produced by the microbes. Another factor in sodium bicarbonate's bactericidal abilities comes from changes in osmotic pressure. The hypertonic sodium bicarbonate solution causes the more hypotonic microbial cell to lose water, consequently dehydrating and eventually killing the cell.Although these are all desirable outcomes, some studies have shown that the sodium bicarbonate must be allowed to interact at least 30 minutes with the bacteria cell to be fully effective. Fletcher *et al*. [26] showed that sodium bicarbonate had no effect on the viability of *Streptococcus. mutans* when exposed only for a short time**.**

In conclusion, an advantage of NaHCO3 and alum over other antimicrobial agents is its safety, availability and low cost .



A B

C D

Figure (3) Inhibitory effect of 1,5 and 10 % alum on bacterial contaminants ; (A) Nutrient agar, (B) Mannitol Salt Agar (C) MacConkey agar and (D) Blood agar.

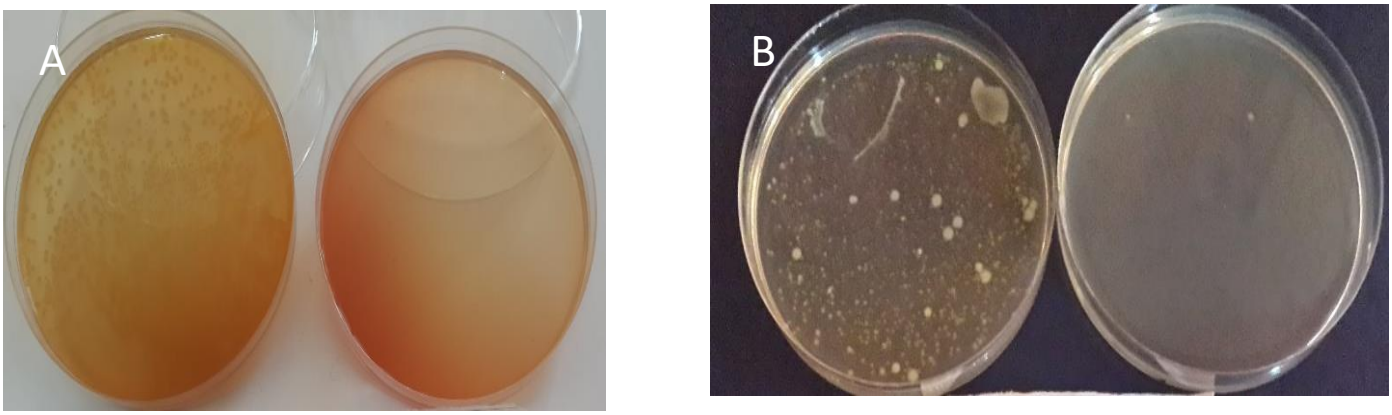


Figure (4): Effect of 10% Na- bicarbonate on bacterial contaminants in (A) MacConkey agar (B) Nutrient agar

References

1.Noah N. A.Guide to Hygienic Skin Piercing. In: Milady's Standard Textbook for Professional Estheticians, Milady Publishing Co., New York, pp. 1-11, 1995.
2. Dadashi L, Dehghanzadeh R . Investigating incidence of bacterial and fungal contamination in shared cosmetic kits available in the women beauty salons. Health Promot Perspect 2016;6(3):159-163.
3.Kabara J.; Orth, D. Preservative-free and self-preserving cosmetics and drugs. In: Principles for Product Preservation (USA,) pp. 1-14,1997.
4.Zichichi L;AstaG;Noto G. Pseudomonas aeruginosa folliculitis after shower /bath exposure. International Journal of Dermatology 2000;39:270-3.
5.Dayan N.; Lambros K. Formulating, packaging, and marketing of natural cosmetic products. By John Wiley &Sons Incorp. Hoboken, New Jersey, 2011.
6.Naz S ; M. Iqtedar; Q. ulAin; K. Aftab. Incidence of human skin pathogens from cosmetic tools used in beauty saloons from different areas of Lahore, Pakistan. J. Sci. Res.2012; 4 (2): 523-527 .
7.Osuala F.I. Evaluation of the efficacy and safety of alum in the treatment of tuberculosis, ecotoxicology laboratory, Department of Zoology, University of Lagos, Nigeria, European J. of Biol. Sci. 2009;1 (1): 10-14.
8.Bestoon M. Evidence for feasibility of aluminum potassium sulfate (alum) solution as a root canal irrigant, J Bagh College Dentistry 2012; 24 (1):1-5.
9.Abdulkarim K. Al-Zomor; Moharram A.; Al-Absi N. Formulation and evaluation of potash alum as deodorant lotion and after shaving astringent as cream and gel. International Current Pharmaceutical Journal. 2014;3(2): 228-233.
10.SiljeStorehagen; NannaOseogShilpiMidha. Dentifrices and mouthwashes ingredients and their use. Institutt for kliniskodontologi. Universiteteti Oslo, 2006.
11.Coskunses F. Sodium bicarbonate mouth rinse: An Uncommon Complication . Journal of case reports. 2012;2(1):4-5 .
12. Bird K. Alcan creates rolling sponge applicator for L'Oreal. Cosmetics Design.com. Decision News Media .Sept 22,2009.
13.Roosjen A ; H. J. Busscher; W. Norde ; H. C. Vander Mei . Bacterial factors influencing adhesion of Pseudomonas aeruginosa strains to a poly(ethylene oxide) brush. Microbiology 2006;152: 2673-82.
14.Enemuor S.; Ojih M.; Isah S.; Oguntibeju O. Evaluation of bacterial and fungal contamination in hairdressing and beauty salons. African j microbial Res.2013; 7 (14) : 1222-1225.
15.Al-Hasso, M.; Khalaf, S. Resistance of some gram negative enteric Bacilli isolated from lower respiratory tract infections of ß-lactamase antibiotics. Raf J of Scie. 2013;24(6): 66-79.
16.Siegert W. Microbiological quality management for the production of cosmetics and detergents. English Edition. International Journal for Applied Science.2012;138:1-9.
17.Noore, H.; Shareef, A. Isolation and identification of bacteria contamination the operating theaters. Raf J of Scie. 2005;16(8): 237-250.
18.Mwambete K.; Simon A. Microbiological quality and preservative capacity of commonly available cosmetics in Dar es Salaam, Tanzania. East and Central African Journal of Pharmaceutical Sciences 2010;13 3- 11 .
19.Yue W; Liu WH; Wang LF; Fu SX; Li YS; Kong ZK; Tang ZX; Chen ZL Zhongguo Zhongya Zazhi . China Journal of Chinese Materia Medica, 1989;14(2):42-5.
20.Dutta S; De S.; Bhattacharya SK . In vitro antimicrobial activity of potash alum. Indian J Med Res. 1996;10 (4):157-9.

21.Al Ani M. Evaluation of some prepared solutions from some medical plants and chemicals on Pseudomonas aeruginosa, Higher Diploma thesis; Institute of Genetic Engineering and Biotechnology for Postgraduate Studies, Baghdad University,2004..
22.Miyasaki K.; Genco R.; Wilson M . Antimicrobial properties of hydrogen peroxide and sodium bicarbonate individually and in combination against selected oral, gram-negative, facultative bacteria. J Dent Res. 1986;65(9): 1142-8.
23.UNEP Publications . Sodium Bicarbonate. SIDS Initial Assessment Report For SIAM 15 Boston, USA, 22-25 October, 2002.
24.Labaiden M.; Kasai H.; Yoshimizu M.; Direkbusrakom S. Elimination of Escherichia coli from oysters using sodium bicarbonate .Walailak Journal of Science and Technology (WJST) . 2013;10(6):601-606.
25. Gawande P.; LoVetri K.; Yakandawala N.; Romeo T.; Zhanel G.; Cvitkovitch D.; Madhyastha S. Antibiofilm activity of sodium bicarbonate, sodium metaperiodate and SDS combination against dental unit waterline-associated bacteria and yeast. Journal of Applied Microbiology. 2008;10(5): 986–992.
26.Fletcher R.; Brastins E.; Albers A.; Conway J. The effect of the Keyes procedure in vitro on microbial agents associated with periodontal disease. Quintessence Int. 1984;15(3): 329-334.