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HURDLE TECHNOLOGY: a self preserving technique in cosmetics

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Abstract:

Additives are added to the product for fundamental reasons; that are to avoid microbial spoilage. In this paper, traditional additive are supplanted by other cosmetic ingredients with the antimicrobial properties. Furthermore, this is usually alluded to be as hurdle technology. "Hurdle technology", an innovation that has been utilized for the breaking point of product security inside the food scruples since 1970s, has other than been useful for the get together of self preservative cosmetics. 'Hurdle technology' could even be a term need to depict the keen blend of different additive factors or hurdles to crumble the expansion of microorganism. Dependability to existing great manufacturing practice, appropriate packaging, and sensitive cautious determination of the type of the emulsion, low or high pH value and low water activity are critical factors for the control of microbial development in superficial formulation. This review paper depicts the appliance of the fundamental standards of 'hurdle technology' inside the assembly of self-additive cosmetics. Multi-functional antimicrobial ingredients and plant determined fundamental oils that are utilized as optional or natural additive.

Keywords*: Hurdle technology, preservation strategies, natural preservative, self-preservative, multifunctional antimicrobial ingredients.*

1.0 Introduction:

The word "cosmetics" comes from the Greek "kosm tikos," which means "having the ability to arrange, skilled in adornment," and "kosmein," which means "to beautify," and "kosmos," which means "order, harmony" [1]. “Cosmetic product” is defined as “any mixture or substances intended to be placed in touch with external parts of human body (lips, nails, epidermis, hair system, and external genital organs) or with the teeth and mucous membranes of the oral cavity with the sole or primary purpose of cleaning, perfuming, or changing their appearance.” In the 1980s, dermatologist Albert Kligman popularized the term "cosmeceutics" (active cosmetics). This phrase refers to products that combine cosmetics and pharmaceuticals that can have a favorable effect on skin but are not deemed to have a clear biological therapeutic impact (e.g., certain bleaching agents, retinol, etc.)[2].

The past few decades has shown it is difficult to find preservatives that have the strong antimicrobial impacts expected to guarantee the wellbeing of cosmetics and also are gentle enough to concern purchasers or contrarily interface with different ingredients. Reacting to these difficulties, Inolex reconsidered how to get antimicrobial properties into the cosmetics. The outcome is Hurdle technology, an idea acquired from food science. In the cosmetics, the microbial safety is generally of specific significance in the industry. since microbial course can harm the skin or acquire contact with harmed skin and microbes, which may imperil the strength of the customer furthermore, spread the infection. preservatives are antimicrobial synthetics added to cosmetics to shield them from microbial problems brought about by crude materials, customers, and production.

Paraben, the generally utilized preservative on the world, has insignificant estrogenic properties. Since there is a doubt of a association between the presence of parabens in breast carcinoma and breast issues [3, 4]. Lately, there has been a developing interest inside the improvement of preservative-free productions. These aqueous productions are usually made microbiologically steady by appropriate packaging and sterile production. However, this methodology probably won't work for the premier cosmetics packed in multi-use containers. It is to be commented that the basic definition for preservative-free method means the product doesn't contain substances that are named as preservatives predictable with the cosmetic legislation. Thus, the term 'Hurdle technology' is more proper than preservative-free.

The objective is to dam the development of microorganisms by fixing different hindrances in their way that should each diminish the microorganism number yet not murder the entire population. Every obstruction should allow a decreased enduring population so as that on the grounds that the amount of obstructions becomes the quantity of survivors will be diminished and eventually become null. Number of the creatures may beat the essential hurdle; of these that endure, some may defeat the second then forward until none endure the last hurdle. This survey article momentarily audits the methods utilized for the get together of non-traditionally preserved following the idea of 'Hurdle technology'. Multi-functional ingredients, plant-inferred fundamental oils with antimicrobial properties that are utilized as natural or alternative preservatives.

➢ The basic principles of self-preserving Hurdle technology are:

- pH control
- Appropriate packaging
- Good manufacturing practice (GMP)
- Water activity
- Multifunctional antimicrobial ingredients

2.0 Types of micro-organism:

There is no wrong preservative or right preservative for each circumstance as there is no set in stone stabilizer for every equation. The selection of ingredients that is utilized is, even today, to a great extent observational. Since when conservation is referred microorganisms usually come to mind, those found in cosmetics as impurities are gone over exhaustively.

2.1 Bacteria: -

The microorganisms are significantly more hard to make speculations regarding than either forms or the yeasts. Most microscopic organisms are tiny, around 0.5 to 3 microns, microbes are single celled organic entities that recreate by double parting, are influenced by osmotic pressing factor and surface pressure, and as a rule murdered by high temperature. a few microorganisms those are found in the climate are gainful just as unsafe. The pH needed to develop that between 7.2 to 7.6. examples are[5]:

- Harmful bacteria-
- Bacillus subtilis
- Escherichia coli
- Staphylococcus albus
- Beneficial bacteria-
- Monococcus
- Lactobacillus
- Bifidobacterium

Microbes grow in water	**Microbes in oil Pseudomonas**
Escherichia coli	Bacillus subtilis
Salmonella	Micrococcus roseus
Vibrio	Corynebacterium sp
Cyanobacteria	Micrococcus roseus

Table 1: microorganisms growing in water and oil.

2.2 Fungus:

A fungus is from the group of eukaryotic microorganisms such as yeast and molds.

2.2.1 Molds: -

Molds are filamentous fungi and are generally disseminated all through the earth in water and soil, and as the parasites in animals and plants. They are multi-cellular and unicellular parasites. Their normal size is around 30 micron diameter. They require darkness to grow and moisture and they grow best at room temperature. The pH should be somewhere in the range of 2 and 5.5, however the solitary pH for them is 4.5 to 5.5[5].

- The followings are likely the most successive molds found in the cosmetics: Examples are-
- Aspergillus

- Penicillium
- Mucor Mucedo
- Rhizopus

2.2.2 Yeast: -

Yeast are unicellular life forms containing no chlorophyll, however they contain pigments (red, yellow, green, pink or black). They are doing not frame hyphae, are keep away from or circular fit, and normal around 5 micron in measurement, yet they will be somewhere in the range of 5 to 30 micron long. Most yeast will develop best on any medium containing fermentable sugar, will develop over a pH scope of 2.2 to 8, and as a rule develop best at room temperature. They ordinarily require a bountiful measure of oxygen to develop.

- The following are presumably the most successive yeast found in cosmetics [5].
- Cryptococcus
- Saccharomyces
- Zygosaccharomyces
- Candida

3.0 Preservation strategies:

Cosmetics production involves a variety of ways to prevent microbial contamination without compromising the product's characteristics. The phrase "preservation" usually refers to the employment of chemical preservatives, both synthetic and natural. Self-preservation or free preservation, on the other hand, is preservation without the use of a chemical ingredient defined as a preservative in the cosmetic legislation's annexes [6, 7]. Through reduce the possibility of microbial contamination, microbial preservation measures are used from the initial stages of production to the final stages of consumption. This procedure's main stages will be briefly outlined. Furthermore, all of the tactics listed below, with the exception of the synthetic chemical preservatives, are described by various writers in the idea of "Hurdle Technology" for cosmetic preservation. The phrase 'hurdle technology' refers to the intelligent combination of numerous elements that prevent microbial proliferation [8].

Preservatives counteract microbial growth in a variety of ways: some lead to cell wall lysis and cell wall leakage (e.g. phenols, organomercurials) or to irreversible cross-linking in the cell wall (e.g. glutaraldehyde), while others impair the growth of the integrity of the plasma membrane (e.g. chelators such as EDTA, quaternary ammonium compounds). Alcoholic and weak carboxylic acid preservatives disrupt the active transport mechanisms. For example, benzoic acid and parabens inhibit folic acid synthesis. Unfortunately, microorganisms will become resistant to the antimicrobial preservatives in a variety of ways[9].

- This includes one or more of these following mechanisms:
- Outbound transport mechanisms. ,
- enzymatic inactivation of the anti-microbial additives or
- Change of the body's metabolic pathways.

Some types of bacteria develop resistance to the antimicrobial preservatives through the genetic mutation, transformation, transduction, conjugation or rearrangement. this resistence makes the anti-microbial testing task critical.

4.0 Preservation Needs and Factors: -

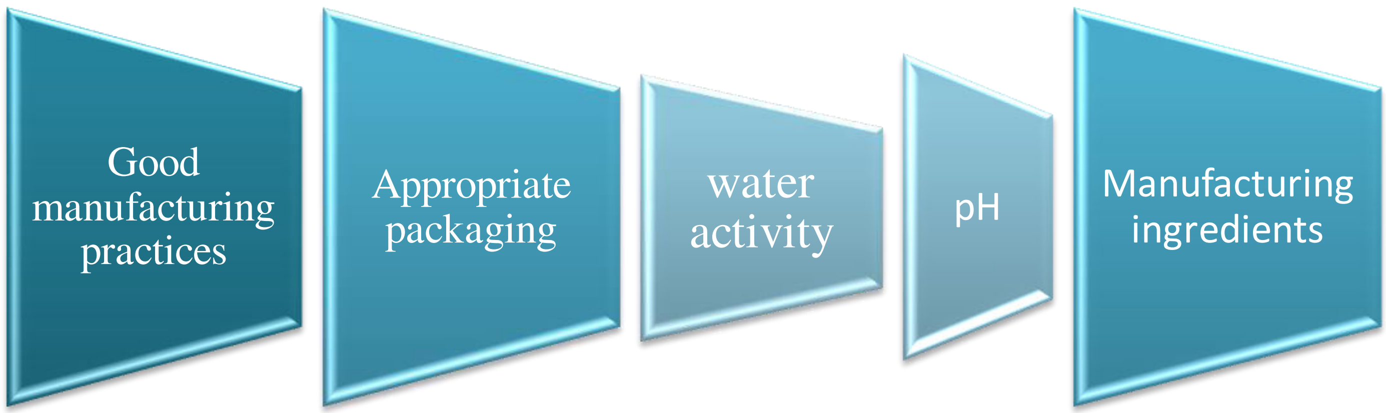
- The use of preservatives in cosmetics is important to prevent changes from contamination during formulation and microorganisms, storage, shipping or use by the consumer.
- To protect against damage from exposure to oxygen antioxidants can be used.

Fig 1:- Illustrating the factors affecting preservative action in cosmetics

1. •CONCENTRATION- Effectiveness and activity is directly prportional to the concentration of preservatives
2. •pH VALUE: Microorganisms of one kind or another can grow between pH 2 and 11. Many preservatives depends on pH.
3. •SOLUBILITY : The more soluble derivatives exhibits a lower inhibiting capacity
4. •SURFACTANTS: several cationic surfactants have powerful antimicrobial properties when they are used with antiseptics. Soaps and anionics have mild antimicrobial characteristics at high concentrations. Nonionic surfactants not only serve as an energy source for bacteria but also inactivate preservatives.
5. •PARTITION COEFFICIENT: The preservative molecules are distributed in the oil phase, the aqueous phase, the micelles of the surfactant through Solubilization and the solutes through Displacement of water, thereby reducing the levels of preservatives available at each of these stages

5.0 MATERIAL AND METHOD:

Fig 2: - Illustrating different factors of hurdle technology.



5.1 Good Manufacturing Practice:

When assembling cosmetic products, the use of traditional or alternative preservatives must strictly adhere to the standards of good manufacturing practice. The manufacture of the cosmetic product under strictly aseptic conditions must prevent the penetration of microorganisms. The water filtration and radiation system, overpressure, microbial testing of raw materials, disinfection of equipment and properly dressed and trained personnel can significantly reduce the risk of contamination [10, 11]. Therefore, the use of strictly aseptic conditions during an assembly of the cosmetic is suggested, especially if it is a self-preserving product. The system is used within the formulations.

5.2 Product packaging and preservation:

If you want to use formulas without preservatives or self-preservatives, then using the best cosmetic protective container should be seen as an obstacle. Included in this concept is the use of dispensing devices that do not allow contamination during use. For example, flip top shampoo lids and lotion pump lids are examples of containers that help reduce contamination during use. While the disposable container is an proper solution to the problem, other more ingenious solutions are developing [10, 11]. In recent years this type of packaging has been used to preserve the product without using preservatives in containers in which the product can be dispensed without contamination.

5.3 pH control:

The optimal pH for microbial proliferation in cosmetic products is between 5 and 8, which means that any pH outside of this range creates unfavorable conditions, slowing their development rate [12, 13]. The antibacterial effect of cationic hair conditioners is aided by their acidic pH (pH = 4, approximately) [14, 15].

Other products with an acidic pH, such as antiperspirants containing salicylic acid and aluminum compounds (pH ranging from 3.5 to 4.5) [16], can hinder the growth of microorganisms. Due to the effects of ionised fatty acids and free alkalinity of the present NaOH, liquid soaps with an alkaline pH (pH 9.5 to 10.5) provide an unfavorable environment for microbial growth (e.g., disrupting their membrane). Microorganisms cannot develop or live in a cosmetic production with a pH less than 4 or greater than 10 in general [16, 17].

5.4 Water activity:

As all microorganisms need water for growth, formulations that usually limit the provision of water for microorganisms to help control growth of the microbes and become one among hurdles placed within the organism's path. The water activity (aw) portrays the number of biologically accessible water inside cosmetic formulations and is set by comparing vapor pressure of the equation containing water with vapor pressure of the pure water. Water activity can also be reduced by the utilizing water binding substances, resembling polyols, salts, macromolecule, amino acids, hydrolysates and hydrocolloids [18]. Different categories of microorganisms have completely different tolerance to the tide activity; bacterium usually have higher water necessities than yeasts, and yeasts have higher than molds [19]. Gram-positive bacteria usually show less susceptibility to low water activity (aw) values than gram-negative bacteria. Glycerol and Sorbitol, in concentrations around 20% w/w, are commonly used to reduce the water activity. Vapor-resistant bottles, vapor-repellent film coatings, film strips and polyacrylamide hydrogels can also be used to minimize water activity [20].

5.6 Emulsion form:

More than oil-in-water (O/W) emulsions, water-in-oil (W/O) emulsions can reduce the danger of microbial contamination [8]. The size of the emulsion droplets has the potential to boost the cosmetics' efficacy. In many circumstances, shrinking the size of emulsion droplets (nano-emulsion) boosts antibacterial activity. However, the chemical composition of the oil phase, namely the type of phenolic compounds, chemical structure, and their concentration, influences antibacterial action [21, 22, 23].

5.7 Multifunctional antimicrobial ingredients:

As per the European guideline, the solitary permitted preservatives are those which are recorded in annex four of 7th amendment of cosmetic directive. In any case, many cosmetic ingredients, as such essential oil, alcohol, bio-mimetic phospholipid, chelating agents, surfactants, antioxidants, fatty acid, have antimicrobial property. These materials that are utilized for their useful impact on the skin and may adventitiously add to the protection of the formulation are not recorded as preservatives of formulation in annex four. By a cautious selection of such ingredients, possible to eliminate or to decrease the utilization of chemical preservatives/traditional and to plan cosmetics with their improved restorative properties.

- The following are recorded a few elective preservatives [8].
  - Bio-mimetic phospholipids

- Surfactants
- Antioxidants as preservatives
- Fatty acid and ester
- Aroma chemicals as preservatives
- Fragrance ingredients
- Chelating agents as preservatives potentiators

5.7.1 Bio-mimetic phospholipids:-

Phospholipids are some other instance of emulsifiers which might also have unique properties. While a few phospholipids such as lecithin can inactive preservatives, lipids those mimicking shape and overall performance of the phospholipids are organized that have antimicrobial activity. This new groups of phospholipids has been advanced at some stage in which the association of the quaternary groupings and phosphate has been reversed. Rather than interfering with preservative structures the bio-mimetic phospholipid presents potent anti-microbial activities without displaying enormous toxicity or pores and skin infection effects[26].

5.7.2 Surfactants:

Surfactants are categorized as cationic, anionic or non-ionic, and they can form micelles when present in aqueous solution at levels above their critical micelle concentration (CMC). Due to a fall in preservative concentration, preservatives absorbed or contained in micelles have lesser preservative efficiency. Surfactants, on the other side, may aid in the solubilization of preservatives, and increasing their effectiveness [26].

The classification of surfactants is depicted in the diagram below:

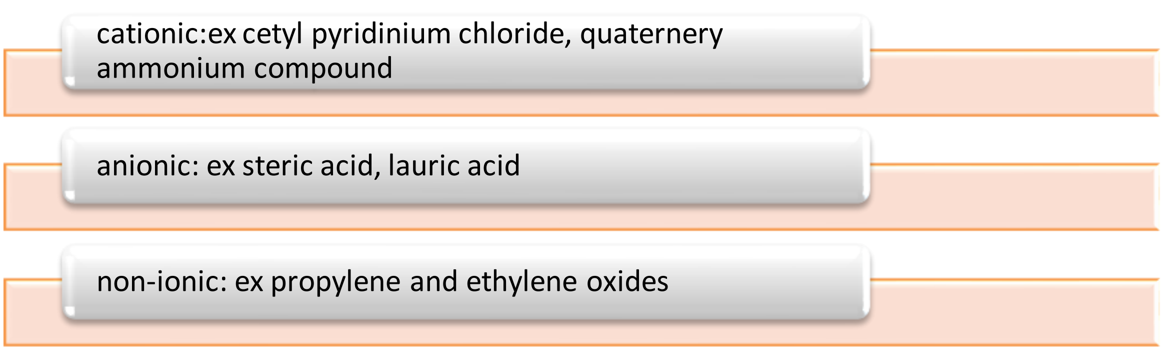


Fig 3: classifications of surfactants

5.7.2. A Cationic surfactants:

Surfactants that are cationic ionize in aqueous solution to form positively charged organic ions which are responsible in surface activity. Quaternary salts (e.g. BAC, CPC) have been utilized in cosmetics, mouthwashes, sanitizers and toothpastes since 1935, when Domagt discovered the antibacterial effects of cationic surfactants. The most common ingredients in these formulations are cetyl pyridinium chloride (CPC) and benzalkonium chloride (BAC). Additional preservatives are reduced or eliminated as a result of their existence. The diverse array of antimicrobial effect of quarts across a range of pH values is one of their advantages[26].

5.7.2. B Anionic Surfactants:

Fatty acid soaps, for example, are an early example of an anionic substance that helps preserve products. Under alkaline conditions, most anionic surfactants have mild antibacterial properties and are often more potent against gramme negative than gramme positive microorganisms. Gram-negative bacteria have a high level of resistance concerning the protection provided by their outer membrane. The administration of chelating drugs at the same time can weaken or eliminate this protection [26].

5.7.3 Antioxidants are used as preservatives in the following ways:

The major role of phenolic antioxidants is to prevent unsaturated oils from auto-oxidizing, which would change the color and, as a result, the odor of the product. Phenolic compounds are the primary antioxidants. The most frequent phenolics used in cosmetics are butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate (PG), and tertiary butylhydroquinone (TTBHQ). The phenolic antioxidants TBQH and BHA are the most potent antimicrobials and are more active than conventional parabens. These phenolics are effective against several gram-negative organisms as well as mould and yeasts, although they are more potent against gram-positive organisms. At a concentration of 0.5 % (w/w), propyl gallate is a water-soluble compound with antimicrobial and antioxidant properties against bacteria and fungi [24]. Other instances include: Antimicrobial action has also been found in coumaric, caffeic, and ferulic acids [27-30]. The antioxidant chosen is determined by the company's convenience, the product's content, the order of addition, and the packaging. Safety, adherence to government rules, and cost should all be taken into account. The final choice of the "hurdles" to be used in a preservative system is determined by the formula's precision, the manufacturing process, and hence the buyer's ultimate use [26].

5.7.4 Aroma compounds as preservatives:

Essential oils and spices have long been used to keep cosmetics from deteriorating. The genuine efficacy of the various extracts was not thoroughly investigated because most research for evaluating essential oils and fragrances employed the agar streak or disc approach. Despite these flaws, aromatic compounds' antibacterial capabilities have been found to be helpful. Aroma compounds are multifunctional, thus their application in cosmetics should be based not only on the aroma, but also on their intrinsic germicidal properties [26]. The phenol coefficient is a measure of a chemical compound's bactericidal activity in comparison to phenol. Under the proper conditions, the activity of a substance is represented as the ratio of dilution at which it kills in 10 minutes but not in 5 minutes. It is frequently determined in the absence of organic matter or with a standard amount of additional organic matter. A phenol coefficient of less than 1 indicates that the disinfectant is less effective than phenol.

5.7.5 Fragrance Ingredients:

Antimicrobial scents have a chemical composition that isn't too dissimilar from antimicrobial essential oils and extracts. A fragrance blend mostly composed of benzyl acetate, phenethyl alcohol, and Linalool was previously used to minimize the amount of Paraben used in cosmetic formulations [32]. Antimicrobial perfumes are now commercially available, including the main ingredients p-anisic acid (p-methoxybenzoic acid) and levulinic acid (4- oxopentanoic acid). Pimpinella anisum and other herbs contain p-anisic acid, while levulinic acid was discovered as a by-product of the assembly of diosgenin from wild yam (Dioscorea villosa) [33]. However, substituting aroma components for chemical preservatives does not guarantee a reduction in the formulation's irritating effect.

5.7.6 Chelating agents as preservatives potentiators:

EDTA, carboxylic acid, acid, and phytic acid are chelators that increase cell membrane permeability and make cells more sensitive to antimicrobial drugs. Furthermore, chelating chemicals prevent the iron from being used in microbial metabolism and development. Chelators could thus be key components in improving the efficacy of antimicrobial drugs for the control of gram-negative bacteria, which are known to be resistant to antibiotics [27, 31].

6.0 Conclusion: -

This new cosmetics preservative system strategy for product protection incorporates multi-functional substances (hurdles) and packaging components that will help keep the environment hostile to germs directly or indirectly. Formulas that are preservative-free or self-reserving have a number of advantages. Studies have shown that combining some traditional/chemical preservatives, such as Paraben, formaldehyde releasers, and isothiazolinones, enhanced customers' desire for "natural" products, prompting the cosmetic industry to improve current preservation methods. The use of proper packaging, as well as the control of critical parameters for the proliferation of microorganisms, such as water activity (aw) and pH, can significantly reduce the quantity of traditional/chemical preservatives required for the stability of a cosmetic composition. Old preservatives are replaced in self-preserving formulations by alternative chemical components having antibacterial capabilities, such as surfactants, fatty acids, chelating agents, essential oils, and so on. These materials are utilized for their positive effects on the skin and, by chance, also contribute to the formulation's preservation. However, using alternative or natural chemicals does not guarantee that irritating effects, unpleasant effects, or sensitization will be completely avoided. The "perfect solution" to replace traditional/chemical preservatives that is also completely safe, effective, and suitable with all applications has yet to be discovered, and will very certainly never be. This hurdle technology is the optimal solution.

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