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(54) LACTIC ACID COMPOSITION

(71) We, JOSEPH DAVID MANDELL, of 250 Parkside Drive, Palo Alto, State of California 94306, United States of America and SHELDON LEO MATLOW, of 2545 Booksin Avenue, San Jose, State of California, 95125, United States of America, both citizens of the United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

Living organisms, including microorganisms such as bacteria, require the biological oxidation of carbohydrates as an energy source. During this succession of oxidation reactions, glycogen, the form in which carbodydrates are stored in an animal body, is converted to carbon dioxide and water. This conversion may be divided into three states, (a) glycogen is broken down into its component D-glucose molecules; (b) in glycolysis, D-glucose is itself broken down into three carbon compounds; and (c) such compounds, in respiration, are converted into carbon dioxide and water.

The last step of glycolysis is the reduction of pyruvic acid to lactic acid according the the following equation:

$$CH_3COCOO^- + NADH + H^+ \rightleftharpoons CH_3CHOHCOO^- + NAD^+ \quad (1)$$

Pyruvate	Reduced nicotinamide adenine dinucleotide	Lactate	Nicotinamide adenine dinucleotide

The above reaction is catalyzed by a set of enzymes collectively referred to as "lactate dehydrogenase". This reaction is important for the regeneration of NAD^+ which is required for the conversion of 3-phosphoglyceraldehyde to 1,3-diphosphoglycerate in the Embden-Meyerhof-Parnas (EMP) pathway, for the conversion of pyruvate to acetyl-coenzyme A, called "acetyl CoA", and for the conversion of isocitrate to oxalosuccinate, 2-ketoglutarate to succinyl-coenzyme A, and malate to oxaloacetate in the tricarboxylic acid cycle (aerobic oxidation of glucose).

One known technique for limiting the growth of harmful bacteria or other microorganisms is by the addition of an inhibitor of an enzyme such as an antibiotic. One problem with this approach is that if the bacteria are not destroyed rapidly, a mutant population may arise which is not affected by the inhibitor. For example, there are now several strains of staphylococcus which are resistant to the antibiotic penicillin. Another problem with this approach is the serious allergic reaction of certain patients to the presence of such foreign antibiotic substances.

It is known that the growth of microorganisms can be reduced by lowering pH level of their environment. For example, microorganisms grow substantially slower or are killed at a pH of 3 in comparison to a pH of 4. One reason for this is that a low pH environment is deleterious to cytochrome C which is necessary for the oxidative phosphorylation path.

Microorganisms such as bacteria are also adversely effected by contact with alcohols which serve to denature the protein of the microorganisms. Thus, alcohol is a well known bactericide.

It is also known that the unpleasant odor due to perspiration is caused by the attack of

bacteria on the secretions of the sweat glands. U.S. Patent 3,124,506 discloses a number of compositions which are stated to be useful as an inhibitor of foot odor or as an underarm deodorant. There is no disclosure of any suggested mechanism for the effectiveness of such compositions for this purpose. However, one set of nonaqueous compositions including malic acid, hexachlorophene, and isopropyl alcohol, is disclosed for use as a deodorant. Another set of compositions is disclosed for use as a dentifrice and prophylactic nose and throat composition including a water based mixture of calcium lactate, malic acid, or lactic acid and calcium malate, both in water. There is no suggestion of using an alcohol composition in this formulation or that the composition could exclude calcium.

In accordance with the present invention, there is provided a solution having biostatic activity comprising one or more lactic acid yielding compounds, (as hereinafter defined) a volatile alcohol, and water said biostatic solution having a pH no greater than 3.0.

A biostat of biostatic material is defined as a chemical composition which inhibits the growth of living cells such as microorganisms (e.g., bacteria). The compositions of this invention include effective quantities of a lactic acid yielding compound (e.g., lactic acid), an alcohol, and water, and have a pH level no greater than 3.0. The biostatic activity of the solution is thought to derive from three primary factors. Firstly, the presence of lactic acid thermodynamically drives the reversible reaction of equation (1) to the left to reduce the concentration of NAD^+. As set forth above, NAD^+ is essential in the production of energy in microorganisms. Secondly, since the preferred solutions include no metal ion, they are not buffered and so have a highly acidic pH level which is detrimental to the function of cytochrome C, also important in energy production of microorganisms. Thirdly, the presence of the alcohol denatures the protein of the microorganisms. When a solution of the invention is employed as a disinfectant and cleanser, in addition to the above biostatic activity, the lactic acid reacts with soap to displace the sodium ion of typical soap films to form long chain fatty acids which are soluble in the alcoholic solution. Thus, difficult to remove soap deposits are readily washed away in the alcoholic solution without large expenditures of effort.

The biostatic solution of the present invention includes a lactic acid yielding compound, a volatile alcohol, and water. The term "lactic acid yielding compound" is defined to means lactic acid, and compounds hydrolyzable to lactic acid. Substances hyrolyzable to lactic acid include lactide, lactyl lactic acid and higher polymers, of lactic acid and ethyl and methyl lactate. Naturally, mixtures containing some or all of these compounds can be used. For simplicity of description, the specification will refer to lactic acid as the lactic acid yielding compound.

For convenience of reference, equation (1) set forth above is repeated as follows:

$$CH_3COCOO^- + NADH + H^+ \rightleftharpoons CH_3CHOHCOO^- + NAD^+ \quad (1)$$

Pyruvate	Reduced nicotinamide adenine dinucleotide	Lactate	Nicotinamide adenine dinucleotide

By well known principles of chemical equilibria, it is apparent that an increase in lactate ion or its source, lactic acid, in the above equation will drive the reaction to the left, and so reduce the production of NAD^+. As set forth above, this reduces the energy source for the growth of microorganisms.

It has been determined that the lactic acid concentration in perspiration varies from 0.147 to 0.371 weight/volume percent with a mean value of 0.232 percent (Ralph G. Harry, *The Principles and Practice of Modern Cosmetics,* Vol. 1, Chemical Publishing Co., New York, (1962), p. 469). For the present formulation to be effective as a deodorant in the presence of perspiration, the additional lactic acid concentration should be substantial in comparison to that present in the perspiration. A suitable lower value for this purpose of about 0.5 weight/volume percent of lactic acid will be effective for use as a deodorant for a typical human application.

In view of the foregoing, a preferred range of lactic acid in the composition is from 0.5% to 4%. A greater concentration is permissible but 0.5% to 2% is more preferred. The maximum value is determined as that which would cause undue irritation in the particular area of the subject treated. Of course, this limitation is not present when the solution is employed as a combination cleanser and disinfectant as set forth hereinafter.

The foregoing preferred lower limitation of 0.5% is related to the destruction of bacteria which combines with perspiration to yield an unpleasant odor. It should be understood that other living cells such as fungi and yeast are also inhibited by the same reduction in the source of energy. It is assumed that the foregoing lower limit would be comparable to that which

would be effective in the reduction of such other living cell growths on the skin.

Lactic acid also serves to lower the pH of the solution to a level between about 2.0 and 3.0 which inhibits the function of cytochrome C, which also reduces the energy source for growth of microorganisms as set forth above. The pH of the solution is maintained at a level below 3.0 to take advantage of this effect. Thus, it is preferable that the solution exclude any substantial amount of metal ion compound which would have a buffering effect in combination with the acid.

It is noted that most soaps are alkaline and so increase the pH of the skin to levels on the order of 8 to 9. At such pH levels, the skin is highly susceptible to bacteria growth before it returns to its normal acidic levels. This is a particular problem with unhealthy skin which takes a longer time to return to its normal pH levels. This problem is avoided by the use of the present solution which actually lowers the pH level of the skin to inhibit growth of bacteria or the like.

The second element in the present composition is an alcohol which is known to be an effective bactericide by denaturation of the protein content of bacteria or the like. In addition, it has a relatively low surface tension enabling it to penetrate deeply into crevices in the surface of the skin and into the pores. Furthermore, by attacking the lipoproteins in the microorganism cell membranes, the alcohol permits more effective penetration of the solution into the cells. Another function of the alcohol is dependent on its high volatility. Thus, when it is present in a high proportion, the mixture vaporizes rapidly, an important feature for use as a deodorant or the like.

Suitable alcohols which may be employed in the above compositions are the lower alkyl alcohols such as methyl, ethyl, n-propyl, and isopropyl alcohol. It is known that higher alcohols have better bactericidal efficiency but lower solubility in water, lower volatility, and a higher cost. Isopropyl alcohol is a preferable balance for all of these factors.

The concentration of the alcohol is selected to be at least a minimum quantity for good efficacy of biostatic activity as well as causing at least a minimum rate of evaporation of solution after application. For application to a human subject, the maximum concentration is determined by an acceptable level of irritation to the particular area of contact with the skin. Suitable concentrations of isopropyl alcohol may range between 30 and 90% (volume/volume) while an optimum concentration is on the order of 50%.

The remainder of the solution comprises water which serves as a diluent for adjustment of the desired concentrations. Thus, the bulk of the remainder of the solution after addition of alcohol and lactic acid comprises water.The water also serves as a medium for ionizing the lactic acid for reduction of the pH level of the solution.

The mechanism for dermatological application as a deodorant as for underarm or foot odors is for the solution to attach the bacteria in the vicinity of the secretions of the sweat glands. Since such bacteria cause the unpleasant odors in such secretions, the present solution is particularly effective as a deodorant. When used as a deodorant, a maximum alcohol content should be employed as the increases the rate of evaporation.

The present solution may also serve as a bactericide in treatment of acne. It is known that *coryne bacterium acnes* and other bacteria secrete lipases which hydrolyze fats in the sebum producing long chain fatty acids which are irritating to the follicles. The present solution serves to prevent the follicular inflammation by inhibiting the growth of the lipase secreting bacteria.

Chapped skin, dandruff and psoriasis are all abnormal skin conditions which may be aggravated by secondary microbial infections. It has been found that the present solution is an effective treatment for such abnormal skin conditions. The present solution can also be employed in the treatment of fungus infections such as "athlete's foot" and yeast infections.

The present solution is also effective as a post-scrub lotion, especially for persons required to wash their hands frequently such as medical doctors. The present solution leaves the skin moist after application and at a pH level which minimizes bacterial growth.

In addition to the foregoing use as a treatment for human subjects, the solution of the present invention is also particularly effective for simultaneous cleaning and disinfecting of a dirty surface. It has been found that application of the solution removes dirt, especially in the form of dirty soap films with minimal effort while simultaneously disinfecting the surface. The ease of removal of the dirt such as soap is believed to be due to the following mechanism. The soap, formed of a metal (e.g., calcium) salt of a fatty acid, reacts with the lactic acid component of the solution to form a fatty acid which is highly soluble in the alcoholic solution. Such fatty acid is dissolved in the alcohol and rapidly removed from the surface without the necessity for excessive rubbing.

It should be apparent that other additives may be added in minor proportion to augment the above solutions. For example, scents may be added to form an after shave lotion or scented deodorant. Also, humectants such as glycerine or propylene glycol may be added to a solution, or mineral oil may be used to increase lubricity for such use as hand lotion.

Furthermore, malonic acid may be added to the deodorants to reduce the amount of perspiration. Finally, urea may be employed to assist in the inhibition of yeast cell growth.

For convenience, the solution of the present invention may be prepared by the consumer at home from its components. Thus, a lactic acid forming compound in solid form such as a tablet or powder may be added to a commercially available aqueous alcoholic solution (e.g., isopropyl alcohol). Lactide is a suitable lactic acid yielding solid. The solution of the present invention may also be prepared by the consumer by adding a commercially available aqueous alcoholic solution to an aqueous solution of a lactic acid forming compound.

A further disclosure of the nature of the present invention is provided by the following specific examples of the practice of the invention. It should be understood that the data disclosed serve only as examples and are not intended to limit the scope of the invention. The following examples will utilize a three-digit number as a code for the formulations. The first digit refers to the lactic acid concentration in weight/volume percent. The second and third digits refer to the percentage of isopropyl alcohol (volume/volume). The remainder of the formulation is water.

Example 1

Formula 230 is a satisfactory underarm deodorant, but has a relatively low evaporation rate. Formula 260 is preferred for this purpose as having a rapid evaporation rate without being unduly irritating. Formula 460 is employed for persons with severe body odor problems. The same formulations may be employed as a foot deodorant or treatment for "athlete's foot" or other fungus infections.

Example 2

Formulation 260 is employed for the treatment of acne. If a person has a relatively non-sensitive skin, the stronger formulation, 460 is preferable. For very difficult cases of acne, formulations 480, or 660 are employed.

Example 3

Formulation 230 is employed as a treatment for dandruff effectively since residual moisture in the hair is not detrimental. Formulations 260 or 460 are employed for more severe cases of dandruff.

Example 4

Formulations 260 and 460 are employed for the treatment of chapped skin. If formulation 460 is too irritating for severe cases, alternating use of formulations 260 and 460 are effective.

An advantage of the illustrated formulations is that they are unlikely to cause an allergic reaction.

WHAT WE CLAIM IS:-

1. A solution having biostatic activity comprising one or more lactic acid yielding compounds, (as hereinbefore defined) a volatile alcohol, and water said biostatic solution having pH no greater than 3.0

2. A solution as claimed in claim 1 in which said volatile alcohol is methyl alcohol, ethyl alcohol, n-propyl alcohol, or isopropyl alcohol.

3. A solution as claimed in claim 1 or claim 2 in which the or a lactic acid yielding compound is lactide, lactyl lactic acid or higher polymers of lactic acid ethyl lactate, or methyl lactate.

4. A solution as claimed in claim 1 or claim 2 in which the or a lactic acid yielding compound is lactic acid.

5. A solution as claimed in any preceding claim in which said alcohol comprises 30 to 90% by volume of the total solution.

6. A solution as claimed in any preceding claim in which the lactic acid yielding compound or compounds make up at least 0.5% of said solution on a weight/volume basis.

7. A solution as claimed in any preceding claim essentially devoid of metal ions.

8. A solution as claimed in claim 1 substantially as hereinbefore described in any one of the Examples.

9. A method for cleaning and disinfecting a dirty surface comprising applying to the surface a solution as claimed in any preceding claim.

10. A method as claimed in claim 9 in which the dirt on the surface comprises a soap.

11. A method of forming a solution having biostatic activity which method comprises dissolving a dry lactic acid yielding compound (as hereinbefore defined) in an aqueous alcoholic solution to form a solution having a pH level no greater than 3.0.

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