

Monolaurin

A Review of Monolaurin and Lauric Acid - Natural Virucidal and Bactericidal Agents

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Monolaurin has “Generally Recognized As Safe (GRAS)” status and is considered to be nontoxic. **It is effective against many microorganisms and can be taken on a daily basis**, given that evidence suggests it does not create antiviral or antibacterial resistance.

The general recommended adult dose of monolaurin is 1–3 g. Higher amounts can be used to achieve desired results if necessary. It is safe for children (ages 3–10) with the recommended dose being smaller—30 mg, one to three times per day. Monolaurin is available as minipellets that should be swallowed and not chewed.

Coconut oil, coconut cream and grated coconut are excellent sources of lauric acid and the other medium-chain fatty acids as well. Coconut oil provides mostly medium-chain triglycerides that are rapidly absorbed and transported to the mitochondria where they are utilized for fuel and may be less likely to be stored as body fat.

Coconut oil does not have a deleterious effect on cholesterol or other blood lipids. In fact, it may raise high-density lipoprotein cholesterol. Coconut oil is rich in “good” saturated fatty acids that conserve the elongated omega-3 fatty acid. Animal studies have shown that some omega-3 fatty acids can be formed as a result of ingestion of coconut oil. Coconut oil does not contain trans fatty acids that have deleterious effects on blood lipids and insulin binding. **Both monolaurin and coconut oil are excellent choices for combating a host of microorganisms—both therapeutically and preventively.** More human studies are needed to elucidate the best therapeutic dose of monolaurin and coconut for addressing specific

microorganisms and conditions. It is also important to quantify how much monolaurin is metabolized from a specific quantity of coconut oil. Finally, it is equally important to compare large doses of coconut oil to specific doses of monolaurin for their antimicrobial action as was done in the HIV study population. Dietary supplements such as monolaurin may be unavailable to some populations while coconut oil may be a less-costly alternative.

Coconut oil in health and disease: its and monolaurin's potential as cure for HIV/AIDS

By Dr. Conrado S. Dayrit

The coconut is called the tree of life for it has been providing us, humans, food and drink, materials for housing, fuel and many industrial uses. And its medicinal uses are many and varied. **The latest medical potential of products of the coconut first identified by Jon Kabara and others in the 70s, is the anti-bacterial, anti-viral and anti-fungal activity of its medium chain fatty acids, particularly lauric acid (C12:0) in its monoglyceride form (monolaurin or ML).**The first clinical trial ever of ML was on 15 HIV-infected patients reporting regularly at the San Lazaro Hospital, Manila who, never having received any anti-HIV medication, were randomly assigned to 3 treatment groups: 7.2 g ML, 2.4 g ML and 50 ML of coconut oil daily for 6 months. The San Lazaro Hospital Team was led by Eric Tayag. Viral, CD4 and CD8 counts, complete blood counts, blood lipids and tests for liver and kidney functions were done at the beginning of the study and after 3 and 6 months of treatment. In one patient, the viral load was too low to count. By the 3rd month, 7 of the patients (50%) showed reduced viral load and by the 6th month 8 patients (2 receiving 7.2h ML, 4 receiving 2.4 g ML and 3 receiving, coconut oil had a lowered viral count. The CD4/CD8 counts showed a favorable increase in 5 patients. There were no serious side effects observed. Three patients developed AIDS on 3rd month of therapy when their CD4 count dropped below 200. One of these three, who was in the coconut oil group died 2 weeks after the study. The two other AIDS patients were in the 2.4 g ML group; one recovered fully on the 6th month and the other showed a rapid return towards normal CD4 and CD8 counts.

Effects of Essential Oils and Monolaurin on *Staphylococcus aureus*: *in vitro* and *in vivo* Studies

Harry G. Preuss, Bobby Echard

The antimicrobial properties of volatile aromatic oils and medium chain fatty acids derived from edible plants have been recognized since antiquity.

To give examples, Origanum oil, used as a food-flavoring agent, possesses a broad spectrum of antimicrobial activity due, at least in part, to its high content of phenolic derivatives such as carvacrol and thymol. Similarly, lauric acid, present in heavy concentrations in coconuts, forms monolaurin in the body that can inhibit the growth of pathogenic microbes.

Using *Staphylococcus aureus* in broth cultures and a micro dilution method, comparative efficacy of Origanum oil, and a constituent carvacrol, other essential oils, and monolaurin were examined. Origanum oil was the most potent of the essential oils tested and proved bactericidal in culture to two strains of *Staphylococcus aureus* at 0.25 mg/ml. *In vitro*, monolaurin's effects mirrored Origanum oil. The combination of both was bactericidal at the 0.125 mg/ml concentration of each. In two separate *in vivo* experiments, injected *Staphylococcus aureus* killed all 14 untreated mice within a one-week period. In treated mice, over one third survived for thirty days when given oral Origanum oil daily for 30 days (6/14). Fifty percent of the mice survived for 30 days when receiving daily vancomycin (7/14) and monolaurin (4/8). Over sixty per cent of mice survived when receiving a daily combination of Origanum oil and monolaurin (5/8). **Origanum oil and/or monolaurin may prove to be useful antimicrobial agents for prevention and therapy of *Staphylococcus aureus* infections.**

Technical information on Monolaurin

The antiviral, antibacterial, and antiprotozoal properties of lauric acid and monolaurin have been recognized for nearly three decades by only a small number of researchers: their work, however, has resulted in 50 or more research papers and numerous U.S. and foreign patents. Prof. Dr. Jon J. Kabara performed the original seminal research in this area of fat research. Kabara (1968) first patented certain fatty acids (FAs) and their derivatives (e.g., monoglycerides (MGs) can have adverse effects on various microorganisms. While nontoxic and approved as a direct food additive by the FDA, monolaurin adversely affects bacteria, yeast, fungi, and enveloped viruses.

Kabara found that the properties that determine the anti-infective action of lipids are related to their structure: e.g., free fatty acids & monoglycerides. The monoglycerides are active; diglycerides and triglycerides are inactive. Of the saturated fatty acids, lauric acid has greater antiviral activity than either caprylic acid (C-8), capric acid (C-10), or myristic acid (C-14).

Fatty acids and monoglycerides produce their killing/inactivating effects by several mechanisms. An early postulated mechanism was the perturbing of the plasma membrane lipid bilayer. The antiviral action attributed to monolaurin is that of fluidizing the lipids and phospholipids in the envelope of the virus, causing the disintegration of the microbial membrane. More recent studies indicate that one antimicrobial effect in bacteria is related to monolaurin's interference with signal transduction/toxin formation (Projan et al 1994). Another antimicrobial effect in viruses is due to lauric acid's interference with virus

assembly and viral maturation (Hornung et al 1994). The third mode of action may be on the immune system itself (Witcher et al, 1993).

Hierholzer and Kabara (1982) first reported the antiviral activity of the monoglyceride of lauric acid (monolaurin) on viruses that affect humans.. They showed virucidal effects of monolaurin on enveloped RNA and DNA viruses. This work was done at the Center for Disease Control of the U.S. Public Health Service. This study was carried out using selected virus prototypes or recognized representative strains of enveloped human viruses. All these viruses have a lipid membrane. The presence of a lipid membrane on viruses makes them especially vulnerable to lauric acid and its derivative monolaurin. These initial findings have been confirmed by many other studies.

Research has shown that enveloped viruses are inactivated by added fatty acids and monoglycerides in both human and bovine milk (Isaacs et al 1991). Others (Isaacs et al 1986, 1990, 1991, 1992; Thormar et al 1987) have confirmed Kabara's original statements concerning the effectiveness of monolaurin.

Some of the viruses inactivated by these lipids are the measles virus, herpes simplex virus (HSV-1 and -2), herpes family members (HIV, hepatitis C, vesicular, stomatitis virus (VSV), visna virus, and cytomegalovirus (CMV). Many of the pathogenic organisms reported to be inactivated by these antimicrobial lipids are those known to be responsible for opportunistic infections in HIV -positive individuals. For example, concurrent infection with cytomegalovirus is recognized as a serious complication for HIV positive individuals (Macallan et al 1993).

These antimicrobial fatty acids and their derivatives are essentially nontoxic to man. According to the published research, lauric acid is one of the best "inactivating" fatty acids, and its monoglyceride is even more effective than the fatty acid alone (Kabara 1978, Sands et al 1978, Fletcher et al 1985, Kabara 1985).

The lipid-coated (envelope) viruses, bacteria and other microorganisms are dependent on host lipids for their lipid constituents. The variability of fatty acids in the foods of individuals as well as the variability from de novo synthesis accounts for the variability of fatty acids in their membranes.

Monolaurin does not appear to have an adverse effect on desirable gut bacteria, but rather on only potentially pathogenic microorganisms. For example, Isaacs et al (1991) reported no inactivation of the common *Escherichia coli* or *Salmonella enteritidis* by monolaurin, but major inactivation of *Haemophilus influenzae*, *Staphylococcus epidermidis* and Group B gram positive streptococcus.

The potentially pathogenic bacteria inactivated by monolaurin include *Listeria monocytogenes*, *Staphylococcus aureus*, *Streptococcus agalactiae*, Groups A, streptococci-gram-positive organisms, and some gram-negative organisms (*Vibrio parahaemolyticus* and *Helicobacter pylori*).

Decreased growth of *Staphylococcus aureus* and decreased production of toxic shock syndrome toxin-I was shown with monolaurin (Holland et al 1994). Monolaurin was 5000 times more inhibitory against *Listeria monocytogenes* than ethanol (Oh & Marshall 1993). In vitro monolaurin rapidly inactivate *Helicobacter pylori*. Of greater significance

there appears to be very little development of resistance of the organism to the bactericidal effects (Petschow et al 1996) of these natural antimicrobials.

A number of fungi, yeast, and protozoa are also inactivated or killed by monolaurin. The fungi include several species of ringworm (Isaacs et al 1991). The yeast reported to be affected is *Candida albicans* (Isaacs et al 1991) The protozoan parasite *Giardia lamblia* is killed by monoglycerides from hydrolyzed human milk (Hemell et al 1986, Reiner et al 1986, Crouch et al 1991, Isaacs et al 1991).

Chlamydia trachomatis is inactivated by monolaurin (Bergsson et al 1998). Hydrogels containing monocaprin/monolaurin are potent in vitro inactivators of sexually transmitted viruses such as HSV-2 and HIV-1 and bacteria such as *Neisseria gonorrhoea* (Thormar 1999).

MicroOrganisms inactivated by MonoLaurin

Viruses

Measles (Rubeola) virus

HIV

Herpes simplex virus- (HSV-1 & 2)

Vesicular stomatitis virus (VSV)

Visna virus

Cytomegalovirus (CMV)

Influenza virus

Pneumonovirus

Syncytial virus

Bacteria

Gram-positive organisms

Listeria monocytogene

Groups A,B,F& G streptococci

Staphylococcus aureus

Clostridium botulinum

Streptococcus agalactiae

Neisseria gonorrhoea

Gram-negative organisms

Chlamydia trachomatis

Helicobacter pylorus

Salmonella typhimurium

Vibrio parahaemolyticus

Others if used concurrently with a chelator

Yeasts, Fungi and Molds

Aspergillus niger

Penicillium citrinum

Candida utilis and C. albicans

Saccharomyces cerevisiae

Several species of Ringworm

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Monolaurin



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Monolaurin

Product Write up

Introduction



Monolaurin is a wide spectrum anti-viral, anti-fungal and anti-bacterial ingredient. Monolaurin is the glycerol ester of lauric acid, a 12-carbon chain fatty acid found naturally in breast milk and certain vegetable oils like coconut oil.

Coconut oil is a fat consisting of about 90% saturated fat. It is classified as medium-chain fatty acid (MCT) containing



- 87% saturated fatty acid
- 6% monounsaturated fatty acids, and
- 2% polyunsaturated fatty acids.



Of the saturated fatty acids, Coconut oil is primarily composed of almost 50% Lauric Acid. Lauric acid is a Medium Chain Fatty Acid and has been recognized as a germicidal agent¹ for centuries. Lauric acid was originally discovered when microbiologists studied human breast milk to determine the antiviral substances which protected infants from microbial infections.

The glyceride ester derivative of Lauric acid is Monolaurin². Antimicrobial activity of lauric acid was found to be superior in its Monolaurin form.³

Monolaurin is an anti-microbial agent that helps protect the immune system from wide range of infectious diseases. It has been shown to have anti-viral activity against a number of membraned viruses, including influenza viruses and herpes viruses.

Kabara et al⁴⁻⁷ followed by others in the 1990s⁸⁻¹⁴ reported on monolaurin's antibacterial, antiviral, and antifungal properties.

Clinical Studies:

In a clinical study conducted at Makati Medical Center (MMC) Department of Dermatology in Phillipines, Monolaurin was evaluated for its antimicrobial effects in a hand gel study following US FDA approved protocol.

This study compared the antimicrobial effects of 15 mg/ml monolaurin and 70% alcohol gels with saline as control on 77 post-duty nurses who volunteered for the study. Using the hand-dip glove juice sampling method of the previous study, 58 of the 77 nurses grew *S. epidermidis*, *S. citreus*, *A. baumannii*, *P. aeruginosa*, *C. albicans* and *Enterobacter* sp.

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In the in vitro part of the study, 25 µl of an 18- to 24-hour culture of the 6 organisms was added to 1.5 g each of 15mg/ml monolaurin, 70% alcohol, and saline control solutions. At baseline, after 30 seconds, and after 5 minutes, these were similarly cultured, plated, and counted.

Colony count reduction comparisons between baseline and 5 minutes after monolaurin and alcohol gel applications in vitro and in were the same and highly significant for both (P=.000). Adverse effects were Zero after Monolaurin and saline, but 10 out of 15 (66.7%) had stinging and burning one hour after application of alcohol. After 72 hours, 9 out of 15 (60%) developed erythema under the patch tests in the alcohol group, which compared with monolaurin was significant (P=0.001).

Monolaurin compared with Antibiotics¹⁶.

A cross-sectional laboratory study to determine the in vitro sensitivity and resistance of organisms in culture isolates from skin infections and mechanisms of action of monolaurin, a coconut lauric acid derivative, compared with 6 common antibiotics: penicillin, oxacillin, fusidic acid, mupirocin, erythromycin, and vancomycin.

Monolaurin has statistically significant in vitro broad-spectrum sensitivity against Gram-positive and Gram-negative bacterial isolates from superficial skin infections. Most of the bacteria did not exhibit resistance to it.

Monolaurin exhibited high sensitivity and low resistance rates to these organisms. The sensitivity and resistance rates for the following 4 micro-organisms is illustrated in Fig 1 and Fig 2.

- 1 - **Staphylococcus Aureus**
- 2 - **Coagulase (-) Staphylococcus**
- 3 - **Streptococcus sp.**
- 4 - **Klebsiella sp.**

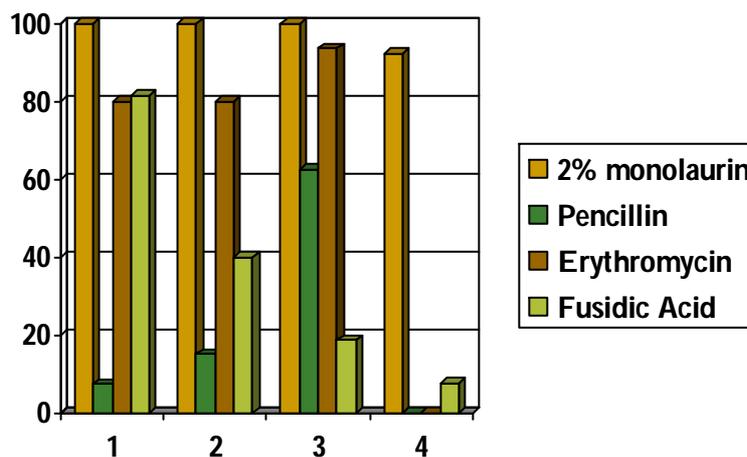


Fig 1 : A comparison of sensitivity rates with the four species of micro-organisms
Higher the sensitivity of the micro-organism to the anti-microbial agent, greater is the potency of the agent

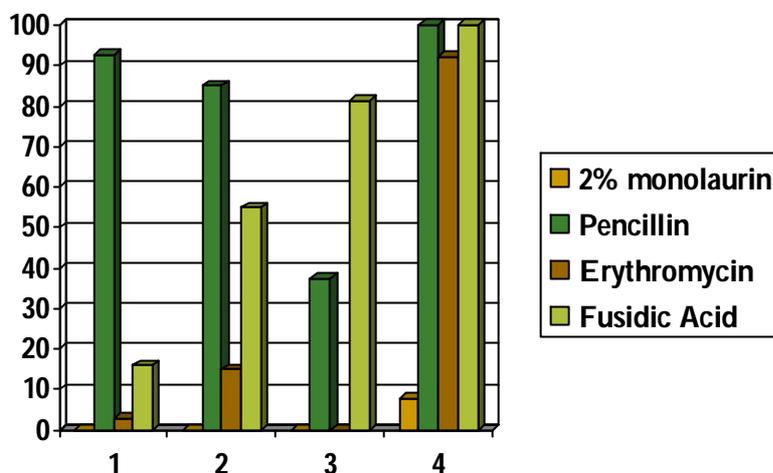


Fig 2 : A comparison of resistance rates with the four species of micro-organisms

Lower the resistance of the micro-organism to the anti-microbial agent, greater is the potency of the agent

Probable Mechanism of Antimicrobial Action:

Recent publications have shown that monolaurin and lauric acid inhibit the replication of viruses by interrupting the binding of virus to host cells and thus preventing the uncoating of viruses necessary for replication and infection. Other studies have shown that monolaurin is able to remove all measurable infectivity by directly disintegrating the viral envelop. Binding of monolaurin to the viral envelop also makes the virus more susceptible to degradation by host defences, heat, or UV light.

Most studies focus on Monolaurin's effects on the bacterial cell envelope¹⁷. Composed of membranes these structures are critical barriers vital to the function of cells for the penetration, selective transport, or uptake of materials. When this membrane function is altered, reversible and irreversible changes may lead to the death of the cell.

The specific effect of Monolaurin on cell membranes may fit into several possible mechanisms:

1. Monolaurin is lipophilic by virtue of size⁴
2. As a monoglyceride, monolaurin is made up of a glycerol molecule to which is linked, lauric acid, a medium-chain (C12) fatty acid. The resulting size of the molecule is small enough to be readily dissolved in the lipid phase, and to penetrate cell membranes. Ionized

molecules such as those from conventional antibiotics whose mechanism of action acts more on bacterial enzymes, do not readily bridge the membrane barrier because of charge or size¹⁸

The effects of these theoretical considerations have in fact been demonstrated by fatty acids and especially monolaurin, another monoglyceride of a medium-chain fatty acid (C10), on the bacterium *Chlamydia*.¹⁰

In a novel 2-color fluorescent assay of viability and by electron microscopy, 5 minutes after treatment no visible changes in the bacteria were seen, but after 10 minutes the bacteria appeared deformed and partly disintegrated. In time, the cell membranes were shown to be partly or completely dehydrated causing cell lysis.

In similar experiments, Bergsson et al also demonstrated that *Staphylococcus aureus* is killed by medium-chain fatty acids and their monoglycerides, through disintegration of the cell membrane leaving the cell wall intact.

This mechanism of action, which has been described as novel,¹⁸ is similar to that described for some of the newer antibiotics for methicillin-resistant *Staphylococcus aureus* (MRSA) and other resistant organisms.

Antiviral properties:

Monolaurin was found to be active against enveloped DNA and RNA viruses such as the influenza virus, paramyxoviruses, rubeola virus, bronchitis virus, and the herpes family. However it had no effect on diseases caused by non-enveloped viruses such as polio virus, coxsackie virus, encephalomyocarditis virus, rhinovirus, and rotaviruses. Clinical Studies have shown that monolaurin is effective against Epstein-Barr virus, Influenza, Cytomegalovirus, and Herpes type I and II.

Antifungal:

Monolaurin is reported to be effective against yeast and fungi, *Chlamydia trachomatis*, *Candida albicans*, *Giardia lamblia* and *H. pylori*.

Antibacterial:

Monolaurin is effective against *Staphylococcus aureus* and *Streptococcus agalactiae*.

Nutraceutical Application:

Monolaurin does not appear to have an adverse effect on desirable digestive bacteria, but rather only on unwanted microorganisms. Internally, monolaurin has been regarded as safe⁷ and is fed to animals, comprising 25% of their total diet without any sign of harm. Since 1964, the US FDA has placed monolaurin on the list of generally recognized as safe (GRAS) substances⁷. It is a component of coconuts, which have a long safety record as food.¹⁹

Suggested Dosage : 1.0 to 5 % based on the intended application.

Cosmeceutical Application:

Monolaurin lends itself useful in formulations requiring antimicrobial activity.

It has an MIC of 40µ/ml i.e., at 0.004% as such against p. acnes and hence useful in anti-acne preparations. It also has a potential role as component of a natural preservative blend. Being a non-ionic surfactant, it can also be used in anti-microbial soaps and shampoos.

Suggested Dosage: 0.3 to 2 % based on the intended application.

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Monolaurin

Product Write up

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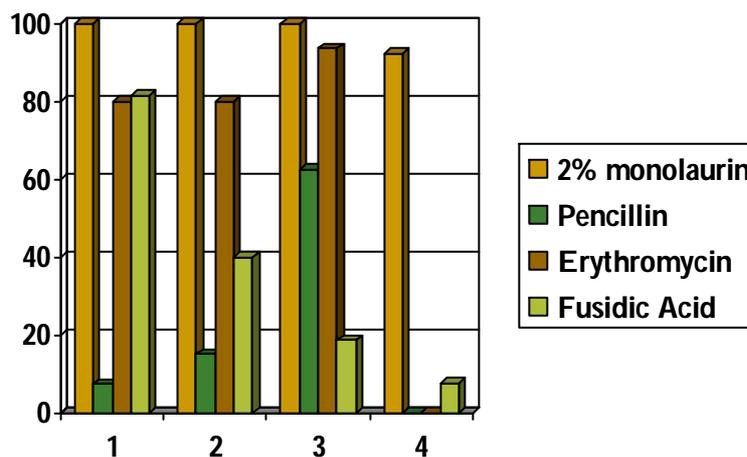


Fig 1 : A comparison of sensitivity rates with the four species of micro-organisms
Higher the sensitivity of the micro-organism to the anti-microbial agent, greater is the potency of the agent

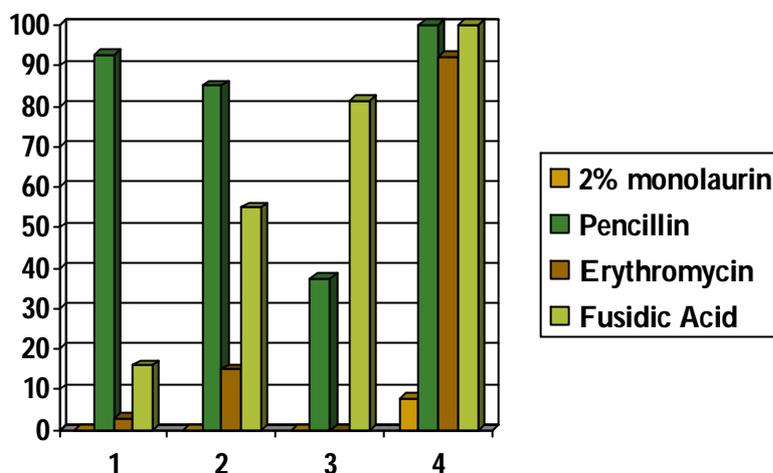


Fig 2 : A comparison of resistance rates with the four species of micro-organisms

Lower the resistance of the micro-organism to the anti-microbial agent, greater is the potency of the agent

Probable Mechanism of Antimicrobial Action:

Recent publications have shown that monolaurin and lauric acid inhibit the replication of viruses by interrupting the binding of virus to host cells and thus preventing the uncoating of viruses necessary for replication and infection. Other studies have shown that monolaurin is able to remove all measurable infectivity by directly disintegrating the viral envelop. Binding of monolaurin to the viral envelop also makes the virus more susceptible to degradation by host defences, heat, or UV light.

Most studies focus on Monolaurin's effects on the bacterial cell envelope¹⁷. Composed of membranes these structures are critical barriers vital to the function of cells for the penetration, selective transport, or uptake of materials. When this membrane function is altered, reversible and irreversible changes may lead to the death of the cell.

The specific effect of Monolaurin on cell membranes may fit into several possible mechanisms:

1. Monolaurin is lipophilic by virtue of size⁴
2. As a monoglyceride, monolaurin is made up of a glycerol molecule to which is linked, lauric acid, a medium-chain (C12) fatty acid. The resulting size of the molecule is small enough to be readily dissolved in the lipid phase, and to penetrate cell membranes. Ionized

molecules such as those from conventional antibiotics whose mechanism of action acts more on bacterial enzymes, do not readily bridge the membrane barrier because of charge or size¹⁸

The effects of these theoretical considerations have in fact been demonstrated by fatty acids and especially monolaurin, another monoglyceride of a medium-chain fatty acid (C10), on the bacterium *Chlamydia*.¹⁰

In a novel 2-color fluorescent assay of viability and by electron microscopy, 5 minutes after treatment no visible changes in the bacteria were seen, but after 10 minutes the bacteria appeared deformed and partly disintegrated. In time, the cell membranes were shown to be partly or completely dehydrated causing cell lysis.

In similar experiments, Bergsson et al also demonstrated that *Staphylococcus aureus* is killed by medium-chain fatty acids and their monoglycerides, through disintegration of the cell membrane leaving the cell wall intact.

This mechanism of action, which has been described as novel,¹⁸ is similar to that described for some of the newer antibiotics for methicillin-resistant *Staphylococcus aureus* (MRSA) and other resistant organisms.

Antiviral properties:

Monolaurin was found to be active against enveloped DNA and RNA viruses such as the influenza virus, paramyxoviruses, rubeola virus, bronchitis virus, and the herpes family. However it had no effect on diseases caused by non-enveloped viruses such as polio virus, coxsackie virus, encephalomyocarditis virus, rhinovirus, and rotaviruses. Clinical Studies have shown that monolaurin is effective against Epstein-Barr virus, Influenza, Cytomegalovirus, and Herpes type I and II.

Antifungal:

Monolaurin is reported to be effective against yeast and fungi, *Chlamydia trachomatis*, *Candida albicans*, *Giardia lamblia* and *H. pylori*.

Antibacterial:

Monolaurin is effective against *Staphylococcus aureus* and *Streptococcus agalactiae*.

Nutraceutical Application:

Monolaurin does not appear to have an adverse effect on desirable digestive bacteria, but rather only on unwanted microorganisms. Internally, monolaurin has been regarded as safe⁷ and is fed to animals, comprising 25% of their total diet without any sign of harm. Since 1964, the US FDA has placed monolaurin on the list of generally recognized as safe (GRAS) substances⁷. It is a component of coconuts, which have a long safety record as food.¹⁹

Suggested Dosage : 1.0 to 5 % based on the intended application.

Cosmeceutical Application:

Monolaurin lends itself useful in formulations requiring antimicrobial activity.

It has an MIC of 40µ/ml i.e., at 0.004% as such against p. acnes and hence useful in anti-acne preparations. It also has a potential role as component of a natural preservative blend. Being a non-ionic surfactant, it can also be used in anti-microbial soaps and shampoos.

Suggested Dosage: 0.3 to 2 % based on the intended application.

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“The vision of a research scientist takes on social and commercial expressions.” This in short explains the genesis and growth of the Sabinsa – Sami Labs Group of Companies.

Company Profile:

Sabinsa Corporation, founded in 1988, is a manufacturer and supplier of herbal extracts, cosmeceuticals, minerals and specialty fine chemicals. Sabinsa’s mission is to provide alternative and complementary natural products for human nutrition and well - being. Over the past ten years, Sabinsa has brought to market more than 50 standardized botanical extracts and privately funded several clinical studies in conjunction with prestigious institutions in support of these products. Its present operations have grown to employ 1000 people worldwide in ten manufacturing, R&D and/or distribution facilities. Additionally, botanical cultivation efforts undertaken by the organization now total nearly 40,000 acres to ensure sustainable supplies on its key products. All products intended for human consumption are certified Kosher.

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