Method Version: GreenScreen® Version 1.2

Verified or Non-Verified: VERIFIED

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Expiration Date:	**October 22, 2016**
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GreenScreen® Verification Performed By:	Clean Production Action
	Date: October 22, 2013
	Verification Review Plan Prepared By: Dr. Eric Rosenblum
Verified GreenScreen® Prepared by Licensed Profiler:	Organization: ToxServices LLC
	Date: October 15, 2013

Lactic Acid (CAS #50-21-5) GreenScreen® Assessment

Prepared for:

Clean Production Action

Date:

October 15, 2013

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING
1367 Connecticut Ave., N.W., Suite 300
Washington, D.C. 20036

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GreenScreen® Executive Summary for Lactic Acid (CAS #50-21-5)

Lactic acid is a chemical that functions as an acidulant in food, beverage and bakery products; it is used in the textile and leather industries as a mordant in printing woolen goods, a solvent for water-insoluble dyes, and to reduce chromates in mordanting wool, and dehairing, plumping, and decalcifying hides, and in the chemical industry for various purposes.

GreenScreen® Benchmark Score for Relevant Route of Exposure:
Lactic acid (in liquid form) was assigned a GreenScreen® Benchmark Score of 2 ("Use but Search for Safer Substitutes") as it has a Very High hazard score for Skin and Eye Irritation/Corrosivity which are Group II* Human endpoints, due to the corrosiveness of highly concentrated lactic acid solutions (Appendix B). This corresponds to GreenScreen® benchmark classification 2f in CPA 2011. A data gap (DG) exists for Respiratory Sensitization (SnR*). Although a data gap exists, lactic acid meets requirements for a GreenScreen® Benchmark Score of 2 as outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), even with its hazard data gap. In a worst-case scenario, if lactic acid were assigned a H score for respiratory sensitization, the overall Benchmark Score for lactic acid will not be affected because it has been assigned hazard scores of vH for both eye and skin irritation.

GreenScreen® Hazard Ratings for Lactic Acid

Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeated*	single	repeated*										
L	L	*L*	L	*L*	M	L	L	M	*L*	L	DG	vH	vH	L	L	L	vL	L	L

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated (modeled) values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M and L) instead of three (i.e., H, M and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms

GreenScreen® Assessment for Lactic Acid (CAS #50-21-5)

GreenScreen® Version 1.2 Assessment

Chemical Name: Lactic Acid

CAS Number: 50-21-5

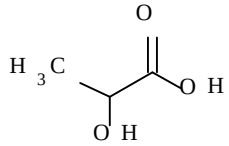
GreenScreen® Assessment Prepared By:
Name: Bingxuan Wang, Ph.D.

Title: Toxicologist
Organization: ToxServices LLC
Date: April 8, 2013 (Draft); May 29, 2013 (Revision #1); September 27, 2013 (Revision #2)

Quality Control Performed By:
Name: Dr. Margaret H. Whittaker, Ph.D., M.P.H., CBiol., F.S.B., E.R.T., D.A.B.T.
Title: Managing Director and Chief Toxicologist
Organization: ToxServices LLC
Date: April 11, 2013 (Draft); June 3, 2013 (Revision #1), October 15, 2013 (Revision #2)

Confirm application of the *de minimus* rule[1]: Not applicable, lactic acid is not a mixture

Chemical Structure(s):



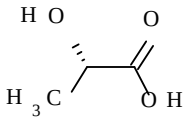
Lactic Acid (CAS #50-21-5)

Also called:
2-Hydroxypropanoic acid; 2-Hydroxypropionic acid; DL-Lactic acid; Lactic acid [USP:JAN]; Lactic acid, dl-; Propanoic acid, 2-hydroxy-; (+-)-2-Hydroxypropanoic acid; (RS)-2-Hydroxypropionsaeure; 1-Hydroxyethanecarboxylic acid; 2-Hydroxypropanoic acid; 2-Hydroxypropionic acid; EINECS 200-018-0; EINECS 209-954-4; Ethylidenelactic acid; Lactate; Lactic acid (natural); Lactic acid USP; Milk acid; Ordinary lactic acid; Propionic acid, 2-hydroxy-; Racemic lactic acid (ChemIDplus 2013)

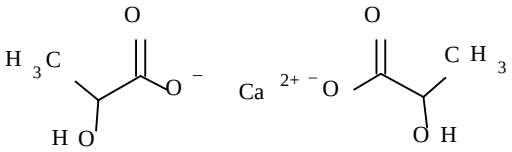
Chemical Structure(s) of Chemical Surrogates Used in the GreenScreen®:
Lactic acid (CAS #50-21-5) is the racemic mixture of lactic acid. Most suppliers of this chemical state that they only manufacture the natural form, L(+) lactic acid (CAS #79-33-4), and that most available hazard data are for this form. U.S. EPA adopted this selection of surrogate (U.S. EPA 2008). In addition, calcium lactate (CAS #814-80-2) is also used as a surrogate as lactic acid. Although lactic acid and calcium lactate are different chemicals in their purified forms, when they enter the body and come into contact with bodily fluids, both chemicals will dissociate to lactate and their respective cations, hydrogen in the case of lactic acid and calcium in the case of calcium lactate. Therefore, for non-local toxicity endpoints, calcium lactate and lactic acid are functionally equivalent as little hazard is expected from the hydrogen or calcium moieties.

[1] Every chemical in a material or formulation should be assessed if it is:
1. intentionally added and/or
2. present at greater than or equal to 100 ppm

AND Enantiomer



L-(+)-Lactic Acid (CAS #79-33-4)



Calcium Lactate (CAS #814-80-2)

Identify Applications/Functional Uses:
1. Acidulant in food, beverage and bakery products, 85% (HSDB 2006)
2. Textile and leather (as mordant in printing woolen goods; solvent for water-insoluble dyes; reducing chromates in mordanting wool; dehairing, plumping, and decalcifying hides), 10% (HSDB 2006)
3. Chemicals and miscellaneous, 5% (HSDB 2006)

GreenScreen® Summary Rating for Lactic Acid[2]: Lactic acid (in liquid form) was assigned a GreenScreen® Benchmark Score of 2 ("Use but Search for Safer Substitutes") as it has a Very High hazard score for Skin and Eye Irritation/Corrosivity which are Group II* Human endpoints, due to the corrosiveness of highly concentrated lactic acid solutions (Appendix B). This corresponds to GreenScreen® benchmark classification 2f in CPA 2011. A data gap (DG) exists for Respiratory Sensitization (SnR*). Although a data gap exists, lactic acid meets requirements for a GreenScreen® Benchmark Score of 2 as outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), even with its hazard data gap. In a worst-case scenario, if lactic acid were assigned a H score for respiratory sensitization, the overall Benchmark Score for lactic acid will not be affected because it has been assigned hazard scores of vH for both eye and skin irritation.

Figure 1: GreenScreen® Hazard Ratings for Lactic Acid

Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeated*	single	repeated*										
L	*L*	*L*	*L*	*L*	**M**	*L*	*L*	**M**	*L*	*L*	DG	*vH*	*vH*	*L*	*L*	*L*	*vL*	*L*	*L*

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated (modeled) values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M and L) instead of three (i.e., H, M and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms.

[2] For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.

Transformation Products and Ratings:

Identify relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) and/or moieties of concern[3]

When heated to decomposition, lactic acid emits acrid smoke and irritating fumes (HSDB 2006). Based on its molecular formula, possible combustion products of lactic acid are CO and CO_2, which are naturally occurring, ambient substances and not relevant with respect to the GreenScreen® Benchmark score for lactic acid.

Introduction

Lactic acid is an organic acid obtained synthetically or through the fermentation of carbohydrates. It is a high production volume (HPV) chemical in the United States. It is mainly used as an acidulant in food, beverages and bakery products. Additionally, it has been used in the textile and leather industry, in oil well acidizing, as an intermediate material for calcium lactate, sodium lactate and emulsifiers, and as a veterinary medication. Lactic acid occurs in sour milk, molasses, apples and other fruits, beer and wines. It is a principal metabolic intermediate in most living organisms and a constituent in animal blood and muscle tissues (HSDB 2006). The CAS # 50-21-5 refers to the racemic mixture of L (+) and L (-) lactic acid. Most of the suppliers of lactic acid only manufacture the natural form of lactic acid, L (+) lactic acid (CAS # 79-33-4), and most available hazard data are for this form. As a result, data on L (+) lactic acid are used to fill the data gaps (U.S. EPA 2008).

ToxServices assessed Lactic Acid against GreenScreen® Version 1.2 (CPA 2013) following procedures outlined in ToxServices' SOP 1.37 (GreenScreen® Hazard Assessment)(ToxServices 2013).

GreenScreen® List Translator Screening Results

The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to identify GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2013) is an online list-searching tool that is used to screen chemicals against the List Translator electronically. It checks all of the lists in the List Translator with the exception of the U.S. Department of Transportation (U.S. DOT) lists (U.S. DOT 2008a,b) and these should be checked separately in conjunction with running the Pharos query. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. The output for lactic acid can be found in Appendix C and a summary of the results can be found below:

Lactic acid has a high hazard for the following endpoints:

- Eye Irritation – GHS-New Zealand – Category 8.3A – corrosive to ocular tissue
- Skin Irritation – GHS-New Zealand – Category 8.2C – corrosive to dermal tissue

Lactic acid has a medium hazard for the following endpoints:

- Mammalian toxicity – GHS-New Zealand – Category 6.1D (Oral) – acutely toxic

Lactic acid is not listed on the U.S. DOT lists (U.S. DOT 2008a,b).

[3] A moiety is a discrete chemical entity that is a constituent part or component of a substance. A moiety of concern is often the parent substance itself for organic compounds. For inorganic compounds, the moiety of concern is typically a dissociated component of the substance or a transformation product.

PhysioChemical Properties of Lactic Acid

Lactic acid is a low molecular weight carboxylic acid that is a clear to slightly yellow liquid at room temperature. It has a high vapor pressure (0.0813 mm Hg), meaning that it is mostly in the vapor (gas) phase. It is very soluble in water with a solubility of 876 g/L, and is hydrophilic as suggested by the log K_{ow} of -0.62. Its dissociation constant of 3.86 indicates that it is a moderate to weak acid.

Table 1: Physical and Chemical Properties of Lactic Acid

Property	Value	Reference
Molecular formula	$C_3H_6O_3$	HSDB 2006
SMILES Notation	C([C@@H](C)O)(O)=O	ChemIDplus 2013
Molecular weight	90.0774 g/mol	ChemIDplus 2013
Physical state	Liquid	U.S. EPA 2008
Appearance	Clear to slightly yellow liquid	U.S. EPA 2008
Melting point	16.8°C	HSDB 2006
Vapor pressure	0.0813 mm Hg at 25°C	HSDB 2006
Water solubility	876 g/L	U.S. EPA 2008
Dissociation constant	3.86 at 20°C	HSDB 2006
Density/specific gravity	1.2 g/cm^3	HSDB 2006
Partition coefficient	Log Kow = -0.62	U.S. EPA 2008

Hazard Classification Summary Section:

Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M or L): L

Lactic acid was assigned a score of L for carcinogenicity based on negative findings in a study using calcium lactate and the fact that lactic acid occurs in a variety of foods and is a normal metabolite in humans. GreenScreen® criteria classify chemicals as a Low hazard for carcinogenicity when adequate data are available and negative, and when chemicals have no structural alerts and they are not classified by GHS (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- ECHA 2013
  - In a 2-year carcinogenicity study (GLP status unknown), F344 rats (50/dose/sex) received calcium lactate (CAS #814-80-2), a food additive, in drinking water *ad libitum* at concentrations of 2.5 or 5% (equivalent to 2,662 and 5,324 mg/kg/day for males and 2,975 and 5,949 mg/kg/day for females[4]). Clinical signs, mortality, body weight, water

[4] According to U.S. EPA (1988), water intake for F344 rats in chronic studies are 0.049 and 0.033 L/day for males and females, respectively. Body weights are 0.380 and 0.229 kg for male and female F344 rats, respectively, in a chronic study. 5% in drinking water is therefore equivalent to (50,000 mg/L x 0.049 L/day)/0.38 kg = 6,447 mg/kg/day for males and (50,000 mg/L x 0.033)/0.229 = 7,205 mg/kg/day for females. The 2.5% doses are half of these values and are 3,224 and 3,603 mg/kg/day for males and females, respectively. The molecular weight of calcium lactate is 218 g/mol, and therefore 6,447 mg/kg is 6,447 (mg/kg/day) / 218 (mg/mmol) = 29.58 mmol/kg/day. Each molecule of calcium lactate contains 2 lactate ions. Therefore, 29.58 mmol/kg/day of calcium lactate is equivalent to 29.58 mmol/kg/day x 90 mg/mmol x 2 = 5,324 mg/kg/day lactic acid for high dose males.

consumption, hematology, clinical chemistry, organ weights, gross pathology and histopathology were evaluated. No statistically significant dose-related increase of tumor incidences was found in any organ or tissue. The results indicated that calcium lactate was neither toxic nor carcinogenic in the study.

- In a 5 - 13-month study in rabbits, animals received L-lactic acid (CAS #79-33-4) in drinking water given twice daily at the doses of 100 – 200 mg/kg/day (5 months) and 100 – 700 mg/kg/day (13 months). No tumors were reported after 5 or 16 months. No additional details were provided.

Mutagenicity/Genotoxicity (M) Score (H, M or L): L

Lactic acid was assigned a score of L for mutagenicity/genotoxicity based on negative findings for mutagenicity and chromosomal aberration in *in vitro* studies. These findings would result in no classification under GHS (UN 2013). In addition, lactic acid lacks structural alerts for mutagenicity and is a natural component of mammalian metabolism. GreenScreen® criteria classify chemicals as a Low hazard for mutagenicity/genotoxicity when adequate data are available and are negative for both chromosomal aberrations and gene mutations, when no structural alerts are identified, and the chemical is not classified for mutagenicity/genotoxicity under GHS (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- U.S. EPA 2008
  - In a study conducted by the National Toxicology Program (NTP), lactic acid was not mutagenic in *Salmonella typhimurium* tester strains TA 97, TA 98, TA100 and TA1535 at concentrations up to 10,000 µg/plate in the presence and absence of metabolic activation.
  - In an *in vitro* chromosome aberration assay, lactic acid was not clastogenic in Chinese hamster ovary cells at concentrations of 8-35 mM, with and without metabolic activation.
- Sawatari et al. 2001
  - Lactic acid lacks structural alerts for mutagenicity as the carboxylic acid functional group is not a structural alert for this endpoint.

Reproductive Toxicity (R) Score (H, M, or L): *L*

Lactic acid was assigned a score of *L* for reproductive toxicity based on limited negative data in rats and expert judgment. GreenScreen® criteria classify chemicals as a *Low* hazard for reproductive toxicity when there is limited evidence of no adverse reproductive effects (CPA 2012a). This hazard score is considered to be low confidence based on the lack of detail available for the study identified for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- No relevant data were identified. However, testing is not deemed necessary because the substance is a normal component of human intermediary metabolism (U.S. EPA 2008).
- D'Amour 1934
  - In a dietary study, rats (strain, sex or number not specified) were fed stock diet supplemented with 0, 2.5 or 5% lactic acid prior to breeding and through pregnancy to parturition. The sex ratio of the offspring was not affected by the treatment. No further information was provided.

        - Changes in sex ratio can be viewed as either a reproductive or developmental toxicity endpoint depending on when the parental exposures occurred. Since the exposures were initiated prior to breeding and continued until birth, it is not clear if effects on sex ratio, or lack of effects in the case of lactic acid, should be classified under reproductive or developmental toxicity. Mechanistic data explaining changes in sex ratio following chemical exposure suggest that effects on sex ratio may be due to differential fertilization capacity between X chromosome-bearing and Y chromosome-bearing sperm (Ishihara et al. 2010). Therefore, ToxServices considers effects on sex ratio to be an aspect of reproductive toxicity and concludes that this should be classified under reproductive toxicity and not developmental toxicity.
- Lactic acid is a normal component of mammalian metabolism. Based on limited available data and expert judgment, the reproductive toxicity potential of lactic acid is low.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L): L
Lactic acid was assigned a score of L for developmental toxicity based on negative findings in mice exposed orally to the chemical up to 570 mg/kg/day. GreenScreen® criteria classify chemicals as a Low hazard for developmental toxicity when adequate data are available and negative, no structure alerts are present and they have not been classified by GHS (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* not listed in any authoritative lists
    - *Screening:* not listed in any screening lists
- U.S. EPA 2008
    - Lactic acid was administered to pregnant CD-1 mice via gavage at doses of 0 or 570 mg/kg/day during days 6-15 of gestation. No maternal or developmental effects were seen at this dose. No further details were provided. The NOAEL was established at 570 mg/kg/day.

Endocrine Activity (E) Score (H, M or L): *L*
Lactic acid was assigned a score of *L* for endocrine disruption based on an assessment by the U.S. EPA that lactic acid and its metabolites are not expected to cause adverse effects to the endocrine system. GreenScreen® criteria classify chemicals as a Low hazard for endocrine activity when adequate data are available and negative, no structure alerts are present and they have not been classified by GHS (CPA 2012a). This hazard score is considered to be low confidence based on the lack of experimental data available for this endpoint.

Authoritative and Screening Lists

- *Authoritative:* not listed in any authoritative lists
- *Screening:* not listed in any screening lists

- Not listed as a potential endocrine disruptor on the EU Priority List of Suspected Endocrine Disruptors.
- Not listed as a potential endocrine disruptor on the OSPAR List of Chemicals of Possible Concern.
- U.S. EPA 2009
    - As part of a weight of evidence analysis, the U.S. EPA concluded that there is no evidence that a metabolite of lactic acid acts in an endocrine-disrupting manner. As lactic acid is naturally occurring in plants and animals and is a component of cellular energy production, the U.S. EPA expects no adverse effects to the endocrine system to result from exposures to lactic acid.

Group II and II* Human Health Effects (Group II and II* Human)

Note: Group II and Group II* endpoints are distinguished in the v 1.2 Benchmark system. For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints and test data for single or repeated exposures may be used. If data exist for single OR repeated exposures, then the endpoint is not considered a data gap. If data are available for both single and repeated exposures, then the more conservative value is used.

Acute Mammalian Toxicity (AT) Group II Score (vH, H, M or L): M

Lactic acid was assigned a score of M for acute toxicity based on the oral LD_{50} of 1,810 mg/kg in guinea pigs. GreenScreen® criteria classify chemicals as a Moderate hazard for acute toxicity when oral LD_{50} values are between 300 and 2,000 mg/kg (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* GHS-NZ – Category 6.1D (oral) – acutely toxic (equivalent to GHS Category 4 (oral) for acute mammalian toxicity)
- ECHA 2013
  - *L(+) lactic acid:* oral LD_{50} (male rat) = 4936 mg/kg; oral LD_{50} (female rat) = 3,543 mg/kg
  - *L(+) lactic acid*: inhalation LC_{50} (4h, rat) > 7.94 mg/L
- ChemIDplus 2013
  - Oral LD_{50} (guinea pig) = 1,810 mg/kg
  - Oral LD_{50} (mouse) = 4,875 mg/kg
  - Oral LD_{50} (quail) > 2,250 mg/kg
  - Dermal LD_{50} (rabbit) > 2,000 mg/kg
- HSDB 2006
  - In humans, accidental intraduodenal administration of 100 mL 33% lactic acid was fatal within 12 hours.

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)

***Group II Score (single dose)* (vH, H, M or L): L**

Lactic acid was assigned a score of L for systemic toxicity (single dose) based on the lack of systemic toxic effects at oral doses up to 2,000 mg/kg, dermal doses up to 2,000 mg/kg and inhalation doses up to 7.94 mg/L (4-hour exposure). GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (single dose) when systemic adverse effects are not observed at oral doses less than 2,000 mg/kg, at dermal doses less than 2,000 mg/kg, and inhalation doses less than 10 mg/L (4-hour exposure) (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- ECHA 2013
  - *L(+) lactic acid*: in an acute oral toxicity study performed under GLP according to Guideline EPA OPP 81-1, L(+) lactic acid was administered to albino rats (5/dose/sex) via gavage (vehicle: water) at single doses of 3162, 3548, 3981, 4467, 5012, 5623 and 6310 mg/kg and the study lasted 14 days or less. Mortality, clinical signs, body weight and gross pathology were evaluated. One female died at the low dose, two died at 3548 mg/kg, and all five females died at each of the highest five doses. No males died at the three lowest doses, 1 died at 4467 mg/kg, three died at 5012 mg/kg, 4 died at 5523 mg/kg, and five died at the highest dose. Lethargy, ataxia, prostration, irregular

breathing, piloerection, squinting, lacrimation, salivation, crusty eyes and muzzle, loose stools, and damp or yellow/brown stained fur were observed, and animals were moribund (doses unspecified) as early as 0 – 1 hour after dosing and as late as day 2. Body weights were increased consistently on days 7 and 14 for all surviving animals. Abnormal pathology was observed at necropsy in animals found dead and in the 4 surviving females at 3,162 mg.kg group, including discolored lungs, firm texture of lungs, green foci on the lung, several stomach lesions, discolored liver, white foci on the liver, pale capsular areas, superficial erosion or mottled liver, discolored kidney and red-brown exudate in the nasal and/or oral regions. No other abnormalities were observed during necropsy of all main study animals.

- U.S. EPA 2008
    - *L(+) lactic acid* : In an acute oral toxicity study, Charles River rats (5/sex) received L(+) lactic acid via gavage at 5,000 mg/kg in water and were observed for up to 14 days. One male and all females died on the day of dosing, day 1 or day 10. Four males survived the 14-day study. Three of the surviving animals had body weight gains while one had a small weight loss. All the animals that were found dead had reduced body weights. Clinical signs for some animals on the day of dosing up through day 2 were ataxia, prostration, irregular breathing, squinting, lacrimation, crusty eyes, crusty nose and a body cool to touch.
    - *L(+) lactic acid* : In an acute inhalation toxicity study, Fischer 344 rats (5/sex/dose) were exposed nose-only to L(+) lactic acid as an aerosol at 7.94 mg/L for 4 hours and then observed for 14 days. As lactic acid is a liquid under standard conditions, it would exist as droplets in an aerosol and therefore this exposure should be considered a mist when considering GreenScreen® hazard rankings. Rapid breathing and lacrimation were observed in the treated animals. One and 3 hours after exposure, all the animals displayed hunched posture and red stained fur around the eyes (tearing), ruffled fur and appeared ungroomed with soiled fur. Rats appeared lethargic at 1 and 3 hours of exposure in two and five females, respectively. The 2 females that were lethargic after 1-hour exposure had rapid, shallow breathing and appeared to be gasping briefly following exposure. Most animals appeared to have recovered from lethargy and unkempt fur by 24 hours. Four females had ruffled and ungroomed fur until post-treatment day 4. One female had rapid, shallow breathing and slight tremors on day 5 post-treatment. Another female died on day 8. It was hunched with labored breathing and gasping on Day 7. No gross lesions were observed at necropsy.
    - *L(+) lactic acid* : In an acute dermal toxicity study, male and female New Zealand White rabbits (10 total) were dermally administered L(+) lactic acid in water to clipped, abraded skin at 2,000 mg/kg under occlusive conditions for 2 hours and observed for 14 days. All animals survived and gained weight during the study period. No abnormal clinical signs were found. Severe erythema and edema were found in all animals on day 1 at the application sites. The severity of erythema and/or edema decreased as early as day 2, and was absent in 1 female on day 12 and in 1 male and one female on day 14. Other local effects included blanching, necrosis, eschar formation, atonia, desquamation and denuded areas. A dark red focus was observed on the lung of one male.
- HSDB 2006
    - Several cases of acetic acid, trichloracetic acid and lactic acid poisoning all reported esophageal strictures and gastric lesions.
    - In general, on the basis of animal studies and human use, the most significant effects of lactate esters are respiratory, dermal, and ocular irritation which may be associated with

the formation of lactic acid, a product of hydrolysis of lactate esters.

- Based on the weight of evidence, lactic acid is practically non-toxic to animals via the oral route of exposure with irreversible adverse effects observed at doses higher than 2,000 mg/kg. For the inhalation route of exposure, most of the animals had symptoms but survived the 4-hour dose of 7.94 mg/L. Although, 1 animal died during the inhalation study and this mortality appeared to be related to the treatment, no gross lesions were observed during necropsy and the cause of death was not identified. For the dermal route of exposure, only local signs of irritation without significant systemic toxicity were observed at 2,000 mg/kg. Reversible narcotic effects were observed in some animals after oral and inhalation exposure and are discussed in the Neurotoxicity section below. Respiratory irritation may occur in humans.

Group II* Score (repeated dose) **(H, M, or L): L**

Lactic acid was assigned a score of L for systemic toxicity (repeated dose) based on an oral NOAEL of 500 mg/kg/day in rats in a subchronic study using the surrogate chemical calcium lactate. GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (repeated dose) when effect levels are greater than 100 mg/kg/day via the oral route of exposure (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- U.S. EPA 2008
  - *Calcium lactate:* in a 13-week oral toxicity study, F344 rats (5/sex/dose) received calcium lactate via drinking water at 0, 0.3, 0.6, 1.25, 2.5 and 5% (approximately 0, 30, 60, 125, and 500 mg/kg/day, respectively, according to U.S. EPA, However, these dose levels do not appear correct and ToxServices calculated the equivalent doses as 0, 400, 799, 1665, 3330 and 6660 mg/kg/day lactic acid, respectively[5]). A less than 10% decrease in body weight gain was noted in all dose groups compared to control. Changes in some hematological and biochemical parameters were observed while no severe toxicological findings were found upon histological examination. In another study, F344 rats (10/sex) were exposed to synthetic diet containing 0, 5, 10, 20 or 30% calcium lactate (equivalent to 0, 4397, 8794, 17588 and 26382 mg/kg/day lactic acid)[6] for 20 weeks. Some animals (5/sex/dose) were autopsied in the 8th week while the remaining rats were sacrificed in the 20th week. Body weight gain was decreased in the highest dose group. Histological examination revealed nephrocalcinosis in all groups including the control group, but the degree of occurrence was dose-dependent and females had worse symptoms than males. In a follow-up study, male F344 rats (10/group) were given either the base diet or synthetic diet (no calcium lactate in either diet) for 8 weeks. Five rats from each group were sacrificed in the 4th week while the remaining rats were sacrificed in the 8th week. Nephrocalcinosis was found only in the group given synthetic diet. The authors concluded that nephrocalcinosis was dependent on the low Ca/P ratio (<1) of the synthetic diet. A NOAEL of 6,660 mg/kg/day was established based on the absence of

[5] According to U.S. EPA (1988), water factors for F344 rats in subchronic studies are 0.156 and 0.169 kg/kg/day for males and females, respectively, giving rise to an average of 0.1625 L/kg/day. 5% in drinking water is therefore equivalent to 50,000 mg/L x 0.1625 L/kg/day = 8,125 mg/kg/day. The molecular weight of calcium lactate is 218 g/mol, and therefore 8,125 mg/kg is 8.125 (g)/218 (g/mol) = 0.037 mol/kg. Each molecule of calcium lactate contains 2 lactate ions. Therefore, 0.037 mol/kg/day of calcium lactate is equivalent to 0.037 mol/kg/day x 90 g/mol x 2 x 1000 mg/g = 6660 mg/kg/day lactic acid

[6] According to U.S. EPA (1988), food factors for F344 rats in subchronic studies are 0.100 and 0.113 kg/kg/day in males and females, respectively, giving rise to an average food factor of (0.100 + 0.113)/2 = 0.1065 kg/kg/day. Thus, 5% calcium lactate in the diet is equivalent to 5% x 0.1065 kg/kg/day x 1,000,000 mg/kg = 5,325 mg/kg/day calcium lactate. Using the same method as described in footnote 4, This level is equivalent to 5325/218 x 90 x 2 = 4397 mg/kg/day lactic acid.

effects at the highest dose tested in the initial study, and a LOAEL of 4,397 mg/kg/day for nephrocalcinosis was observed in the 2nd study.

- ECHA 2013
  - *L(+) lactic acid* : In a dermal toxicity study, L(+) lactic acid in a face cream at 0.2125% (886 mg/kg/day) was applied topically to female Sprague-Dawley rats (15/group) 5 days/week for 13 weeks. Animals were observed daily and blood and urine were analyzed during weeks 7 and 13 from randomly selected animals. All animals survived to the end of the study. No significant gross observations except minimal skin irritation throughout the study could be attributed to dosing. Blood urea nitrogen was significantly increased in treated animals compared to controls during week 7 without other hematological effects or urinary parameter changes. Absolute brain weight and relative kidney weight were statistically significantly increased for the test animals. No microscopic findings were observed at necropsy. The study authors concluded that this formulation is "safe in terms of cumulative toxicity" and that "based upon the exaggerated dose level used in this study for skin care products, dermal application is not likely to produce adverse effects under conditions of consumer use." A LOAEL of 886 mg/kg/day was established (presumably based on increases in blood urea nitrogen values, absolute brain weights and relative kidney weights).
- Based on the weight of evidence, no significant systemic/target organ toxicity occurred in animals up to 500 mg/kg/day (oral). Data in the dermal toxicity study are not sufficient to determine the repeated dose toxicity of lactic acid because a mixture was tested.

Neurotoxicity (N)

***Group II Score (single dose)* (vH, H, M or L): M**

Lactic acid was assigned a score of M for neurotoxicity (single dose) based on lethargic effects, including ataxia and lethargy, in single dose studies in animals, which classify the chemical as GHS Category 3 Single Exposure. GreenScreen® criteria classify chemicals as a Moderate hazard for neurotoxicity (single dose) when they are classified as GHS Category 3 Single Exposure (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006).
- ECHA 2013
  - *L(+) lactic acid* : In the acute oral toxicity study described under single dose acute toxicity section above, rats received single doses of lactic acid at 3162, 3548, 3981, 4467, 5012, 5623 and 6310 mg/kg via gavage. Lethargy, ataxia, prostration, irregular breathing, piloerection and squinting were noted (dose levels not reported).
- U.S. EPA 2008
  - *L(+) lactic acid:* In the acute oral toxicity study described above in the single dose systemic toxicity section, single gavage doses of lactic acid at 5,000 mg/kg caused ataxia, prostration, irregular breathing and squinting were observed up through day 2 post exposure.
  - *L(+) lactic acid:* In the acute inhalation toxicity study described above in the single dose systemic toxicity section, 4-hour exposure to lactic acid at 7.94 mg/L caused lethargy in some female animals during exposure, most of which subsidized by 24 hours. One female had rapid, shallow breathing and slight tremors on day 5 post-treatment.
  - *L(+) lactic acid:* In the acute dermal toxicity study in rabbits described above in single

dose systemic toxicity section, lactic acid at the single dose of 2,000 mg/kg induced local atonia at the application sites.

- Neurotoxic effects are not expected after exposure to lactic acid as it is a naturally-occurring metabolite in the body. However, ataxia and/or lethargy were observed in two oral single-dose studies and one inhalation single-dose study so they are not likely to be sporadic effects. Based on GHS guidance (UN 2013), narcotic effects in animal studies may include "lethargy, lack of coordination righting reflex, narcosis, and ataxia." As both ataxia and lethargy can be included in the GHS's definition of narcotic effects and lacking mechanistic or pathological data pointing to systemic effects, ToxServices considers the ataxia and lethargy observed in the acute studies to reflect narcotic effects. Based on the weight of evidence, lethargy and ataxia indicative of narcotic effects were observed in animals exposed to relatively high single doses of lactic acid.

Group II* Score (repeated dose) **(H, M, or L):** *L*

Lactic acid was assigned a score of *L* for neurotoxicity (repeat dose) based on it being a normal metabolite in the body and it not being considered a repeat dose neurotoxicant. GreenScreen® criteria classify chemicals as a Low hazard for neurotoxicity (repeat dose) when there are adequate data and negative studies, no structural alerts, and no classification under GHS are available (CPA 2012a). This hazard score is considered to be low confidence based on the lack of experimental data available for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006).
- Clary et al. 2001
  - L-lactic acid is a natural component of metabolism and is not considered to be neurotoxic.

Skin Sensitization (SnS) Group II* Score (H, M or L): L

Lactic acid was assigned a score of L for skin sensitization based on negative findings in sensitization studies in guinea pigs. GreenScreen® criteria classify chemicals as a Low hazard for skin sensitization when adequate data are available and negative, no structure alerts are present and they have not been classified by GHS (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- ECHA 2013
  - *L(+) lactic acid*: Lactic acid was not sensitizing in female Hartley guinea pigs in a Buehler test performed according to the Guideline EPA OPP 81-6 under GLP.
  - *L(+) lactic acid*: Lactic acid was not sensitizing to guinea pigs in a guinea pig maximization test. No further information was provided

Respiratory Sensitization (SnR) Group II* Score (H, M or L): DG

Lactic acid was assigned a score of DG for respiratory sensitization based on lack of data.

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- No relevant data were identified for lactic acid or its surrogates, L-(+) lactic acid (CAS #79-33-4) and calcium lactate (CAS #814-80-2).

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M or L): vH

Lactic acid was assigned a score of vH for skin irritation/corrosivity based on severe skin irritation and corrosivity in rabbits (for concentrated solutions), classifying the chemical to GHS Category 1 (Corrosive). GreenScreen® criteria classify chemicals as a very High hazard for skin irritation/corrosivity when they are classified as GHS Category 1 (Corrosive) (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* GHS-NZ – Category 8.2C – corrosive to dermal tissue (equivalent to GHS Category 1C for skin corrosion/irritation)
- U.S. EPA 2008
  - Buffered lactic acid was not irritating to rabbit skin (occlusive, 4 hours, intact skin)
  - *L(+) lactic acid:* The chemical (0.5 mL of an 88% solution) was severely irritating and corrosive to rabbit skin (occlusive, 4-h, intact and abraded skin).
  - *L(+) lactic acid:* The chemical (0.5 mL of an 80% solution) was severely irritating and corrosive to rabbit skin (occlusive, 24-h, intact and abraded skin).
  - *L(+) lactic acid:* The chemical (0.5 mL of an 88% solution) was slightly irritating to guinea pig skin (semi-occlusive, up to 4 h).
  - *L(+) lactic acid:* The chemical (0.5 mL of an 88% solution) was not irritating to guinea pig skin (occlusive, up to 4 h).
- HSDB 2006
  - In a human skin test, 49 atopic and 56 nonatopic patients received application of 2.5% lactic acid in water. Finn chambers containing 20 µL test solution were fixed on the skin using porous tape for 20 min. No immediate reactions were seen.
- ECHA 2013
  - *L(+) lactic acid* : In a dermal toxicity study, L(+) lactic acid in a face cream at 0.2125% (886 mg/kg/day) was applied topically to female Sprague-Dawley rats (15/group) 5 days/week for 13 weeks. Animals were observed daily and blood and urine were analyzed during weeks 7 and 13 from randomly selected animals. All animals survived to the end of the study. No significant gross observations except minimal skin irritation throughout the study could be attributed to dosing.

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M or L): vH

Lactic acid was assigned a score of vH for eye irritation/corrosivity based on classification as R41 under EC scheme in an eye irritation test using chicken eyes and on GHS classification of category 1 by GHS-NZ (for concentrated solutions). GreenScreen® criteria classify chemicals as a very High hazard for eye irritation/corrosivity when they are associated with EU Risk Phrase R41 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* GHS-NZ – Category 8.3A – corrosive to ocular tissue (equivalent to GHS Category 1 for eye irritation).
- U.S. EPA 2008 (ECHA 2013)
  - *L(+) lactic acid:* the chemical (0.03 mL of 88% lactic acid in water) was severely irritating to the chicken eye in a chicken enucleated eye test performed under GLP. According to the EC classification scheme, this material can be considered a R41 (severely irritating to eyes).
- ECHA 2013
  - *L(+) lactic acid:* the chemical (85%) is irritating to the eyes. No further information was provided.

- HSDB 2006
    - The lactic acid's effect on human eyes is similar to that of other acid of moderate strength, causing initial epithelial coagulation on cornea and conjunctiva. Its injurious effect is presumably attributed to its acidity, since lactate ion is a normal and nontoxic constituent of body fluids.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M or L): L
Lactic acid was assigned a score of L for acute aquatic toxicity based on measured acute aquatic L/EC_{50} values of over 100 mg/L. GreenScreen® criteria classify chemicals as a Low hazard for acute aquatic toxicity when L/EC_{50} values are over 100 mg/L (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* not listed in any authoritative lists
    - *Screening:* not listed in any screening lists
- ECHA 2013
    - *L(+) lactic acid:* 96h LC_{50} (*Oncorhyncus mykiss*, rainbow trout) = 130 mg/L (No GLP-status provided, EP-669/3-75-009)
    - *L(+) lactic acid:* 96h LC_{50} (*Lepomis macrochirus*, bluegill sunfish) = 130 mg/L (GLP-compliant, EPA-669/3-75-009)
    - *L(+) lactic acid:* 96h LC_{50} (*Danio rerio*, zebra fish) = 195 mg/L (GLP-compliant, OECD 203)
    - *L(+) lactic acid:* 48h EC_{50} (*Daphnia manga*, mobility) = 130 mg/L (GLP-compliant, OECD 202)
    - *L(+) lactic acid:* 48h EC_{50} (*Daphnia manga*, mobility) = 750 mg/L (GLP-compliant, EP 660/3-75-009)
    - *L(+) lactic acid:* 72h EC_{50} (*Pseudokirchnerella subcapitata*, green algae, growth rate) = 3,500 mg/L, 72h EC_{50} (*Pseudokirchnerella subcapitata*, green algae, biomass) > 2,800 mg/L (GLP-compliant, OECD 201)

Chronic Aquatic Toxicity (CA) Score (vH, H, M or L): L
Lactic acid was assigned a score of L for chronic aquatic toxicity based on a 72-hour NOEC of 1,900 mg/L for green algae and modeled values greater 3,000 mg/L for fish and daphnia. GreenScreen® criteria classify chemicals as a Low hazard for chronic aquatic toxicity when chronic effect levels are greater than 10 mg/L (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* not listed in any authoritative lists
    - *Screening:* not listed in any screening lists
- ECHA 2013
    - *L(+) lactic acid:* 72h growth rate NOEC (*Pseudokirchnerella subcapitata*, green algae) = 1,900 mg/L (GLP-compliant, OECD 201).
- No other measured data are available for lactic acid. Therefore, modeling of the chronic aquatic toxicity endpoint was performed with ECOSAR (U.S. EPA 2012) (See Appendix D).
    - U.S. EPA 2012
        - Fish chronic value = 12,975 mg/L
        - Daphnid chronic value = 3,888 mg/L
        - Green Algae chronic value = 3,241 mg/L
- Using a weight of evidence approach, lactic acid does not appear to be a chronic aquatic toxicant.

The measured NOEC value for green algae is exceeds the 10 mg/L cutoff for a low hazard under GreenScreen® by two orders of magnitude. The chronic value for algae estimated with ECOSAR is in the same order of magnitude as the measured value indicating a reasonable degree of accuracy for the model. The estimated values for fish and daphnia also indicate a low hazard for these trophic levels. Therefore, ToxServices considers lactic acid to be a low chronic hazard for aquatic biota.

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): L
Lactic acid was assigned a score of L for persistence based on biodegradability in tests that did not meet the 10-day window. GreenScreen® criteria classify chemicals as a Low hazard for persistence when biodegradation half-lives are less than 16 days and but do not meet the 10-day window (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- ECHA 2013
  - *L(+) lactic acid*: In a ready biodegradability test conducted according to EU Method C.5 and C.6 under GLP, the BOD5 and BOD20 are 50% and 67% of COD, respectively, indicating that the chemical is readily biodegradable.
  - *L(+) lactic acid*: In a ready biodegradability test conducted according to EU Method C.5 and C.6 under GLP, more than 60% lactic acid was degraded within 20 days and therefore it is readily biodegradable. However, it failed the 10-day window.

Bioaccumulation (B) Score (vH, H, M, L, or vL): vL
Lactic acid was assigned a score of vL for bioaccumulation based on a calculated BCF of 3 and a measured Log Kow of -0.62. GreenScreen® criteria classify chemicals as a very Low hazard for bioaccumulation when BCFs are smaller than 100 and Log Kow values are less than 4 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- HSDB 2006
  - An estimated BCF of 3.2 was calculated for lactic acid using an estimated log Kow of -0.72.
- U.S. EPA 2008
  - An estimated BCF of 3 was calculated for lactic acid using a measured log Kow of -0.62.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M or L): L
Lactic acid was assigned a score of L for reactivity based on non-explosiveness. GreenScreen® criteria classify chemicals as a Low hazard for reactivity when they are not explosive as long as there are no data stating otherwise (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* not listed in any authoritative lists
  - *Screening:* not listed in any screening lists
- ICSC 1997

    - Lactic acid is not listed as an explosive or reactive chemical.
- Sigma-Aldrich 2012
    - NFPA Rating for Reactivity Hazard: 0

Flammability (F) Score (vH, H, M or L): L

Lactic acid was assigned a score of L for flammability based on not being classified as a flammable liquid under GHS. GreenScreen® criteria classify chemicals as a Low hazard for flammability when they are not classified as flammable liquids under GHS (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* not listed in any authoritative lists
    - *Screening:* not listed in any screening lists
- ICSC 1997
    - Combustible
    - Flash point: 110℃.
        - According to GHS categorization (UN 2013), lactic acid is not a flammable liquid as its flash point is higher than 93℃.
- *L(+) Lactic acid*: Sigma Aldrich
    - NFPA rating for Fire: 1
    - HMIS classification for flammability: 1
    - Not dangerous goods (DOT)

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APPENDIX A: Hazard Benchmark Acronyms
(in alphabetical order)

(AA) Acute Aquatic Toxicity

(AT) Acute Mammalian Toxicity

(B) Bioaccumulation

(C) Carcinogenicity

(CA) Chronic Aquatic Toxicity

(Cr) Corrosion/ Irritation (Skin/ Eye)

(D) Developmental Toxicity

(E) Endocrine Activity

(F) Flammability

(IrE) Eye Irritation/Corrosivity

(IrS) Skin Irritation/Corrosivity

(M) Mutagenicity and Genotoxicity

(N) Neurotoxicity

(P) Persistence

(R) Reproductive Toxicity

(Rx) Reactivity

(SnS) Sensitization- Skin

(SnR) Sensitization- Respiratory

(ST) Systemic/Organ Toxicity

APPENDIX B: Results of Automated GreenScreen® Score Calculation for Lactic Acid (CAS #50-21-5)

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GREEN SCREEN FOR SAFER CHEMICALS

GreenScreen™ Score Inspector

Table 1: Hazard Table

	Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
	Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
							S	R *	S	R *	*	*								
Inorganic Chemical?	Chemical Name	CAS#	C	M	R	D	E	AT	STs	STr	Ns	Nr	SNS*	SNR*	IrS	IrE	AA	CA	P	B	Rx	F
No	Lactic Acid	50-21-5	L	L	*L*	L	*L*	M	L	L	M	*L*	L	DG	vH	vH	L	L	L	vL	L	L

Table 3a: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	No	No	No		
2	No	No	No	No	No	Yes	No
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen™ Benchmark Score
Lactic Acid	2

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

Chemical Name	Final GreenScreen™ Benchmark Score
Lactic Acid	2

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												
2	Yes	Yes	Yes	Yes	Yes							2
3												
4												

APPENDIX C: Pharos Output for Lactic Acid (CAS #50-21-5)

LACTIC ACID

CAS RN: 50-21-5

Direct Chemical and Compound Hazard Quickscreen — Detailed Hazard Listings

High Hazard of...

EYE IRRITATION	New Zealand HSNO/GHS (GHS-New Zealand): 8.3A - Corrosive to ocular tissue - GreenScreen Benchmark Unspecified
SKIN IRRITATION	New Zealand HSNO/GHS (GHS-New Zealand): 8.2C - Corrosive to dermal tissue - GreenScreen Benchmark Unspecified

Medium Hazard of...

MAMMALIAN	New Zealand HSNO/GHS (GHS-New Zealand): 6.1D (oral) - Acutely toxic - GreenScreen Benchmark Unspecified
TERRESTRIAL	New Zealand HSNO/GHS (GHS-New Zealand): 9.3C - Harmful to terrestrial vertebrates - Not evaluated by GreenScreen

This chemical is NOT present on the hazard lists scanned for the following health and ecotoxicity endpoints...

PBT	CANCER	DEVELOPMENTAL	REPRODUCTIVE	ENDOCRINE
GENE MUTATION	RESPIRATORY	NEUROTOXICITY	SKIN SENSITIZE	ORGAN TOXICANT
ACUTE AQUATIC	CHRON AQUATIC	FLAMMABLE	REACTIVE	GLOBAL WARMING
OZONE DEPLETION	RESTRICTED LIST			

Lifecycle Hazard Quickscreen — Full Lifecycle Map

Research Status: Preliminary literature review drafted
The Pharos team has undertaken a preliminary literature review of some of the processes involved in the manufacture of this substance and identified the following chemicals. This list of chemicals is not exhaustive of all chemicals that may be involved in the production or life cycle of this substance.

May contain residual manufacturing chemicals that have a hazard of...

Comes from additional manufacturing chemicals that have a hazard of...

Description:

"The basic building block for poly(lactic) acid is lactic acid, which was first isolated in 1780 from sour milk by the Swedish chemist Scheele and first produced commercially in 1881. Food-related applications are the major use of lactic acid in the United States and account for about 85% of the commercially produced product. It is used as a buffering agent, acidic flavoring agent, acidulant, and bacterial inhibitor in many processed foods. Lactic acid can be manufactured either by carbohydrate fermentation or chemical synthesis, although fermentation predominates.' (USDA)

APPENDIX D: ECOSAR Output for Lactic Acid (CAS #50-21-5)

ECOSAR Version 1.11 Results Page

SMILES : O=C(O)C(O)C
CHEM : Propanoic acid, 2-hydroxy-
CAS Num: 000050-21-5
ChemID1:
MOL FOR: C3 H6 O3
MOL WT : 90.08
Log Kow: -0.649 (EPISuite Kowwin v1.68 Estimate)
Log Kow: (User Entered)
Log Kow: -0.72 (PhysProp DB exp value - for comparison only)
Melt Pt: (User Entered for Wat Sol estimate)
Melt Pt: 16.80 (deg C, PhysProp DB exp value for Wat Sol est)
Wat Sol: 1E+006 (mg/L, EPISuite WSKowwin v1.43 Estimate)
Wat Sol: (User Entered)
Wat Sol: 1E+006 (mg/L, PhysProp DB exp value)

Values used to Generate ECOSAR Profile

Log Kow: -0.649 (EPISuite Kowwin v1.68 Estimate)
Wat Sol: 1E+006 (mg/L, PhysProp DB exp value)

Available Measured Data from ECOSAR Training Set

No Data Available

ECOSAR v1.1 Class-specific Estimations

****
| Not Related to an Existing ECOSAR Class Definition |
| |
| Estimates provided below use the Neutral Organics QSAR equations which |
| represent baseline toxicity potential (minimum toxicity) assuming a simple |
| non-polar narcosis model. Without empirical data on structurally similar |
| chemicals, it is uncertain if this substance will present significantly |
| higher toxicity above baseline estimates. |
****

ECOSAR Class	Organism	Duration	End Pt	Predicted mg/L (ppm)

--> Acid moeity found: Predicted values multiplied by 10

Neutral Organics-acid	: Fish	96-hr	LC50	1.77e+005
Neutral Organics-acid	: Daphnid	48-hr	LC50	78753.141
Neutral Organics-acid	: Green Algae	96-hr	EC50	21338.494
Neutral Organics-acid	: Fish		ChV	12974.635
Neutral Organics-acid	: Daphnid		ChV	3888.119
Neutral Organics-acid	: Green Algae		ChV	3241.217
Neutral Organics-acid	: Fish (SW)	96-hr	LC50	2.19e+005
Neutral Organics-acid	: Mysid	96-hr	LC50	9.81e+005
Neutral Organics-acid	: Fish (SW)		ChV	4725.966
Neutral Organics-acid	: Mysid (SW)		ChV	1.86e+005
Neutral Organics-acid	: Earthworm	14-day	LC50	2947.999

Note: * = asterisk designates: Chemical may not be soluble enough to measure this predicted effect. If the effect level exceeds the water solubility by 10X, typically no effects at saturation (NES) are reported.

Class Specific LogKow Cut-Offs

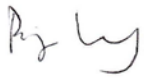
If the log Kow of the chemical is greater than the endpoint specific cut-offs presented below, then no effects at saturation are expected for those endpoints.

Neutral Organics:

Maximum LogKow: 5.0 (Fish 96-hr LC50; Daphnid LC50, Mysid LC50)
Maximum LogKow: 6.0 (Earthworm LC50)
Maximum LogKow: 6.4 (Green Algae EC50)
Maximum LogKow: 8.0 (ChV)

Authorized Reviewers

Lactic Acid GreenScreen® Evaluation Prepared By:



Bingxuan Wang, Ph.D.
Toxicologist
ToxServices LLC

Lactic Acid GreenScreen® Evaluation QC'd By:

Margaret H. Whittaker, Ph.D., M.P.H., CBiol., F.S.B., E.R.T., D.A.B.T.
Managing Director and Chief Toxicologist
ToxServices LLC