SCIENTIFIC OPINION

Scientific Opinion on the re-evaluation of sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482) as food additives[1]

EFSA Panel on Food Additives and Nutrient Sources added to Food (ANS)[2, 3]

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ABSTRACT

Following a request by the European Commission, the Panel of Food Additives and Nutrient Sources added to Food (ANS) was asked to deliver a scientific opinion on the safety of sodium stearoyl-2-lactylate (E 481, SSL) and calcium stearoyl-2-lactylate (E 482, CSL) when used as food additives. SSL and CSL are used as emulsifiers and stabilizers. An Acceptable Daily Intake (ADI) of 20 mg/kg bw/day for SSL and CSL (either singly or in combination) was established in 1974 by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The Scientific Committee on Food (SCF) endorsed this ADI of 20 mg/kg bw/day in 1978. The biological fate of CSL is comparable in rodent and non-rodent species. The acute oral toxicity in rats is low. Subacute and subchronic oral toxicity studies with SSL and CSL in rats and dogs revealed a NOAEL of 5 % in the diet. Neither SSL and CSL nor their breakdown products stearic and lactic acid raise concern for genotoxicity. The NOAEL in a one-year oral toxicity study with SSL in rats was 2214 mg/kg bw/day for males and 2641 mg/kg bw/day for females. No data on reproductive toxicity and carcinogenicity were available. However, no reproductive or carcinogenic effects are expected since the products of hydrolysis, stearic and lactic acid are constituents of natural food and part of endogenous metabolism in mammals. The Panel concluded that based on the NOAEL of 2200 mg/kg bw/day derived from the one-year toxicity study in rats and an uncertainty factor of 100, an ADI of 22 mg/kg bw/day for sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482) either singly or in combination can be established. The estimated exposure to SSL and CSL occurs mainly via the consumption of flavoured fermented milk products including heat treated products, bread and rolls and fine bakery wares and is below the ADI of 22 mg/kg bw/day for all the adult population including the elderly, but exceeds the ADI for other groups of the population at mean level and for all groups of the population at high level.

[1] On request from the European Commission, Question No EFSA-Q-2011-00568 and No EFSA-Q-2011-00569, adopted on 13 March 2013.

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KEY WORDS

Sodium stearoyl-2-lactylate, E 481, SSL, Calcium stearoyl-2-lactylate, E 482, CSL.

SUMMARY

Following a request from the European Commission, the Panel of Food Additives and Nutrient Sources added to Food (ANS) was asked to re-evaluate the safety of sodium stearoyl-2-lactylate (E 481, SSL) and calcium stearoyl-2-lactylate (E 482, CSL) when used as food additives. SSL and CSL are used as emulsifiers and stabilizers. The Panel noted that although the additives E 481 and E 482 are both described in Commission Regulation (EU) No 231/2012 and by JECFA as 'sodium stearoyl-2-lactylate' and 'calcium stearoyl-2-lactylate' respectively, it is stated that the mono-esters of lactic acid are the major components.

The Panel considered the evaluation of SSL and CSL in one opinion and the allocation of a common ADI (either singly or in combination) justified since SSL and CSL differ only due to the cation. Both, sodium and calcium are endogenous cations without toxicological relevance for the evaluation of SSL and CSL as food additives.

The Panel was not provided with a newly submitted dossier and based its evaluation on previous evaluations and reviews, and additional literature that came available since then and the data available following a public call for data. The Panel noted that not all original studies on which previous evaluations were based were available for re-evaluation.

SSL is applied as a dough conditioner/emulsifier in high fat, yeast leavened baked goods. SSL is also used as an aerating agent in both dairy and non-dairy whipped toppings and desserts. It has been used in non-dairy coffee creamers where it functions both as a surfactant and complexing agent, and in whitening powder as fat replacer. CSL is used in yeast-leavened bakery products such as bread, buns, cakes, etc., and also in their respective ready-to-use mixes. As a component of the dough, CSL acts in combination with gluten to give the dough greater tolerance to virtually all processing variables. It is also used in fine bakery wares as a fat replacer. CSL may also be used as an egg-white whipping aid. Furthermore, both SSL and CSL are used in fat spreads, dairy fat spreads and blended spreads.

Maximum levels of permitted uses for SSL and CSL (either individually or in combination) have been defined in Commission Regulation (EU) No 1129/2011.The Maximum Permitted Level (MPL) for fat spreads, dietary fat spreads and blended spreads is defined in the Codex Alimentarius to be 10 000 mg/kg.

An Acceptable Daily Intake (ADI) of 0-20 mg/kg bw for SSL and CSL (either individually or in combination) was established in 1974 by JECFA on the basis of the No Observed Adverse Effect Level (NOAEL) of 1000 mg/kg bw/day in sub-chronic feeding studies in rats and an uncertainty factor of 50. A report published in 1978 by the SCF endorsed this ADI of 20 mg/kg bw/day established by JECFA. An additional evaluation is also available from the Nordic Council of Ministers. They concluded that both additives are degraded to their basic constituents, stearic acid and lactic acid after ingestion. Both metabolites are components of natural food and also part of endogenous metabolism.

In vivo and *in vitro* experiments with CSL labelled with ^{14}C at the lactate moiety (Calcium stearoyl-2-[U-^{14}C]lactylate) ([^{14}CY]CSL) showed a nearly complete absorption of the radiolabel and hydrolysis of CSL to lactic acid and stearic acid. The biological fate of CSL is comparable in rodent and non-rodent species. The Panel noted that the toxicokinetics of SSL and CSL would be similar.

The acute oral toxicity in rats is low. Unpublished studies in rats and dogs on subacute and subchronic oral toxicity revealed a NOAEL of 5 % in the diet (corresponding to 2500 mg/kg bw/day) for SSL or CSL.

Rats appear to tolerate large doses of sodium stearoyl-2-lactylate and calcium stearoyl-2-lactylate for one year without evidence of toxicity. Dogs seem less sensitive than the rat for oral exposure to calcium stearoyl-2-lactylate.

The data on genotoxicity *in vitro* gave no indication for mutagenic activity in the bacterial reverse mutation assay or in a mammalian chromosome aberration test.

The Panel concluded that neither SSL and CSL nor their breakdown products stearic and lactic acid, raise concern for genotoxicity.

From the results of a one-year oral toxicity study in rats with SSL, a NOAEL was determined to be the high dose level of 5 % in the diet corresponding to 2214 mg/kg bw/day for males and 2641 mg/kg bw/day for females.

No data are available on reproductive toxicity and carcinogenicity. However, no reproductive toxic or carcinogenic effects are expected since the products of hydrolysis, stearic acid and lactic acids are constituents of natural food and part of endogenous metabolism in mammals and therefore no additional uncertainty factor would be required.

The Panel concluded that based on the NOAEL of 2200 mg/kg bw/day from a one-year toxicity study in rats and using an uncertainty factor of 100, an ADI of 22 mg/kg bw/day for sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482), either singly or in combination, can be established.

The estimated exposure to SSL and CSL occurs mainly via the consumption of flavoured fermented milk products including heat treated products, bread and rolls and fine bakery wares and is below the ADI of 22 mg/kg bw/day for all the adult population including the elderly, but exceeds the ADI for other groups of the population at mean level and for all groups of the population at high level.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

Regulation (EC) No 1333/2008[4] of the European Parliament and of the Council on food additives requires that food additives are subject to a safety evaluation by the European Food Safety Authority (EFSA) before they are permitted for use in the European Union. In addition, it is foreseen that food additives must be kept under continuous observation and must be re-evaluated by EFSA.

For this purpose, a programme for the re-evaluation of food additives that were already permitted in the European Union before 20 January 2009 has been set up under Regulation (EU) No 257/2010[5]. This Regulation also foresees that food additives are re-evaluated whenever necessary in light of changing conditions of use and new scientific information. For efficiency and practical purposes, the re-evaluation should, as far as possible, be conducted by group of food additives according to the main functional class to which they belong.

The order of priorities for the re-evaluation of the currently approved food additives should be set on the basis of the following criteria: the time since the last evaluation of a food additive by the Scientific Committee on Food (SCF) or by EFSA, the availability of new scientific evidence, the extent of use of a food additive in food and the human exposure to the food additive taking also into account the outcome of the Report from the Commission on Dietary Food Additive Intake in the EU[6] of 2001. The report "Food additives in Europe 2000[7]" submitted by the Nordic Council of Ministers to the Commission, provides additional information for the prioritisation of additives for re-evaluation. As colours were among the first additives to be evaluated, these food additives should be re-evaluated with the highest priority.

In 2003, the Commission already requested EFSA to start a systematic re-evaluation of authorised food additives. However, as a result of the adoption of Regulation (EU) 257/2010 the 2003 Terms of Reference are replaced by those below.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

The Commission asks the European Food Safety Authority to re-evaluate the safety of food additives already permitted in the Union before 2009 and to issue scientific opinions on these additives, taking especially into account the priorities, procedure and deadlines that are enshrined in the Regulation (EU) No 257/2010 of 25 March 2010 setting up a programme for the re-evaluation of approved food additives in accordance with the Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives.

[4] Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives, OJ L 354, 31.12.2008, p. 16.

[5] Commission Regulation (EU) No 257/2010 of 25 March 2010 setting up the program for the re-evaluation of approved food additives in accordance with Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives, OJ L 80, 26.03.2010, p.19.

[6] Report from the Commission on Dietary Food Additive Intake in the European Union, Brussels, 01.10.2001, COM (2001) 542 final.

[7] Food Additives in Europe 2000, Status of safety assessments of food additives presently permitted in the EU, Nordic Council of Ministers. TemaNord 2002:560.

ASSESSMENT

1. Introduction

The present opinion deals with the re-evaluation of the safety of sodium stearoyl-2-lactylate (E 481; SSL) and calcium stearoyl-2-lactylate (E 482; CSL) as food additives. SSL and CSL are used as emulsifiers and stabilizers (JECFA 2006).

The sodium and calcium salts of stearoyl lactylic acid are authorised as food additives in the EU according to Commission Regulation (EU) No 1129/2011[8] and were previously evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1974 (JECFA, 1974a) and the EU Scientific Committee for Food (SCF) in 1978 (SCF, 1978). An evaluation has also been performed by the Nordic Council of Ministers (TemaNord, 2002).

The Panel considered the evaluation of SSL and CSL in one opinion justified since SSL and CSL differ only due to the cation. Both, sodium and calcium are endogenous cations without toxicological relevance for the evaluation of SSL and CSL as food additives.

The Panel was not provided with a newly submitted dossier and based its evaluation on previous evaluations and reviews, and additional literature that came available since then and the data available following a public call for data[9]. The Panel noted that not all original studies on which previous evaluations were based were available for re-evaluation by the Panel.

2. Technical data

2.1. Identity of the substances

2.1.1. Sodium stearoyl-2-lactylate (E 481; SSL)

In Commission Regulation (EU) No 231/2012[10] the additive *"sodium stearoyl-2-lactylate (E 481)"* is defined as "A mixture of the sodium salts of stearoyl lactylic acids and its polymers and minor amounts of sodium salts of other related acids, manufactured by the reaction of stearic acid and lactic acid. Other food fatty acids may also be present, free or esterified, due to their presence in the stearic acid used."

The Panel noted that the additive E 481 is described in EU Regulation No 231/2012 and by JECFA (2006) as 'sodium stearoyl-2-lactylate' (i.e. the lactyl di-ester form), whereas it is further indicated that the mono-esters of lactic acid, sodium stearoyl-1-lactylate and sodium palmitoyl-1-lactylate, are the major components.

Sodium stearoyl-2-lactylate is the sodium salt of stearic acid ester with lactic acid dimer. Its chemical name (IUPAC) is octadecanoic acid, 2-(1-carboxyethoxy)-1-methyl-2-oxoethyl ester, sodium salt; the CAS Registry Number is 25383-99-7, and the EINECS number is 246-929-7. Its molecular formula is $C_{24}H_{43}O_6Na$, and its molecular weight is 450.58 g/mol.

Sodium stearoyl-1-lactylate is the sodium salt of stearic acid with lactic acid monomer. Its chemical name is octadecanoic acid, 1-carboxyethyl ester, sodium salt (1:1), the CAS Registry Number is

[8] Commission Regulation (EU) No 1129/2011 of 11 November 2011 amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council establishing a Union list of food additives. The Panel noted that the Commission Regulation (EU) No 1129/2011 of 11 November 2011 will enter into force on June, 1st 2013 but confirms the approved uses of SSL and CSL as food additive as described in previous directive still active until end of May 2013 - Council Directive No 95/2/EC of 20 February 1995 on food additives other than colours and sweeteners.

[9] Call for scientific data on miscellaneous waxes permitted as food additives in the EU (published: 23 November 2009). Available from: http://www.efsa.europa.eu/en/dataclosed/call/ans091123.htm

[10] Commission Regulation (EU) No 231/2012 of 9 March 2012 laying down specifications for food additives listed in Annexes II and III to Regulation (EC) No 1333/2008 of the European Parliament and of the Council. OJ L 83, 22.3.2012, p 1-295.

18200-72-1 and the EINECS number is 242-090. The molecular formula is $C_{23}H_{39}O_4Na$ and the molecular weight is 378.52.

Sodium palmitoyl-1-lactylate is the sodium salt of palmitic acid with lactic acid monomer. Its chemical name is hexadecanoic acid, 1-carboxyethyl ester, sodium salt, the CAS Registry Number is 35230-15-0 and the EINECS number (not found). The molecular formula is $C_{19}H_{35}O_4Na$ and the molecular weight is 350.47 g/mol.

The general structural formula of the different sodium salts of the food additive E 481 is given in Figure 1.

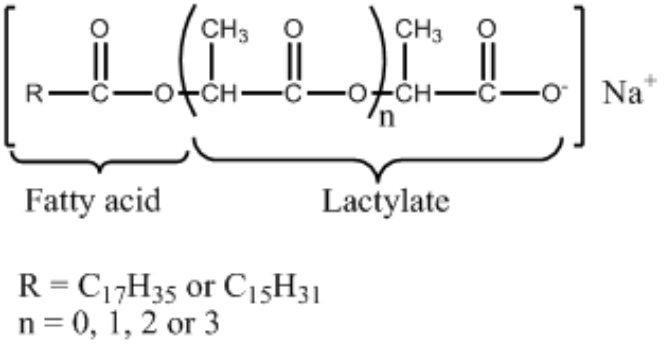

Figure 1: General structural formula of the sodium salts of food additive E 481.

Synonyms for Sodium stearoyl-2-lactylate:
Sodium stearoyl-2-lactylate has as synonyms sodiumsteryllactate; sodium 2-{[2-(stearoyloxy)propanoyl] oxy}propanoate and sodium 2-{[2-(octadecanoyloxy) propanoyl] oxy} propanoate.

2.1.2. Calcium stearoyl-2-lactylate (E 482; CSL)

In Commission Regulation (EU) No 231/2012, the additive "*calcium stearoyl-2-lactylate (E 482)*" is defined as "A mixture of the calcium salts of stearoyl lactylic acids and its polymers and minor amounts of calcium salts of other related acids, manufactured by the reaction of stearic acid and lactic acid. Other food fatty acids may also be present, free or esterified, due to their presence in the stearic acid used."

The Panel noted that although the additive E 482 is described in EU Regulation No 231/2012 as 'calcium stearoyl-2-lactylate' (i.e. the lactyl di-ester form), whereas it is further indicated that the mono-esters of lactic acid, calcium stearoyl-1-lactylate, calcium margaroyl-1-lactylate and calcium palmitoyl-1-lactylate, are the major components.

JECFA (2006) defines '*calcium stearoyl-2-lactylate (E 482')* as "A mixture of calcium salts of stearoyl lactylic acids and minor proportions of other salts of related acids, formed by the esterification of commercial stearic acid with lactic acid and neutralized to the calcium salts; may contain unneutralized palmitoyl and stearoyl lactylic acid, free fatty acids (principally palmitic and stearic acid), free lactic acid and salts of fatty acid esters of lactic and polymerized lactic acid."

The Panel noted that JECFA (2006) indicates that only calcium stearoyl-1-lactylate and calcium palmitoyl-1-lactylate are the major components.

Calcium stearoyl-2-lactylate is the calcium salt of stearic acid ester with lactic acid dimer. Its chemical name (IUPAC) is octadecanoic acid, 2-(1-carboxyethoxy)-1-methyl-2-oxoethyl ester, calcium salt, the CAS Registry Number is 5793-94-2, and the EINECS number is 227-335-7. Its molecular formula is $C_{48}H_{86}O_{12}Ca$, and the molecular weight is 895.26 g/mol.

Calcium stearoyl-1-lactylate is the calcium salt of stearic acid with lactic acid monomer. Its chemical name is octadecanoic acid, 1-carboxyethyl ester, calcium salt (2:1); the CAS Registry Number is 4508-49-0. The molecular formula is $C_{42}H_{78}O_8Ca$ and the molecular weight is 799.2 g/mol.

Calcium margaroyl-1-lactylate is the calcium salt of margaric acid with lactic acid monomer. Its chemical name is heptadecanoic acid, 1-carboxyethyl ester, calcium salt (2:1). The CAS Registry Number (not found) and the EINECS number (not found). The molecular formula is $C_{40}H_{74}O_8Ca$ and the molecular weight is 723.1 g/mol.

Calcium palmitoyl-1-lactylate is the calcium salt of palmitic acid with lactic acid monomer. Its chemical name is hexadecanoic acid, 1-carboxyethyl ester, calcium salt, the CAS Registry Number (not found) and the EINECS number (not found). The molecular formula is $C_{38}H_{70}O_8Ca$ and the molecular weight is 695.05 g/mol.

The Panel noted that although the additive E 482 is described in EU Regulation No 231/2012 and by JECFA as "*calcium stearoyl-2-lactylate"*, it is stated that the mono-esters of lactic acid are the major components.

The general structural formula for the different calcium salts of the food additive E 482 is given in Figure 2.

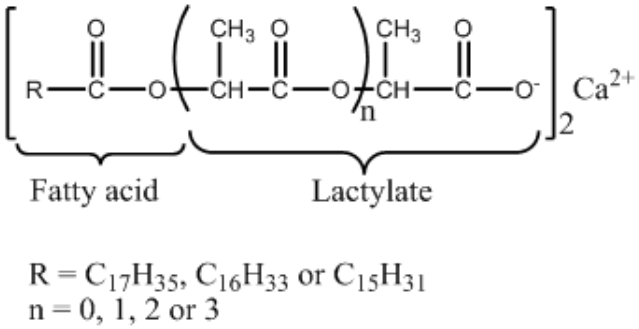

Figure 2: General structural formula of the calcium salts of food additive E 482.

Synonyms for calcium stearoyl-2-lactylate

Calcium stearoyl-2-lactylate has as synonyms: Calcium 2-(1-carboxyethoxy)-1-methyl-2-oxoethyloctadecanoate; Calcium alpha-(alpha-(stearoyloxy)propionyloxy)propionate; Calcium verate; Stearic acid, ester with lactate of lactic acid, ca salt; Stearic acid, ester with lactic acid bimol. ester calcium salt; Calcium bis(2-(1-carboxylatoethoxy)-1-methyl-2-oxoethyl) distearate; Octadecanoic acid, 2-(1-carboxyethoxy)-1-methyl-2-oxoethyl ester, calcium salt (2:1); calcium bis(2-{[2-(octadecanoyloxy)propanoyl]oxy}propanoate).

As already indicated above the Panel noted that sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482) are not single substances but vary in their fatty acid profile as well as in the number of lactic acids residues. This variation of components can be explained by the composition of the starting materials, and by the manufacturing process (see Section 2.3).

The distribution of the components depends on the relative proportion of lactic acid, fatty acid and the amount of sodium/calcium salt used in the neutralisation process. In commercial preparations of SSL and CSL, the number of lactic acids ranges from 1 to 4 (see Figures 1 and 2). The composition is

typically about 50 % stearoyl-1-lactylate, 20 % stearoyl-2-lactylate, 5 % stearoyl-3-lactylate and trace amounts of stearoyl-4-lactylate (Boutte and Skogerson, 2004; Austen Business Solutions, 2010, unpublished report).

Other components present in the product may include sodium/calcium salts of fatty acids or free fatty acids (15-20 %), non-neutralised stearoyl lactylic acid, sodium/calcium lactate, free lactic acid or polymers of lactic acid. (Boutte and Skogerson, 2004; Burch et al., 2007; Austen Business Solutions, 2010, unpublished report). In addition, the actual fatty acid profile of SSL and CSL will depend upon the source of the fatty acids. Commercial stearic acid contains variable range of stearic (C18) and palmitic acids (C16) (see section 2.3).

Both SSL and CSL are normally white to pale yellow, ivory-coloured, waxy materials of a consistency determined by the fatty acids. The products are typically dispersible in warm water and soluble in hot edible oils and fats (EFEMA, 2009).

Table 1: Physico-chemical properties of sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482)

Name	Sodium stearoyl-2-lactylate (SSL) (E 481)	Calcium stearoyl-2-lactylate (CSL) (E 482)
Appearance: Physical state / colour / odour	Solid powder, slight sweetish odour [1] White to pale yellow powder [2]	White to pale yellow powder [3]
Solubility	Very slightly soluble in cold water [1] Insoluble in water, soluble in ethanol [5]	Slightly soluble in hot water [5]
Melting point [°C]	48.889 [1]	45.7 – 48.7 [7]
Boiling point [°C, 760 mm Hg]	532 – 533 (est.) [2]	532 – 534 [3] 532.7 [4]
Flash point [°C]	166.20 (est.) [2]	188.11 [3] 166.2 [4]
Specific gravity [water = 1]	1.063 [1]	-
Log $P_{o/w}$	9.41 (est.) [2]	9.41 (est.) [3]
Vapour pressure [mm Hg, 25°C]	-	$9.06 \cdot 10^{-13}$ [4]
Surface tension [mN/m] [6]	40.00 (0.001 % wt) 34.35 (0.01 % wt) 32.34 (0.10 % wt)	49.50 (0.001 % wt) 41.00 (0.01 % wt) 37.00 (0.10 % wt)

1) Sciencelab (2011); 2) Thegoodscentscompany (2011a); 3) Thegoodscentscompany (2011b); 4) Chemnet (2011); 5) JECFA (2006); 6) Murphy and Baiocchi (1978); 7) Hitaka and Murakawa (1970), cited from SciFinder

Because of their high degree of hydrophilicity, lactylate salts hydrate readily in water at ambient temperature. The less neutralised these materials are, the more soluble they are in fatty products and the slower their rate of hydration. In addition, CSL hydrates more slowly than SSL (Boutte and Skogerson, 2004).

2.2. Specifications

Specifications have been defined in Commission Regulation (EU) No 231/2012 and by JECFA (JECFA, 2006) (Tables 2 and 3).

Both stearoyl-2-lactylates are identified by their solubility and by tests for sodium (or calcium), for fatty acids and for lactic acid. The purity tests are described in detail in JECFA (2006).

Table 2: Commission Regulation (EU) No 231/2012 and JECFA 2006 specifications for sodium stearoyl-2-lactylate (E 481)

	Commission Regulation (EU) No 231/2012	**JECFA (2006)**
Definition	A mixture of the sodium salts of stearoyl lactylic acids and its polymers and minor amounts of sodium salts of other related acids, manufactured by the reaction of stearic acid and lactic acid. Other food fatty acids may also be present, free or esterified, due to their presence in the stearic acid used	A mixture of sodium salts of stearoyl lactylic acids and minor proportions of other salts of related acids, formed by the esterification of commercial stearic acid with lactic acid and neutralized to the sodium salts; may contain unneutralized palmitoyl and stearoyl lactylic acid, free fatty acids (principally palmitic and stearic), free lactic acid and salts of fatty acid esters of lactic acid and polymerized lactic acid.
Description	White or slightly yellowish powder or brittle solid with a characteristic odour	White or slightly yellowish powder or brittle solid with a characteristic odour
Identification		
A.	Positive tests for sodium, for fatty acids and for lactic acid	Test for sodium: Add 10 mL of dilute hydrochloric acid TS to 2 g of the sample, heat for 5 min in a water bath, filter and neutralize the filtrate with ammonia TS. Retain the residue from the filter for test C. To the filtrate, add uranyl zinc acetate TS; a yellow crystalline precipitate appears within a few min. Test for fatty acids: Take the residue from the filter in the test for sodium, add 30 mL of sodium hydroxide TS, heat for 30 min on a steam bath and filter. Add 20 mL of dilute hydrochloric acid TS to the filtrate after cooling, extract twice with 30 mL of diethyl ether, wash the ether solution with 20 mL of water, dry with anhydrous sodium sulfate and evaporate the ether. The residue melts between 54 and 69 Cº. Test for lactate: Passes test
B. Solubility	Insoluble in water. Soluble in ethanol	Insoluble in water. Soluble in ethanol
Purity		
Sodium	Not less than 2.5 % and not more than 5 %	Not less than 2.5 % and not more than 5.0 %
Ester value	Not less than 90 and not more than 190	Not less than 90 and not more than 190
Acid value	Not less than 60 and not more than 130	Not less than 60 and not more than 130
Total lactic acid	Not less than 15 % and not more than 40 %	Not less than 15 % and not more than 40 %
Arsenic	Not more than 3 mg/kg	-
Lead	Not more than 2 mg/kg	Not more than 2 mg/kg

	Commission Regulation (EU) No 231/2012	JECFA (2006)
Mercury	Not more than 1 mg/kg	-
Cadmium	Not more than 1 mg/kg	-

Table 3: Commission Regulation (EU) No 231/2012 and JECFA 2006 specifications for calcium stearoyl-2-lactylate (E 482)

	Commission Regulation (EU) No 231/2012	JECFA (2006)
Definition	A mixture of the calcium salts of stearoyl lactylic acids and its polymers and minor amounts of calcium salts of other related acids, manufactured by the reaction of stearic acid and lactic acid. Other food fatty acids may also be present, free or esterified, due to their presence in the stearic acid used	A mixture of calcium salts of stearoyl lactylic acids and minor proportions of other salts of related acids, formed by the esterification of commercial stearic acid with lactic acid and neutralized to the calcium salts; may contain unneutralized palmitoyl and stearoyl lactylic acid, free fatty acids (principally palmitic and stearic acid), free lactic acid and salts of fatty acid esters of lactic and polymerized lactic acid.
Description	White or slightly yellowish powder or brittle solid with a characteristic odour	White or slightly yellowish powder or brittle solid with a characteristic odour
Identification		
A.	Positive tests for calcium, for fatty acids and for lactic acid	Test for calcium: Add 10 mL of dilute hydrochloric acid TS to 2 g of the sample, heat for 5 min in a water bath, filter and neutralize the filtrate with ammonia TS. Retain the residue from the filter for the test for fatty acids. To the filtrate, add 5 mL of ammonium oxalate TS. A white precipitate is formed, soluble in dilute hydrochloric acid TS, but insoluble in dilute acetic acid TS. Test for fatty acids: Take the residue from the filter in the test for calcium, add 30 mL of sodium hydroxide TS, heat for 30 min on a steam bath and filter. Add 20 mL of dilute hydrochloric acid TS to the filtrate after cooling, extract twice with 30 mL of diethyl ether, wash the ether solution with 20 mL of water, dry with anhydrous sodium sulfate and evaporate the ether. The residue melts between 54 and 69 Cº. Test for lactate: Passes test
B. Solubility	Slightly soluble in hot water	Slightly soluble in hot water
Purity		
Calcium	Not less than 1 % and not more than 5.2 %	Not less than 1.0 % and not more than 5.2 %
Ester value	Not less than 125 and not more than 190	Not less than 125 and not more than 190

	Commission Regulation (EU) No 231/2012	JECFA (2006)
Acid value	Not less than 50 and not more than 130	Not less than 50 and not more than 130
Total lactic acid	Not less than 15 % and not more than 40 %	Not less than 15 % and not more than 40 %
Arsenic	Not more than 3 mg/kg (E481)	-
Lead	Not more than 2 mg/kg (E481)	Not more than 2 mg/kg
Mercury	Not more than 1 mg/kg (E481)	-
Cadmium	Not more than 1 mg/kg (E481)	-

The Panel noted that there is no assay for any of the substances of SSL or CSL. However, there is a test for the content of total lactic acid.

2.3. Manufacturing process

SSL and CSL are both manufactured by base-catalyzed esterification of lactic acid and commercial stearic acid as follows (Austen Business Solutions, 2010, unpublished): sodium hydroxide or calcium hydroxide (or similar basic sodium or calcium salt) is carefully added to a well-stirred mixture of stearic acid and aqueous lactic acid at a temperature above the solidification point of the stearic acid. The mixture heats by itself due to the reaction of the sodium or calcium base and the lactic acid (neutralisation). The mixture is warmed gradually and as the temperature approaches 200 °C the mixture is put under reduced pressure to distil the water formed from the esterification reaction that is taking place. Heating is continued until the desired acid value is reached and then the mixture is cooled. A key to successful manufacture of SSL or CSL is the elimination of air from the reactor during the process. SSL/CSL are typically finished by spray cooling or by flaking and grinding to produce powders. Since SSL is particularly hygroscopic and becomes sticky as the product hydrolyses in moist air, the product is sometimes formulated with added hard fat, or blended with a free-flow agent if difficult transport or storage conditions are anticipated (Austen Business Solutions, 2010, unpublished).

An alternative synthetic process has been described (Boutte and Skogerson, 2004), but it is not clear whether it is used for the manufacturing of food additives. In this process, lactic acid oligomers with a specific degree of polymerisation were synthesised, and dehydrated by azeotropic distillation with benzene. Afterwards these polymers of lactic acids are reacted with acid halides of stearic acid. No data were presented to demonstrated that the more pure lactylates obtained by this method were more functional than those prepared by base-catalysed esterification.

The starting materials, i.e. commercial stearic acid and lactic acid are usually obtained as follows (Austen Business Solutions, 2010, unpublished):

Stearic acid is obtained from food fats and oils by hydrogenation and hydrolysis. Commercial stearic acid usually contains variable quantities of other fatty acids e.g. myristic (C14) acid and palmitic (C16) acid. The actual fatty acid profile will depend on the source of the fat or oil and whether the fatty acids have been subjected to fractional distillation to concentrate particular fatty acids. Commercial stearic acid used in Europe and Asia Pacific regions is typically derived from palm oil and contains roughly 55 % stearic and 45 % palmitic acids, whereas commercial stearic acid used in the USA is typically derived from soya and contains up to 85 % stearic acid.

Commercial lactic acid is available from two sources. DL lactic acid is manufactured synthetically from petrochemical sources, whereas L(+) lactic acid is produced by fermentation of sugar-containing substrates e.g. sugar beet. Both the synthetic DL lactic acid and the fermented L(+) lactic acid are used in the manufacture of SSL and CSL. Racemic DL lactic acid (E 270) is a permitted food additive in the EC (Austen Business Solutions, 2010, unpublished).

2.4. Methods of analysis in food

SSL was measured in flour and flour blends by extraction with chloroform, separation from other lipids by Thin-Layer Chromatography (TLC), and colorimetric measurement of a SSL hydroxamic acid derivative/Fe^{3+} complex. Recoveries of 92-97 % were obtained; the lowest tested concentration was 0.13 % (Wheeler, 1979).

For the determination of CSL in bread, methyl esters of CSL were prepared which were measured by gas chromatography (Yukawa and Hanada, 1982). CSL was extracted from bread with chloroform after treatment with α-amylase, the applied extraction methods were previously described by De Stefanis et al. (1977) and Thewlis (1981).

A gas-liquid chromatography method for determining SSL in baked wheaten products has been described (Kokot and March, 1985). SSL was extracted from bread using bacterial α-amylase, tris buffer and chloroform/methanol. The extract was methylated with boron trifluoride-methanol complex, the substance was finally analysed by gas chromatography/mass spectrometry (GC/MS). The difficulty in analysing SSL is that SSL is not a pure compound, thus no analytical pure standards are available. Therefore, before the bread was analysed, the commercial SSL added in the bread was analysed in order to create a calibration curve. A detection limit was not reported, the lowest analyzed SSL concentration in bread was given as 0.1 %.

In addition, general methods are given in the literature which probably are suitable for SSL and CSL in foods after appropriate extraction. A High Performance Liquid Chromatography (HPLC) method for the analysis of SSL and CSL has been published but only the components of the commercial SSL and CSL were analysed and not their content in foods (Sudraud et al. (1981). Furthermore, a general method for the gas chromatographic determination of the components of ester-emulsifiers has been developed (Brueschweiler and Hautfenne, 1990). The method is based on derivatisation by hydrolysis and silylation and determination by gas chromatography. Although SSL or CSL have not been tested, the authors stated that the method is also appropriate for oils, fats, wax esters and other hydrolysable lipids.

2.5. Reaction and fate in food

Information on reaction in food is not available.

2.6. Case of need and proposed uses

Maximum Permitted Levels (MPLs) of SSL and CSL have been defined in the Commission Regulation (EU) No 1129/2011 on food additives for use in food, with MPLs ranging from 2 000 to 10 000 mg/kg in foods.

Table 4 summarises foods that are permitted to contain SSL and CSL and the corresponding MPLs as set by Commission Regulation (EU) No 1129/2011. An extension of authorisation to the use of SSL has been requested for the use in emulsified cooked meat products (e.g. mortadella, paté) within food category 08.2.2 Heat-treated processed meat at a proposed use level of 2 200 mg/kg food in combination with iota carrageenan (E 407) at a level of 0.8 g/kg food.

Table 4: MPLs of SSL and CSL in foods according to the Commission Regulation (EU) No 1129/2011

Category number	Foods	Restrictions/exception	Maximum level (mg/L or mg/kg as appropriate)
01.4	Flavoured fermented milk products including heat-treated products		5000

01.8	Dairy analogues, including beverage whiteners	only beverage whiteners	3000
02.2.2	Other fat and oil emulsions including spreads as defined by Council Regulation (EC) No 1234/2007[11] and liquid emulsions		10 000 [1]
04.2.4.1	Fruit and vegetable preparations excluding compote	only mostarda di frutta	2000 [1]
05.2	Other confectionery including breath freshening microsweets	only sugar confectionery	5000 [1]
05.3	Chewing gum		2000 [1]
05.4	Decorations, coatings and fillings, except fruit-based fillings covered by category 4.2.4		5000 [1]
06.3	Breakfast cereals		5000 [1]
06.7	Pre-cooked or processed cereals	only quick-cook rice	4000 [2]
07.1	Bread and rolls	except products in 7.1.1 and 7.1.2	3000 [1]
07.2	Fine bakery wares		5000 [1]
08.2.2	Heat-treated processed meat	only minced and diced canned meat products	4000[1 3]
13.2	Dietary foods for special medical purposes defined in Directive 1999/21/EC[12] (excluding products from food category 13.1.5)		2000 [1]
14.1.4	Flavoured drinks	only powders for the preparation of hot beverages	2000 [1]
14.1.5	Coffee, tea, herbal and fruit infusions, chicory; tea, herbal and fruit infusions and chicory extracts; tea, plant, fruit and cereal preparations for infusions, as well as mixes and instant mixes of these products other than coffee and coffee extracts	only powders for the preparation of hot beverages	2000 [1]
Category number	**Foods**	**Restrictions/exception**	**Maximum level (mg/L or mg/kg as appropriate)**
14.2.6	Spirit drinks as defined in Regulation (EC) No 110/2008[13]	only emulsified liqueurs	8000 [1]
14.2.8	Other alcoholic drinks including mixtures of alcoholic drinks with non-alcoholic drinks and spirits with less than 15 % of alcohol	only flavoured drinks containing less than 15% of alcohol	8000 [1]

[11] Council Regulation (EC) No 1234/2007 of 22 October 2007 establishing a common organisation of agricultural markets and on specific provisions for certain agricultural products (Single CMO Regulation). OJ L 299, 16.11.2007, p. 1-49.
[12] Commission Directive 1999/21/EC of 25 March 1999on dietary foods for special medical purposes. OJ L 91, 07.04.1999, p. 1-29.
[13] Regulation (EC) No 110/2008 of the European Parliament and of the Council of 15 January 2008 on the definition, description, presentation, labelling and the protection of geographical indications of spirit drinks and repealing Council Regulation (EEC) No 1576/89. OJ L 39, 13.02.2008, p. 16-54.

15.1	Potato-, cereal-, flour- or starch-based snacks	only cereal-based snacks	2000 [1]
16	Desserts excluding products covered in categories 1, 3 and 4		5000 [1]

[1] The additives may be added individually or in combination
[2] The maximum level is applicable to the sum and the levels are expressed as the free acid
[3] As requested in the authorisation to the use of SSL, levels In addition to the use of iota carrageenan (E 407) of 0.8 g/kg

2.6.1. Reported use levels or data on analytical levels of SSL and CSL

SSL and CSL are used at levels of about 0.5 % (based on flour weight) in baked goods. SSL is used at a level of approximately 0.5 % in both dairy and non-dairy whipped toppings and desserts, and to 0.2 % in non-dairy coffee creamers. CSL is used at a level of approximately 0.5 % as an egg-white whipping aid (SCF, 1978).

In France, 179 food products containing stearoyl lactylates as an emulsifier were identified (Bemrah et al., 2008). Breakfast cereals, milk-based desserts, flavoured desserts, peeled potatoes, powdered hot beverages, fine bakery products, canned meat products, and rice account for approximately 80 % of the dietary exposure. Thus, the current use spectrum seems to be broader than described by the SCF in 1978. The average concentrations in foods containing the additive were 664.3 mg/kg in 9 breads and 1079.8 mg/kg in 5 fine bakery products.

According to Commission Regulation (EU) No 1129/2011 the maximum level of the permitted uses for SSL and CSL is restricted (Table 4: These additives may be added individually or in combination according to Annex II to Commission Regulation (EC) No 1333/2008 as amended by Commission Regulation (EU) No 1129/2011, i.e. the sum of both additives may not exceed the maximum level). Furthermore, two new food categories are included in Commission Regulation (EC) No 1129/2011: "Flavoured fermented milk products including heat-treated products" and "Decorations, coatings and fillings, except fruit-based fillings covered by category 4.2.4", with maximum levels of each 5000 mg/kg.

Most food additives in the EU are authorised at a specific MPL. However, a food additive may be used at a lower level than the MPL. In the framework of Regulation (EC) No 1333/2008 on food additives and of Regulation (EU) No 257/2010 regarding the re-evaluation of approved food additives, EFSA issued a public call for scientific data on SSL and CSL (E 481 and E 482) including present use and use patterns (i.e. which food categories and subcategories, proportion of food within categories/subcategories in which it is used, and actual use levels (typical and maximum use levels).

Summarised data on reported use levels in foods from industries and other sources

Information about the actual levels in use has been provided by the European Food Emulsifier Manufacturers' Association (EFEMA). According to the questionnaire from ELC (Federation of European Food Additives, Food Enzymes and Food Cultures Industries), stearoyl-2-lactylate salts are typically used in bread at a level of 0.14-0.21 % (unpublished report), which is about 30 % lower than recommended by EFEMA in commercial data sheets. In addition, the level recommended in commercial technical data sheets by EFEMA for both bread and beverage whiteners are 0.2-0.3 %. Furthermore use levels are given in the questionnaire for SSL and CSL in bread, beverage whiteners, fine bakery wares, quick-cook rice, breakfast cereals, emulsified liqueur, cereal-based snacks, potato powders for mashed potato meals, fat emulsions, desserts, sugar confectionery, cereal- and potato-based snacks, minced and diced canned meat products, powders for the preparation of hot beverages, dietetic foods intended for special medical purposes - dietetic formulae for weight control intended to replace total daily food intake or individual meal, and Mostarda di frutta (specific Italian food within the food category "Fruit and vegetable preparations excluding compote" - 4.2.4.1).

A data collection from the Confederation of the Food and Drink Industries of the EU resulted in the information given in Table 5 (CIAA, 2009, unpublished report). However, there is no information given on usages by beverages. Table 5 provides data on the use levels of SSL and CSL in foods as reported by industries. Table 5 also shows the levels used for the refined exposure assessment identified by the Panel.

Table 5: Usages data collection exercise for lactylates (E 481-482) (CIAA, 2009)

Food	Maximum level (1129/2011)	Typical use level	Extreme use level	Comments	Level used for exposure assessment based on reported use levels
Fine bakery wares	5 g/kg	0.4-3 g/kg	0.4-5 g/kg	Partly representative of the European market	5 g/kg
Panification sèche		2-2.7 g/kg	2-2.7 g/kg	Partly representative of the French market	
Biscuits		0.7-0.8 g/kg	0.7-0.8 g/kg	Partly representative of the French market	
Quick-cook rice	4 g/kg	Products not representatively covered by CIAA's membership			4 g/kg[1]
Breakfast cereals	5 g/kg	No data received so far from CIAA´s Membership			5 g/kg
Cereal-based snacks	2 g/kg	No data received so far from CIAA´s Membership			2 g/kg
Desserts	5 g/kg	0-3 g/kg	5 g/kg	Limited representation of the European market. Some producers reported that these additives are typically not used.	5 g/kg
Sugar confectionery	5 g/kg	No data received so far from CIAA´s Membership			5 g/kg
Cereal- and potato-based snacks	5 g/kg	No data received so far from CIAA´s Membership			5 g/kg
Dietetic foods intended for special medical purposes - Dietetic formulae for weight control intended to replace total daily food intake or individual meal	2 g/kg	No data received so far from CIAA´s Membership			2 g/kg
Bread (except that referred to in Annex II)	3 g/kg	1-2.6 g/kg	0.7-3 g/kg	Partly representative of the European market	3 g/kg

[1] When no data was available the Panel used the maximum level.

2.7. Information on existing authorisations and evaluations (Allocation of ADI by SCF, EFSA, JECFA in previous evaluations)

An Acceptable Daily Intake (ADI) of 0-20 mg/kg bw for SSL and CSL was established in 1974 by JECFA. The Panel noted that the JECFA document refers to "Stearoyl lactylic acid, calcium and sodium salts" pointing to a group ADI, which is in accordance with the SCF in 1978. No long-term studies were available for this evaluation. The 2 % level in sub-chronic feeding studies in rats (corresponding to 1000 mg/kg bw/day) has been taken as the No Observed Adverse Effect Level (NOAEL) (JECFA, 1974a). However, it is not clear on which sub-chronic study this NOAEL is based. An uncertainty factor of 50 (no justification given) was applied to set an ADI of 20 mg/kg bw/day.

A report published in 1978 by the SCF endorsed the ADI of 20 mg/kg bw/day as established by JECFA without any details on the toxicological basis of this evaluation. The SCF cited the document published by JECFA (1974a), including unpublished studies not available for the present evaluation.

An evaluation is also available from the Nordic Council of Ministers (TemaNord, 2002). They concluded that both additives are degraded to their basic constituents stearic acid and lactic acid after ingestion. Both metabolites are components of natural food and also part of endogenous metabolism. The Nordic Council of Ministers did not recommend a re-evaluation although the existing studies (JECFA, 1974a) are old and data gaps are obvious.

In the United States, sodium stearoyl-2-lactylate is approved for use in foods as described in FDA (2002). Details on use or intended use (dough strengthener, emulsifier, stabiliser, or texturiser) were given but no ADI was reported.

2.8. Exposure

2.8.1. Exposure assessment

Exposure assessment has been published as a separate statement following a request by the European Commission on 13 April 2012, to carry out an exposure assessment of sodium stearoyl-2-lactylate (E 481) (SSL) and calcium stearoyl-2-lactylate (E 482) (CSL) as food additives including extension of the uses to use in emulsified cooked meat products (e.g. mortadella, paté). Details of the exposure assessment are provided in this statement (EFSA Panel on Food Additives and Nutrient Sources added to Food (ANS), 2013).

The Panel noted that its estimates should be considered as being conservative as it is assumed that all processed foods contain SSL and CSL added at the MPLs or the maximum reported use levels.

Exposure was estimated using the food additives intake model (FAIM), available on the EFSA website[14].

The Panel noted uncertainties in its exposure estimates based on the inability to calculate exposure for several food categories at a more detailed level as insufficiently robust data on food consumption is available from the EFSA Comprehensive Food Consumption Database. In particular this applies to the use of SSL and CSL in food category 01.8 Dairy analogues, where the additive is authorised only for beverage whiteners, 08.2.2 Heat-treated processed meats, where the additive is authorised only for minced and diced canned meat products, and 15.1 Potato-, cereal-, flour- or starch-based snacks, where the additive is authorised only for cereal-based snacks. For these food categories it was assumed that the additive is used for all foods falling into this category, thus leading to an overestimation of exposure.

For the food categories 02.2.2 Other fat and oil emulsions including spreads as defined by Council Regulation (EC) No 1234/2007 and liquid emulsions, 04.2.4.1 Fruit and vegetable preparations, 06.7 Pre-cooked or processed cereals, 14.1.4 Flavoured drinks, 14.1.5 Coffee, tea, herbal and fruit infusions, chicory; tea, herbal and fruit infusions and chicory extracts; tea, plant, fruit and cereal preparations for infusions, as well as mixes and instant mixes of these products other than coffee and coffee extracts, 14.2.6 Spirit drinks as defined in Regulation (EC) No 110/2008[15], and 14.2.8 Other alcoholic drinks including mixtures of alcoholic drinks with non-alcoholic drinks and spirits with less than 15 % of alcohol it was assumed that the additive is not used at all since the authorisation applies only to a small part of these categories. Moreover, the food category 5.4 Decorations, coatings and fillings, except fruit-based fillings covered by category 4.2.4 is not referenced in the FoodEx

[14] http://www.efsa.europa.eu/en/topics/topic/additives.htm

[15] Regulation (EC) No 110/2008 of the European Parliament and of the Council of 15 January 2008 on the definition, description, presentation, labelling and the protection of geographical indications of spirit drinks and repealing Council Regulation (EEC) No 1576/89. OJ L 39, 13.02.2008, p 16-54.

nomenclature and couldn't be taken into account in the present evaluation. This leads to a slight underestimation of exposure.

Table 6 summarises the estimated exposure to SSL and CSL from the use as food additives of all five population groups. The Panel noted that no differences were calculated for exposure estimates based on MPL and reported use levels due to the small number of use levels provided and the maximum reported use levels being at the MPL for all food categories.

Table 6: Summary of anticipated exposure to SSL and CSL from the use as food additives using MPLs in five population groups (mg/kg bw/day)

	Toddlers (12-35 months)	Children (3-9 years)	Adolescents (10-17 years)	Adults (18-64 years)	The elderly (>65 years)
Estimated exposure using MPLs or reported use levels					
• Mean	29-92	28-81	13-32	8-21	5-15
• High level[16]	69-223	44-190	21-59	19-53	16-31

2.9. Main food categories contributing to exposure of SSL and CSL using MPLs

Table 7: Main food categories contributing to exposure to SSL and CSL using MPLs and reported use levels and number of surveys in which each food categories is contributing.

		Toddlers	Children	Adolescents	Adults	The elderly
Category number	**Foods**	**% contribution to total exposure (Number of Surveys)**				
1.4	Flavoured fermented milk products including heat treated products	6-78 (4)	11-52 (13)	6-28 (10)	5-50 (13)	7-32 (6)
5.2.1	Other confectionery with added sugar		6-8 (4)	7-10 (2)	6-7 (2)	
6.3	Breakfast cereals	7 (1)	5-20 (8)	5-13 (7)	9-20 (4)	6-24 (2)
7.1	Bread and rolls	17-43 (3)	13-49 (14)	20-48 (12)	27-57 (14)	38-61 (6)
7.2	Fine bakery wares	12-40 (3)	12-42 (13)	5-39 (12)	6-30 (14)	7-29 (6)
8.2	Processed meat	6-14 (4)	8-22 (15)	10-22 (12)	12-33 (15)	13-37 (7)
16	Desserts excluding products covered in category 1, 3 and 4	13-16 (2)	6-14 (9)	6-10 (3)	8-10 (2)	8 (2)

2.10. Uncertainty analysis

Uncertainties in the exposure assessment of SSL and CSL have been previously discussed in the present opinion in section 2.8.1. According to the guidance provided in the EFSA opinion related to uncertainties in dietary exposure assessment (EFSA, 2007), the following sources of uncertainties have been considered and summarised below:

[16] typically 95th percentile of consumers only.

Table 8: Qualitative evaluation of influence of uncertainties

Sources of uncertainties	Direction *
Consumption data: different methodologies / representativeness / under reporting / misreporting / no portion size standard	+/-
Extrapolation from food consumption survey of few days to estimate chronic exposure	+
Linkage between reported use levels and food items in the consumption database: uncertainties on which precise types of food the use levels refer.	+/-
Occurrence data: maximum reported use levels within a food category	+
Exposure model: uncertainty in possible national differences in use levels of food categories, data set not fully representative of foods on the EU market, exposure calculations based on the maximum reported use levels (no use of typical use levels when available)	+

* + = uncertainty with potential to cause over-estimation of exposure; - = uncertainty with potential to cause underestimation of exposure.

3. Biological and toxicological data

The evaluation of SSL and CSL by JECFA (1974a) was based on unpublished reports only. The authors of the SCF evaluation in 1978 cited the document published by JECFA (1974a) as well as additional unpublished studies. The original unpublished study reports featured in both evaluations were not available for the present opinion. A literature search identified three studies of toxicological relevance for the core endpoints toxicokinetics (Philips et al., 1981), genotoxicity (Ishidate et al., 1984) and chronic toxicity (Lamb et al., 2010).

Both mixtures, SSL and CSL differ only in their cation. The cations sodium and calcium are endogenous components without toxicological relevance for the evaluation of SSL and CSL as food additives.

3.1. Absorption, distribution, metabolism and excretion

Limited data on absorption, metabolism and excretion were presented in JECFA, 1974a.

New literature

The absorption, metabolism, tissue distribution and excretion after a single oral dose (gavage) of radio-labelled CSL (^{14}C-CSL) was studied in male Tuck TO mice and male Dunkin-Hartley guinea pigs (Phillips et al.,1981). CSL was labelled via the lactate moiety giving calcium stearoyl-2-[U-^{14}C]lactylate. Ninety or 900 mg/kg bw ^{14}C-CSL (aqueous suspension) were administered to groups of 4 male mice or 4 male guinea pigs. Radioactivity was determined in exhaled air, urine, faeces, liver, kidneys, heart, lungs, spleen, testes and gastrointestinal tract. In addition, the same parameters were determined in an additional group of 3 male animals per species receiving 325 mg/kg bw DL-^{14}C-sodium lactate, equivalent to 900 mg/kg bw CSL. The results are presented in Table 9.

Table 9: Excretion of radioactivity by male mice and male guinea-pigs given a single oral dose of ^{14}C-labelled CSL or ^{14}C-lactate (Phillips et al., 1981)

Recovery of eliminated radioactivity	Time period after gavage in hours	Means of excreted radioactivity in % of applied dose		
		90 mg/kg bw ^{14}C-CSL (n=4)	900 mg/kg bw ^{14}C-CSL (n=4)	325 mg/kg bw ^{14}C-lactate (n=3)
Studies in mice				
In exhaled CO_2	0-7	69.7	57.5	81.3
	7-24	7.1	22.3	8.0
	24-48	3.4	2.8	2.9

Recovery of eliminated radioactivity	Time period after gavage in hours	Means of excreted radioactivity in % of applied dose		
		90 mg/kg bw ^{14}C-CSL (n=4)	900 mg/kg bw ^{14}C-CSL (n=4)	325 mg/kg bw ^{14}C-lactate (n=3)
	0-48	80.2	82.6	92.2
In urine	0-24	14.8	14.1	3.4
	24-48	0.7	2.1	0.6
	0-48	15.5	16.2	4.0
In faeces	0-24	2.4	1.8	0.9
	24-48	0.3	0.3	0.2
	0-48	2.7	2.1	1.1
In sampled organs [(a)]	At 48	1.8	2.1	2.1
Only in liver		0.8	0.9	1.0
Total recovery		100.2	103	99.4
Studies in guinea pigs				
In exhaled CO_2	0-7	63.1	60.5	77.6
	7-24	12.2	18.1	4.0
	24-48	3.5	3.3	2.5
	0-48	78.8	81.9	84.1
In urine	0-24	9.2	8.1	3.3
	24-48	0.8	1.0	0.4
	0-48	10.0	9.1	3.7
In faeces	0-24	3.0	2.3	1.6
	24-48	0.8	0.6	0.5
	0-48	3.8	2.9	2.1
In sampled organs [(a)]	At 48	6.1	6.7	10.2
Only in liver		2.4	4.1	7.9
Total recovery		98.7	100.6	100.1

(a): Total radioactivity in the following organs: liver, kidneys, heart, lungs, spleen, testes and gastrointestinal tract

The results presented in Table 9 revealed rapid absorption of radioactivity from the gastro-intestinal tract after oral application of calcium stearoyl-2-[U-^{14}C]lactylate ([^{14}CY]CSL) in mice as well as in guinea pigs since more than 50 % of the applied radioactivity was exhaled as CO2 within 7 hours. In both species, approximately 80 % of the applied dose was exhaled within 48 hours. Most of the remaining radioactivity was excreted in the urine within 24 hours after treatment. Only minor amounts were detected in the faeces of both species. No relevant differences were detected between the high and low dose levels of CSL. However, in mice the rate of metabolism to $^{14}CO_2$ over the first 7 hours was lower at the high dose but increased 7-24 hours after application. Approximately 2 % (mice) or 6 % (guinea pig) of the administered dose remained in the tissues, mainly in the liver and gastrointestinal tract (not shown in the Table). Only traces of radioactivity were found in other organs (kidneys, lungs, testes, spleen, heart) (Phillips et al., 1981).

Similar results were obtained in experiments with ^{14}C-lactate. The excretion via exhaled $^{14}CO_2$ was higher in comparison to CSL and less radioactivity was excreted via the urine. The total residual radioactivity in the sampled organs was similar in both species 48 hours after administration of either ^{14}C-CSL or ^{14}C-lactate (Phillips et al., 1981).

Data on excretion of radioactivity after a single oral dose of ^{14}C-labelled CSL or ^{14}C-lactate suggested that the main metabolite was CO_2 in mice and guinea pigs: 60-70 % of the applied CSL and 78-81 % of the applied lactate were exhaled as CO_2 (Table 9). TLC of the urine of both species indicated lactic acid as metabolite. The authors suggested that the additional radioactivity in the urine of CSL-treated animals is lactoyllactic acid (Phillips et al., 1981).

Results reported in the JECFA evaluation (1974a) are in accordance with the study of Phillips et al., (1981). Rats fed SSL or CSL excreted only traces of lactate in the faecal fat. The authors reported a good utilization of stearic acid and calcium (Hodge, 1961, unpublished report, cited in JECFA, 1974a). In *in vivo* experiments the metabolic fate of mixed stearic acid and ^{14}C-lactic acid was compared with ^{14}C-CSL (lactic acid labelled). In this study 58 % of the radioactivity of the physical mixture and 60 % of the radioactivity of CSL was excreted as ^{14}C-CO_2 within 24 hours indicating no difference between the two groups. The authors concluded that lactate derived from CSL is metabolised normally (Hodge, 1955c, unpublished report, cited in JECFA, 1974a).

In vitro studies (Phillips et al., 1981) demonstrated hydrolysis of ^{14}C-CSL radio-labelled at the lactate moiety with liver homogenates from rats, mice and guinea pigs, and with intestinal mucosa scrapings from rats, mice and human volunteers. Whole blood from rats and mice also hydrolysed the compound, but at a much slower rate. No significant hydrolysis of CSL was detected using human blood. In liver homogenates 55 % (rat liver), 50 % (guinea pig liver), or 40 % (mouse liver) of the initial ^{14}C-CSL disappeared and 55 % (rat liver), 45 % (guinea pig liver), or 35 % (mouse liver) of the initial radioactivity occurred in the form of ^{14}C-lactate within 60 minutes after initiation of incubation. Valid negative control incubations were carried out using boiled homogenates of the liver. Similar results were obtained in experiments with intestinal mucosal scrapings from rats, mice and guinea-pigs. However, the single sample of human duodenal mucosa rapidly hydrolysed ^{14}C-CSL, although the rate of hydrolysis was lower (snap-frozen and thawed sample) than in freshly prepared homogenates from intestinal mucosal scrapings of experimental animals (Phillips et al., 1981).

In vitro hydrolysis experiments with lipase have shown the formation of stearic and lactic acid (Hodge, 1961, unpublished report, cited in JECFA, 1974a).

The *in vitro* and *in vivo* studies of Phillips et al. (1981) show that CSL is nearly completely hydrolysed to lactic acid and stearic acid after oral application. The lactate moiety is rapidly and completely absorbed and most of the lactic acid is metabolised and exhaled as CO_2; smaller amounts are excreted as lactic acid in the urine. Minor amounts of radioactivity are found in the liver and in the gastrointestinal tract after two days. The metabolism and biological fate of CSL is comparable in mice and guinea pigs. From the results of the *in vitro* studies it can be assumed that there are no major species differences, including humans, with respect to hydrolysis. The products of hydrolysis, i.e. stearic acid and lactic acid, are endogenous substances in mammals.

Since all the absorption, distribution, metabolism and excretion (ADME) data were obtained on CSL, the Panel considered that the toxicokinetics of SSL and CSL would be similar.

3.2. Toxicological data

3.2.1. Acute oral toxicity

In rats, an oral LD_{50} value > 25 g/kg bw was reported (Schuler and Thornton, 1952; unpublished report cited in JECFA, 1974a). It was not indicated whether the test substance was SSL or CSL.

In male rats an oral LD_{50} of 25 g/kg bw was given for SSL and CSL (Murphy and Baiocchi, 1978).

Overall, the results indicate very low acute oral toxicity of stearoyl lactylates.

3.2.2. Short-term and subchronic toxicity of SSL and CSL

The JECFA evaluation (1974a) reported subacute and subchronic toxicity data in rats and dogs from unpublished study reports, which were not available for the present re-evaluation. The data presented in Table 10 are from the JECFA evaluation (1974a).

Table 10: Summary of subacute and sub-chronic oral toxicity in experimental animals exposed to SSL or CSL

Substance, Species, strain, sex[(a)], n[(b)]	Duration	Dosing information	Investigated parameters/Effects	Reference
CSL, rat, n.d.[(c)], n.d., 10	27 days	0 or 5 % in the diet (paired feeding)	**5 %**: food efficiency ↓, liver weight ↑ but no effects on liver histopathology except slight increase in glycogen	Hodge, 1953, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d, m&f, 10	Presumably 27 days	0.5 % in the diet (paired feeding, no data about controls)	**0.5 %**: histology of livers and kidneys normal, X-rays of femurs normal	Hodge, 1953, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., n.d., 12	28 days	0 or 5 % in the diet	**5 %:** no effects on body weight gain and food efficiency; liver weight ↑ but pathology (no details) without effects	Wisconsin Alumni R. S., 1955, unpublished report; cited in JECFA, 1974a
SSL, rat, n.d. m, 20 (5 rats per post exposure period)	28 days, post exposure period up to 4 months	0 or 5 % in the diet	**5 %:** slight increase in liver weight; effect was reversible after 90 days (no further parameters investigated)	Hodge, 1954, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d. m, 32 (5 rats per post exposure period)	32 days, post exposure period up to 4 months	0 or 5 % in the diet	**5 %:** no effect on liver weight (no further parameters investigated)	Hodge, 1954, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d. m, 32	unknown	0 or 5 % in the diet, further groups received 3.1% calcium stearate or 3.2% sodium stearate	**5 %:** no effects on body weight gain but relative liver weight ↓	C. J. Patterson Co., 1956, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., m&f, 10	1 month	0 or 5 % in the diet	Chemical composition of the liver 5 %: slight changes in glycogen, protein and lipid content; lipid and protein slightly increased (no further details)	Hodge, 1955a, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., n.d., 25	1 month	0, 0.1, 1, 2, 3, 4, 5 or 7.5 % in the diet	**≥5 %**: body weight gain ↓ and relative liver weight ↑	Hodge, 1956, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., m, 5	30 days	15 % lard (control) or 5 % CSL plus 10 % lard in the diet	**5 %:** body weight gain ↓ and relative liver weight ↓	Hodge, 1956, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., n.d., 10	30 days	5 % of calcium palmitoyl lactylate or calcium oleyl lactylate	**5 %:** body weight gain ↑ and relative liver weight ↓; no effects on kidney weight; histopathology of liver, kidneys and fatty tissues	Hodge, 1956, unpublished report; cited in JECFA, 1974a

Substance, Species, strain, sex[a], n[b]	Duration	Dosing information	Investigated parameters/Effects	Reference
		(controls) or 5% CSL in the diet	revealed no abnormalities	
CSL, rat, n.d., m, 5	43 days	0.5, 2, or 12.5 % in the diet (no data about control)	no mortality observed **≥2 %**: body weight gain ↓, relative liver weight ↑ **12.5 %**: heart, brain, stomach and testes weight ↑	Hodge, 1953, unpublished report; cited in JECFA, 1974a
Stearoyl lactylate, rat, n.d., m&f, 8	90 days	3.5 % cellulose fibre (control) or 3.5% stearoyl lactylate in the diet	**3.5 %:** no effects on growth rate, food consumption, faecal fat elimination, gross and histopathology.	Schuler et al., 1952, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., m&f, 10	98 days	0.5, 5 or 12.5 % in the diet (no data about control)	No effects on urinalysis, haematology, and radiological studies of femurs. **12.5 %:** body weight gain ↓; weights of liver, brain, stomach, heart and spleen ↑ but gross and histopathology normal except lipogranulomata in the adipose tissue.	Hodge, 1953, unpublished report; cited in JECFA, 1974a
SSL, rat, n.d., m&f, 10	102 days	0, 0.5, 5 or 12.5 % in the diet	No effects in urinalysis, haematology, and faecal excretion. **12.5 %:** weights of liver, brain, stomach and spleen ↑ but gross and histopathology normal	Hodge, 1953, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., n.d., 5	Up to 6 months	3-25 % in the diet; control not specified	**16 %:** body weight gain ↓ Total fat content 20 %.	Hodge, 1964, unpublished report; cited in JECFA, 1974a
CSL, rat, n.d., m&f, 40	Up to 6 months	25 % in the diet, no control	**25 %:** mortality ↑; severe lipogranulomata detected in histopathology; rapid recovery after feeding a diet containing half corn oil half lard	Hodge, 1960, unpublished report; cited in JECFA, 1974a
CSL, dog, n.d., 1m & 3f per group	Not specified	0 or 7.5 % in the diet	**7.5 %**: dogs sacrificed after two years; no effects in urinalysis & haematology; necropsy & histopathology negative; no effects on organ weights or liver content	Hodge, 1955b, unpublished report; cited in JECFA, 1974a
CSL, dog, n.d., n.d., 1	10-11 weeks	7.5 % in the diet for 1 month followed by 12.5% for 2 weeks and 15 % for 1 month	**7.5-15 %**: no changes in haematology and organ weights; no effects in histopathology. No control	Hodge, 1955b, unpublished report; cited in JECFA, 1974a

(a): m: male; f: female
(b): number of animals/sex/dose
(c): n.d.: no data available
↑: increase; ↓: decrease

In sub-chronic feeding studies with SSL (exposure period 102 days) and CSL (exposure period 98 days), no toxic effects occurred in rats at a dose level of 5 % in the diet corresponding to 5000 mg/kg bw/day (Hodge, 1953, unpublished report; cited in JECFA, 1974a). On the other hand, in a feeding study in rats, the application of a diet containing 2 % CSL for 43 days (corresponding to 2000 mg/kg bw/day) resulted in decreased body weight gain and increased liver weights (Hodge, 1953, unpublished report; cited in JECFA, 1974a). However, the Panel considered that this study is less reliable than the sub-chronic studies because controls were not specified and results are in contrast to other sub-acute studies revealing no effects on body weight at the 5 % level (e.g. Wisconsin Alumni R. S., 1955, unpublished report; cited in JECFA, 1974a). There is some indication that the dog is less sensitive than the rat as the only two studies in dogs showed no effect at levels of 7.5 % and 15 % (the dosage was stepwise increased from 7.5 % to 12.5 % and finally to 15 % for one month) CSL in the diet (Hodge, 1955b, unpublished report; cited in JECFA, 1974a).

Histopathological examinations revealed lipogranulomata in the adipose tissue of rats exposed for 98 days to 12.5 % CSL in corn oil (Hodge, 1953, unpublished report; cited in JECFA, 1974a; Table 10). The authors of the JECFA evaluation (1974a) related the appearance of "lipogranulomata" and increased relative liver weight to the excessive intake of long-chain fatty acids. The Panel noted that in long-term feeding studies in rats fed high doses of acetostearin and aceto-olein (Ambrose et al., 1958; Cox and DeEds, 1958) or saturated fat (Herting and Crain, 1958) similar (reversible) effects were observed in fat tissue. Therefore, the Panel considered that the development of these lipogranulomata is induced by simultaneous feeding of corn oil and reversible by return to normal diet.

A concentration of 2 % in the diet (corresponding to 1000 mg/kg bw/day) was reported in the JECFA evaluation (1974a) as the NOAEL. However, no detailed information was given with respect to the study where this NOAEL was based upon, and which substance was tested (SSL or CSL). The Panel noted that the data of the sub-chronic studies of Hodge et al (1953, unpublished report; cited in JECFA, 1974a) could also indicate a NOAEL of 5 % in the diet. This is supported by the results of a long-term feeding study in rats (Lamb et al., 2010; Section 3.2.4).

3.2.3. Genotoxicity

No data on genotoxicity *in vitro* or *in vivo* were presented in the JECFA evaluation (1974a).

New literature

In a bacterial reverse mutation test, the *S. typhimurium* strains TA92, TA1535, TA100, TA1537, TA94 and TA98 were used in a pre-incubation assay to determine the mutagenic activity of CSL. Duplicate plates were used for each of 6 different concentrations; the maximum concentration was 300 µg CSL/plate (no further details). No data were given about cytotoxicity. The authors used benzene as vehicle. No mutagenic activity was reported with or without S9 (Ishidate et al., 1984).

Ishidate et al. (1984) performed a chromosome aberration test with CSL in the Chinese hamster lung fibroblast cell line (CHL). The cells were exposed to CSL (vehicle: ethanol) at three different concentrations for 24 and 48 hours without metabolic activation; the maximum dose tested was 63 µg CSL/mL. This concentration represents the highest non-cytotoxic dose level. The cytotoxic effects were studied in preliminary tests and the dose level resulting in 50 % cell-growth inhibition was chosen as highest dose for genotoxicity testing. One hundred metaphases per concentration were analysed for polyploid cells and structural chromosomal aberrations. Chromosome and chromatid gaps were included in the evaluation of clastogenic effects. The exposure to CSL did not result in polyploidy or clastogenic effects.

There is no indication for gene mutations in bacteria or induction of chromosomal aberrations in mammalian cells *in vitro*. Therefore, the Panel concluded that neither stearoyl lactylates nor their breakdown products steric acid and lactic acid give raise to concern for genotoxicity.

3.2.4. Chronic toxicity and carcinogenicity

No data on chronic toxicity and carcinogenicity were presented in the JECFA evaluation (1974a).

New literature

Lamb et al. (2010) published a one-year oral toxicity study with SSL in Wistar rats. The study was conducted in accordance with the OECD Principles of Good Laboratory Practice and according to OECD Guideline 452. SSL obtained from the American Ingredients Company was mixed into the basal diet at concentrations of 0, 1.25 %, 2.5 %, and 5 %. Analyses of concentrations, stability and homogeneity were performed. Groups of 30 rats/sex/group were exposed via the diet for 1 year. The dosage was equivalent to mean daily intakes of 0, 558, 1115, and 2214 mg/kg bw/day in males and 0, 670, 1339, and 2641 mg/kg bw/day in females.

Clinical signs were recorded at least once daily. A functional observation battery assessment was performed in all animals prior to the first day of treatment and at weeks 12, 25, and 51. Body weights, food and water consumption (measured over 7-day periods) were determined weekly for the first 13 weeks, at the end of week 16, and once every 4 weeks thereafter. Ophthalmology was performed in all rats prior to treatment and in controls and high-dose rats near study termination. Urinalysis was performed during weeks 2, 13, 26, and 52 in 10 rats/sex/group. Blood samples were collected during weeks 3, 13, 26, and at termination of all surviving rats for haematology and clinical chemistry. In treatment weeks 33–34, faeces were collected from 5 female rats/group over 3 consecutive days, pooled per animal and analysed for dry matter, crude protein, crude fat, and ash. The excretion of energy was calculated. All rats were sacrificed at termination and necropsy was performed. Organ weights of liver, kidneys, adrenals, brain, heart, thymus, spleen, thyroid (with parathyroids), ovaries, uterus, testes and spididymides were recorded. Microscopic examination of lungs, trachea/bronchi, brain, spinal cord, sublingual, submaxillary, and parotid salivary glands, thymus, heart, sternum with bone marrow, adrenals, liver, spleen, kidneys, thyroid/parathyroids, urinary bladder, ovaries and fallopian tubes, uterus, vagina, oesophagus, ileum, caecum, prostate and seminal vesicles with coagulating glands, peripheral nerve (sciatic), stomach, duodenum, jejunum, colon, rectum, gut associated lymphoid tissue including Peyer's patches, mesenteric and mandibular lymph nodes, axillary lymph nodes, pancreas, pituitary, aorta, mammary gland, Harderian glands, skin, nasal turbinates, skeletal muscle, femur with joint, epididymides, testes, eyes, exorbital lachrymal glands, and Zymbal's glands of controls and high-dose rats was performed.

Additionally, all gross lesions were examined as well as the organs of one low-dose and one mid-dose female that were sacrificed early. The histopathological examination of the uterus and vagina was extended to the low- and mid-dose groups.

SSL was well tolerated at dietary levels up to 5 % as evidenced by the absence of any treatment-related toxic effect. The slight but significant decrease in body weight (max. 6-7 %) and the slightly reduced feed consumption at the high dose level were not considered by the authors to be of toxicological relevance. The findings in haematology, clinical chemistry, and urinalysis were considered of no biological or toxicological significance.

Histopathological examination revealed a rather high incidence of endometrial stromal polyps in the uterus of 1 control, 2 low-dose, 6 mid-dose, and 6 high-dose females. A comparison with historical incidences of this tumour type (up to 10 % in control rats of 1 year studies in the laboratory conducting this study) demonstrated that endometrial stromal polyps are common in rats of this strain and age. The authors of the study concluded that given the frequent occurrence of these benign tumours in the strain of rats used, the wide variability in the reported incidence of these polyps in these rats, the lack of statistical significance and lack of biological evidence to suggest a mechanism for the slightly higher incidence in the groups fed 2,5 and 5 % SSL, the endometrial polyps observed in females fed SSL were not related to treatment (Lamb et al., 2010).

The Panel agreed with this conclusion of the authors and considered the NOAEL to be 5 % SSL in the diet (the highest dose tested) corresponding to 2214 mg SSL/kg bw/day for males and 2641 mg SSL/kg bw/day for females.

Overall the Panel concluded that stearoyl lactylates do not raise concern with respect to carcinogenicity.

3.2.5. Reproductive and developmental toxicity

No data are available.

3.2.6. Other studies

Observations in humans

Jensen and Andersen (2005) have shown a positive reaction to SSL in the patch test of a 61-year-old woman with a 20-year history of palmoplantar pustulosis and chronic hand and foot dermatitis possibly associated with the use of a cosmetic product containing SSL. The patient also reacted to dichromate, colofonium, cobalt and nickel. Subsequent tests in humans not suffering from dermatitis indicated that SSL solutions were irritant to the skin. These single case reports of skin reactivity to a complex cosmetic product together with the irritant potential of SSL do not point to a sensitisation concern from its use as food additive. Evaluation of the hydrolysis products stearic acid and lactic acid

Stearic acid

Stearic acid is a typical example of a saturated fatty acid and is part of the general metabolism in man (lipogenesis and energy source). There is no safety concern for stearic acid and palmitic acid (also part of the hydrolysis, see specification in Section 2.2) as concluded in the JECFA evaluation on these two substances (JECFA, 1999); the evaluations are based on the estimated current levels of intake. Stearic acid and palmitic acid are endogenous substances and both are metabolised by beta-oxidation. The resulting 2-carbon-units enter the tricarboxylic acid cycle (JECFA, 1999).

Lactic acid

Lactic acid is a constituent of natural food and both isomers (L-(+)-lactic acid and D-(−)-lactic acid) are found for example in sour milk products and fruits. The L-(+)-lactic acid is part of the endogenous metabolism (see also JECFA, 2002). Lactic acid is a food additive (E 270) and is used as an acidifier and flavouring agent (JECFA, 2005).

The specifications for E 270 are related to both isomers and the racemate of lactic acid (JECFA 2006). A toxicological evaluation of lactic acid and its salts was presented by JECFA in 1974. The authors concluded that no limit needed to be set for the ADI for humans (JECFA, 1974b).

4. Discussion

The present opinion deals with the re-evaluation of the safety of sodium stearoyl-2-lactylate (E 481, SSL) and calcium stearoyl 2- lactylate (E 482; CSL) as food additives. SSL and CSL are used as emulsifiers and stabilizers (JECFA 2006). The Panel noted that although the additives E 481 and E 482 are both described in EU Regulation No 231/2012 and by JECFA as ‘sodium stearoyl-2-lactylate’ and ‘calcium stearoyl-2-lactylate’ respectively, it is stated that the mono-esters of lactic acid are the major components.

The Panel considered the evaluation of SSL and CSL in one opinion justified since SSL and CSL differ only due to the cation. Both, sodium and calcium are endogenous cations without toxicological relevance for the evaluation of SSL and CSL as food additives.

The Panel was not provided with a newly submitted dossier and based its evaluation on previous evaluations and reviews, and additional literature that came available since then and the data available following a public call for data.

The sodium and calcium salts of stearoyl lactylic acid are authorised as food additives in the EU (Commission Regulation (EU) No 231/2012). SSL and CSL were previously evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1974 (JECFA, 1974a) and the EU Scientific Committee for Food (SCF) in 1978 (SCF, 1978) and TemaNord in 2002.

Both stearoyl-2-lactylates are identified by their solubility and by tests for sodium (or calcium), for fatty acids and for lactic acid.

An Acceptable Daily Intake (ADI) of 0-20 mg/kg bw for SSL and CSL was established in 1974 by JECFA. The Panel noted that the JECFA document refers to "Stearoyl lactylic acid, calcium and sodium salts" pointing to a group ADI. The 2 % level in feeding studies in rats (corresponding to 1000 mg/kg bw/day) has been taken as the No Observed Adverse Effect Level (NOAEL) but it is not clear on which study this NOAEL was based (JECFA, 1974a). A report published in 1978 by the SCF endorsed the ADI established by JECFA (ADI of 0-20 mg/kg bw singly or in combination) without any details on the toxicological basis of this evaluation. The Nordic Council of Ministers (TemaNord, 2002) concluded that both additives are degraded to their basic constituents, stearic acid and lactic acid after ingestion. Both metabolites are components of natural food and also part of endogenous metabolism.

Unpublished studies on absorption, distribution, metabolism and excretion were presented in the JECFA evaluation (1974a). The results of these studies support those published by Phillips et al. (1981). The *in vivo* and *in vitro* experiments of Phillips et al. (1981) with CSL labelled with ^{14}C at the lactate moiety showed a nearly complete absorption of the radiolabel and hydrolysis of CSL to lactic acid and stearic acid. The biological fate of CSL is comparable in rodent and non-rodent species. It seems likely that hydrolysis of CSL would be similar in humans. The products of hydrolysis, stearic acid and lactic acid are constituents of natural food and part of endogenous metabolism in mammals. The Panel noted that the toxicokinetics of SSL and CSL would be similar.

The acute oral toxicity in rats is low. Unpublished sub-acute and sub-chronic studies with SSL and CSL in rats and dogs revealed a NOAEL of 5 % in the diet (Hodge et al. 1953).

Rats appear to tolerate large doses of sodium stearoyl-2-lactylate and calcium stearoyl-2-lactylate for one year without evidence of toxicity. Dogs seem less sensitive than the rat for oral exposure to calcium stearoyl-2-lactylate.

The data on genotoxicity *in vitro* presented by Ishidate et al. (1984) gave no indication for mutagenic activity in the bacterial reverse mutation assay or in a mammalian chromosome aberration test. The Panel concluded that neither SSL and CSL nor their breakdown products stearic acid and lactic acid give rise to concern for genotoxicity.

Lam et al (2010) performed a one-year one-year oral toxicity study with SSL in rats. Based on the results of that study, the authors concluded that.the NOAEL of SSL was 5 % in the diet (the highest dose tested) corresponding to 2214 mg/kg bw/day for males and 2641 mg/kg bw/day for females. The Panel agrred with this conclusion.

No data are available on reproductive toxicity and carcinogenicity. However, no reproductive toxic effects or carcinogenicity are expected since the products of hydrolysis, stearic acid and lactic acid are endogeneous substances in mammalians and therefore no additional uncertainty factor would be required.

The Panel concluded that based on the NOAEL of 2200 mg/kg bw/day from a one-year toxicity study in rats and using an uncertainty factor of 100, an ADI of 22 mg/kg bw/day for sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482), either singly or in combination, can be established.

The exposure estimates based on MPLs are in a range of 29-92 mg/kg bw/day for toddlers, 28-81 mg/kg bw/day for children, 13-32 mg/kg bw/day for adolescents, 8-21 mg/kg bw/day for adults, and 5-15 mg/kg bw/day for the elderly at the mean level. At the high level, exposure estimates are in a range of 69-223 mg/kg bw/day for toddlers, 44-190 mg/kg bw/day for children, 21-59 mg/kg bw/day for adolescents, 19-53 mg/kg bw/day for adults, and 16-31 mg/kg bw/day for the elderly.

The estimated exposure to SSL and CSL occurs mainly via the consumption of flavoured fermented milk products including heat treated products, bread and rolls and fine bakery wares and is below the ADI of 22 mg/kg bw/day for all the adult population including the elderly, but exceeds the ADI for other groups of the population at mean level and for all groups of the population at high level.

CONCLUSIONS

The sodium and calcium salts of stearoyl lactylic acid are authorised as food additives in the EU (Commission Regulation (EU) No 231/2012). Sodium stearoyl-2-lactylate and calcium stearoyl-2-lactylate were previously evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1974 (JECFA, 1974a) and the EU Scientific Committee for Food (SCF) in 1978 (SCF, 1978) and TemaNord in 2002.

The Panel concluded that based on the No Observed Adverse Effect Level (NOAEL) of 2200 mg/kg bw/day from a one-year oral toxicity study in rats and an uncertainty factor of 100, an acceptable daily intake (ADI) of 22 mg/kg bw/day for sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482) either singly or in combination, can be established.

The estimated exposure to sodium stearoyl-2-lactylate (E 481) and calcium stearoyl-2-lactylate (E 482) occurs mainly via the consumption of bread and fine bakery products and is below the ADI of 22 mg/kg bw/day for all the adult population including the elderly, but exceeds the ADI for other groups of the population at mean level and for all groups of the population at high level.

DOCUMENTATION PROVIDED TO EFSA

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2. CIAA (Confédération des Industries Agro-Alimentaires de l'UE), 2009. CIAA submission to Commission - intake data - September 2009. Submitted by EFEMA on stearoyl-2-lactylate salts (E 481-E 482), unpublished report.

3. ELC (before 2012) Tier 3 – Category I Additives - Questionnaire for Food Additive Manufacturers, Submitted by EFEMA on stearolyl-2-lactylate salts (E 481-482), unpublished report.

4. Premium Ingredients 2009. Application for the authorisation of the extension for use of additive.

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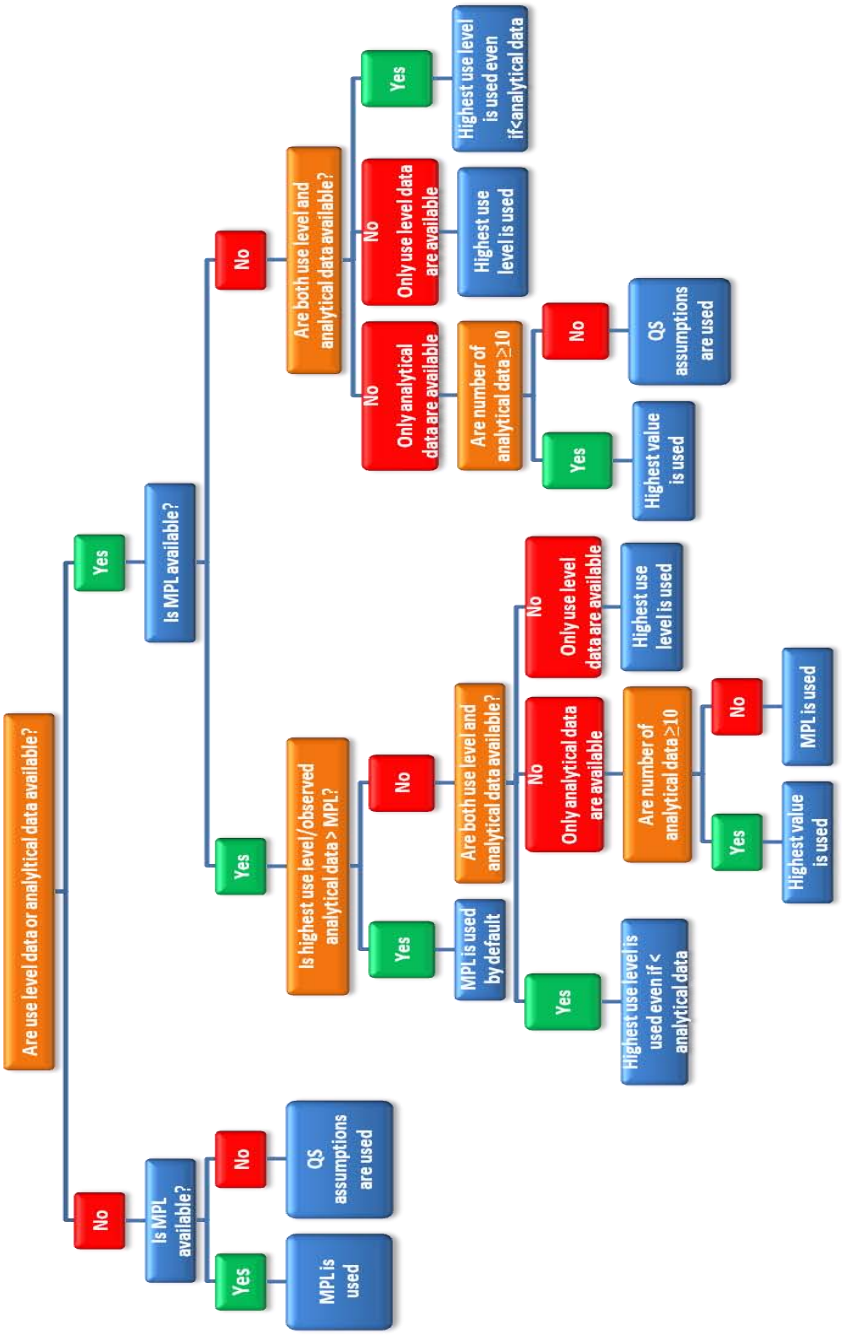
APPENDIX

A. RULES DEFINED BY THE PANEL TO DEAL WITH QUANTUM SATIS (QS) AUTHORISATION, USAGE DATA OR OBSERVED ANALYTICAL DATA FOR ALL REGULATED FOOD ADDITIVES TO BE RE-EVALUATED

Figure 1: Rules defined by the Panel to deal with usage data or observed analytical data for all regulated food additives to be re-evaluated and procedures for estimating intakes using these rules.



GLOSSARY AND ABBREVIATIONS

ADI	Acceptable Daily Intake
ANS	Panel on Food Additives and Nutrient Sources added to Food
bw	Body weight
CAS	Chemical Abstracts Service
CHL	Chinese Hamster Lung
CIAA	Confédération des Industries Agro-Alimentaires de l'UE
CSL	Calcium stearoyl-2-lactylate
EC	European Commission
EFEMA	European Food Emulsifier Manufacturers' Association
EFSA	European Food Safety Authority
EINECS	European Inventory of Existing Commercial chemical Substances
ELC	Federation of European Food Additives, Food Enzymes and Food Cultures Industries
EU	European Union
FDA	Food and Drug Administration
GC/MS	Gas chromatography / mass spectrometry
HPLC	High-performance liquid chromatography
IUPAC	International Union of Pure and Applied Chemistry
JECFA	Joint FAO/WHO Expert Committee on Food Additives
LD_{50}	Lethal Dose, 50 % i.e. dose that cause death among 50 % of treated animals
MS	Mass spectra
NOAEL	No Observed Adverse Effect Level
OECD	Organisation for Economic Co-operation and Development
SCF	Scientific Committee on Food
SCOOP	Scientific co-operation
SSL	Sodium stearoyl-2-lactylate
TemaNord	Nordic Council of Ministers

TLC	Thin-Layer Chromatography