

**Table 1.** BioSA characteristics and physical properties [5]

	<b>Property</b>					
	<b>Melting Point</b>	<b>Boiling Point</b>	<b>Moisture</b>	<b>Other Organic Acids</b>	<b>Appearance</b>	<b>Purity</b>
BioSA	185°C-190°C	235°C	≤0.5%	0.1%	White Crystalline solid	≥99.5%

**Table 2.** Global Life Cycle Inventory data corresponding to the foreground system for the production of BioSA. Data are reported per production batch.

<b>INPUTS from TECHNOSPHERE</b>	
<b>Section 1 (S1)</b>	
Apple pomace (75% moisture)	8,444 kg
Liquefied natural gas	1,457 kg
Electricity	308 kWh
<b>Section 2 (S2)</b>	
Water	107,081 kg
CO <sub>2</sub>	58,539 kg
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> (to inoculum preparation)	277 kg
Na <sub>2</sub> CO <sub>3</sub>	12,522 kg
Yeast extract (nutrient)	1,825 kg
Corn Steep Liquor (nutrient)	69 kg
NaH <sub>2</sub> PO <sub>4</sub> ·H <sub>2</sub> O (nutrient)	248 kg
K <sub>2</sub> HPO <sub>4</sub> (nutrient)	372 kg
MgCO <sub>3</sub> (nutrient)	272 kg
NaCl	117 kg
Cellulase	59.5 kg
β-glucosidase	3.66 kg
Electricity	18,770 kWh
<b>Section 3 (S3)</b>	
H <sub>2</sub> SO <sub>4</sub>	3,878 kg
1-Octanol	200,060 kg
Tri-n-octilamine	19,404 kg
Electricity	40,700 kWh
<b>OUTPUTS to TECHNOSPHERE</b>	
BioSA	4,669
<i>Waste to treatment</i>	
Wastewater to WWTP from SS3	112,693
Solid waste to sanitary landfill from SS3	4,131
<b>OUTPUTS to ENVIRONMENT</b>	
<i>Emissions into air</i>	
CH <sub>4</sub>	166 g
CO	2.49 kg
CH <sub>3</sub> COOH	12.5 g
N <sub>2</sub> O	41.5 g
Particulates (<2.5µm)	8.31 g
NO <sub>x</sub>	1.66 kg
SO <sub>2</sub>	45.7 g

**Table 3.** Description of the main Ecoinvent ® database version 3.2 processes [32] and other literature sources considered in this study for the background processes

<b>Input</b>	<b>Process</b>
Electricity	Electricity, medium voltage {ES}  market for   Alloc Rec, U
Heat	Heat, central or small-scale, natural gas {RER}  market group for   Alloc Def, U
Water	Tap water {Europe without Switzerland}  market for   Alloc Rec, U
Inorganic chemicals	Chemical, inorganic {GLO}  market for chemicals, inorganic   Alloc Rec, U
Organic chemicals	Chemical, organic {GLO}  market for   Alloc Rec, U
Sodium chloride	Sodium chloride, brine solution {GLO}  market for   Alloc Def, S
Sulfuric acid	Sulfuric acid {GLO}  market for   Alloc Def, U
Sodium carbonate	Sodium carbonate from ammonium chloride production, at plant/GLO U
Yeast starch	Yeast paste, from whey, at fermentation/CH U
Corn steep liquor	Corn steep liquor/kg/RNA (NREL), [33]
Wastewater treatment	Wastewater, average {CH}  treatment of, capacity 1E9/year   Alloc Rec, U
Solid waste management	Municipal solid waste {CH}  treatment of, sanitary landfill   Alloc Def, U
Enzymes	Gilpin et al. [36]

**Table 4.** Characterization results per kg of BioSA production from apple pomace.

<b>Impact category</b>	<b>Acronym</b>	<b>Unit</b>	<b>Including enzymes production</b>	<b>Excluding enzymes production</b>
Global Warming Potential	GWP	kg CO <sub>2</sub> eq	504	5.30
Eutrophication Potential	EP	g PO <sub>4</sub> <sup>-3</sup> eq	718	168
Acidification Potential	AP	kg SO <sub>2</sub> eq	2.73	0.73
Ozone Layer Depletion Potential	ODP	mg CFC-11 eq	26	13.6
Photochemical oxidation Potential	POP	g C <sub>2</sub> H <sub>4</sub> eq	174	48
Cumulative Energy Demand	CED	MJ	3,538	227