Life cycle assessment of natural and synthetic astaxanthin pigments

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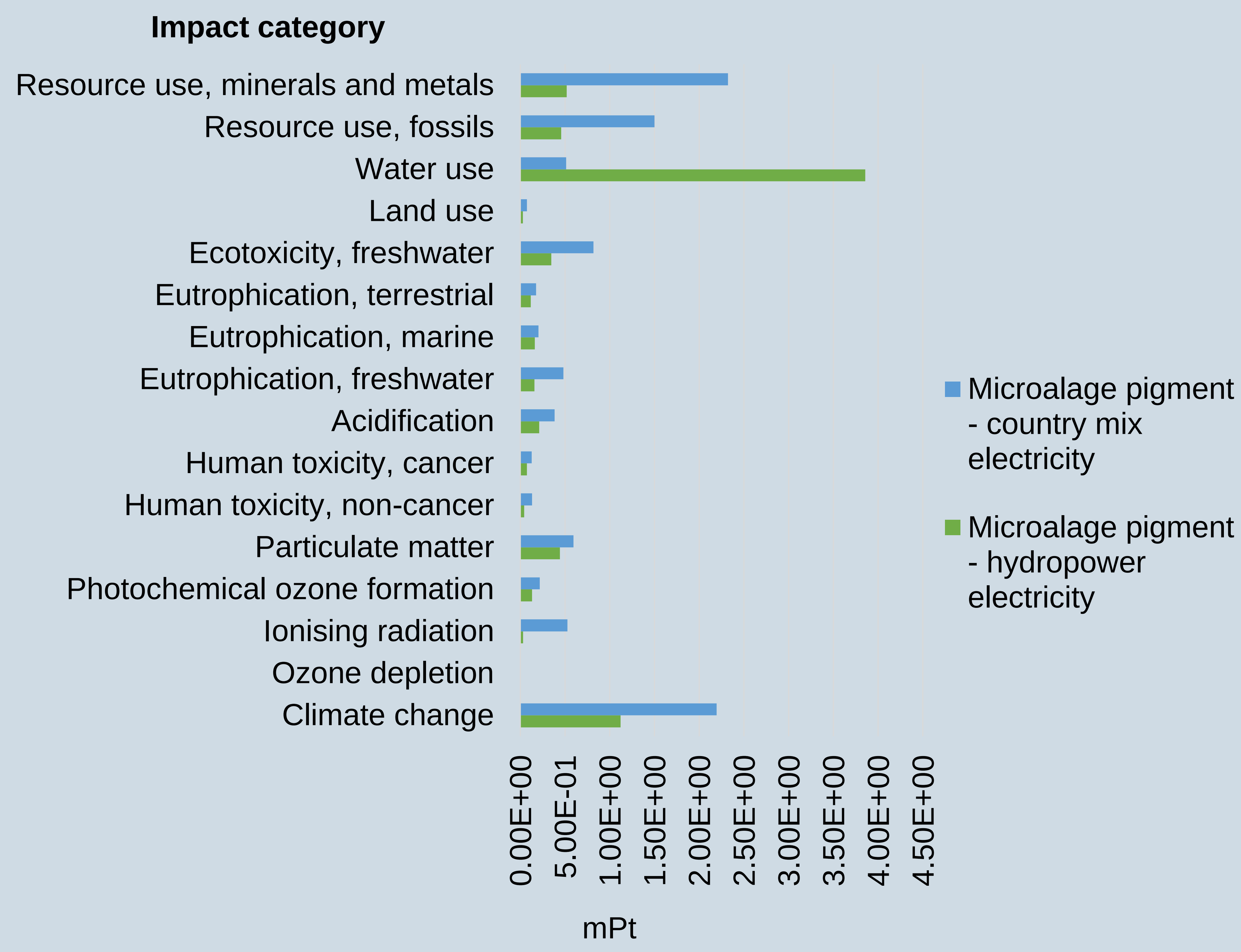
Synthetic pigments have a lower environmental impact than natural pigments. Sensitivity analysis shows that the environmental impact can be reduced by choosing an alternative to electricity.



Introduction

Fish cannot synthesize the pigment by themselves, so it is absorbed from the diet. Pigments give fish an attractive color and astaxanthin is a red pigment which increases salmon marketability due to the appearance of the fish.

Most pigments on the market are chemically synthesized pigments. Synthetic astaxanthin has a lower price and a more complex production than natural astaxanthin. Astaxanthin pigment can be obtained from a variety of microalgae species. The use of microalgae in aquaculture brings economic benefits and also creates ecological benefits, as microalgae culture can capture carbon and release oxygen.

In the study LCA was used and environmental impacts were determined according to the impact categories defined by PEFCR to natural pigment and a synthetic pigment. Also, in the study is sensitivity analysis about used type of electricity.

Methods

The astaxanthin pigment alternatives are natural pigments from microalgae culture *Haematococcus Pluvialis* and synthetic pigments. Functional Unit is characterized 1 kg of pigment and LCA is "cradle to gate".

Life cycle stages consist of – the production of feed ingredients, transport of feed ingredients to the feed mill and feed production phases. Is used EF 3.0 method, which makes impact assessment according to PEFCR assessment categories.

Results and conclusions

The total single score value for natural pigment is 7.69 mPt, and the most significant impact is from the preparation of the culture medium phase and sodium nitrate and magnesium sulfate.

The total single score value for synthetic pigment is 1.07E-01 mPt. The most significant impact is from methanol and electricity consumption.

In sensitivity analysis natural pigments using country mix electricity have 1.3 times higher environmental impact than natural pigments using hydropower electricity.

Visual conclusion

LCA results for microalgae and synthetic pigment from characterization with impact score per environmental category.

Impact category	Unit	Microalgae pigment	Synthetic pigment
Climate change	kg CO_2 eq	4.31E+01	9.46E-01
Climate change - Biogenic	kg CO_2 eq	1.23E+00	1.67E-03
Climate change - Land use and LU change	kg CO_2 eq	3.13E-02	1.60E-03
Ozone depletion	kg CFC_{11} eq	2.28E-06	2.90E-07
Human toxicity, cancer	CTUh	2.60E+00	1.03E-09
Human toxicity, non-cancer	CTUh	1.12E-01	1.53E-08
Particulate matter	disease inc.	2.93E-06	5.87E-08
Ionising radiation	kBq U_{-235} eq	5.35E-07	8.74E-02
Photochemical ozone formation	kg NMVOC eq	5.74E-08	4.07E-03
Acidification	mol H+ eq	1.88E-01	5.39E-03
Eutrophication, terrestrial	mol N eq	8.99E-03	1.36E-02
Eutrophication, freshwater	kg P eq	1.07E-01	2.96E-04
Eutrophication, marine	kg N eq	5.55E-01	1.29E-03
Ecotoxicity, freshwater	CTUe	7.67E+02	1.92E+01
Land use	Pt	2.95E+02	1.78E+01
Water use	m^3 depriv.	5.20E+02	6.01E-01
Resource use, minerals and metals	kg Sb eq	3.57E+02	1.10E-05
Resource use, fossils	MJ	4.36E-04	1.63E+01

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