ICCA-WBCSD Avoided Emissions Guidance Case Study

Comparative life cycle analysis of DL-Methionine, L-Lysine, L-Threonine and L-Tryptophan in broiler and pig production, Evonik Industries AG

1. Purpose of study

This study assesses the reduction potential for environmental impacts on global warming, eutrophication and acidification of the use of the first four limiting amino acids in typical conventional broiler and pig meat production, based on current data from practical production. The study is intended to be a comparative life cycle assessment in line with the requirements defined under ISO 14040 ff. As the study will be published, it will be accompanied by an independent critical review. The target groups are predominantly representatives of environmental movements and of agriculture. The study was commissioned by the Evonik Business Unit Health & Nutrition, conducted by the Evonik Life Cycle Management Group and reviewed by the TÜV Rheinland LGA Product GmbH as an independent third party.

2. Level in the value chain

The study was performed at the product level from cradle to grave.

3. Solutions to compare

Three options were compared:

• Supplementation of a defined premix consisting of the amino acids DL-Methionine, L-Lysine, L-Threonine and L-Tryptophan

• Supply of the respective amounts of amino acids by increasing the content of basic feed ingredients high in amino acids, e. g. oilseeds

• A second unsupplemented option covers the European industrial practice on the use of locally produced rapeseed meal instead of imported soybean

All three options ensure functional equivalence, since they offer the same nutritional value to the animals' meal.

Table 2–1
Alternative options for broiler feeding

	Description
Option 1	Supplementation with the 3 amino acids DL-Methionine, L-Lysine and L-Threonine with a wheat basal diet
Option 2	Compound feed based on SBM without amino acid supplementation
Option 3	Compound feed based on rapeseed meal without amino acid supplementation

Table 2–3
Alternative options for swine feeding

	Description
Option 1	Supplementation with the 4 amino acids DL-Methionine, L-Lysine, L-Threonine, and L-Tryptophan with a wheat/barley basal diet
Option 2	Compound feed based on SBM without amino acid supplementation
Option 3	Compound feed based on rapeseed meal without amino acid supplementation

4. Functional Unit

Methionine, lysine, threonine and tryptophan are the first four limiting essential amino acids in animal production. Methionine as the first limiting amino acid in typical compound feed for poultry has particular importance. Lysine is the first limiting amino acid in swine nutrition and plays a particularly important role here. Threonine and also tryptophan are further limiting amino acids for both species. It is of utmost importance that the respective daily amino acid requirement for each species is fully covered in order to guarantee a healthy and well balanced nutrition. Otherwise a distinct drop in performance and a detrimental effect on the animal's health will occur. Alternatively, the supply of the respective amounts of amino acids has to be ensured by increasing the content of basic feed ingredients high in amino acids, e. g. oilseeds (quality requirement "functionality").
The functional unit was defined as 1.0 kg of an amino acid mix consisting of dl-methionine, l-l-lysine, l-threonine and l-tryptophan which is supplemented to the feed or the equivalent amount of amino acids provided by feed raw materials rich in these amino acids such as oilseed meals.

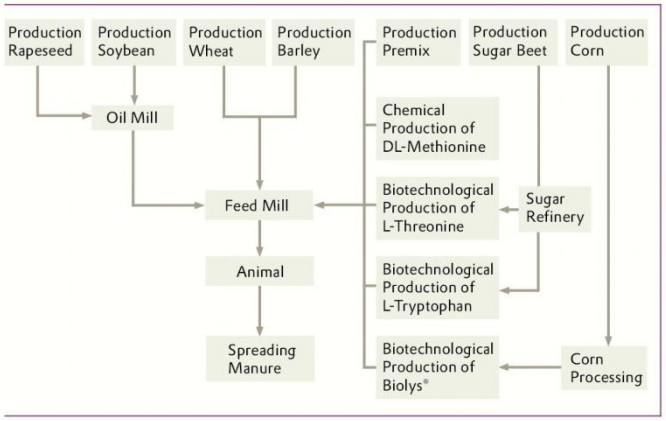
Time and geographic reference

The primary data for the production of the four amino acids represent the situation in 2008. They were provided by the respective production unit. The secondary data for the background systems such as energy supply, agricultural raw materials and minerals, transport and disposal originate from the database of GaBi [GaBi 2009] from PE International. Some of the processes - in contrast – were estimated on the basis of literature data. EcoInvent-Data [EcoInvent 2008] were used for those few cases for which no set of GaBi data was available. The modeling of the life cycle assessment was done with the GaBi software [GaBi 2009] of PE International. The data set for the following sites were used: Belgium for dl-methionine, United States for l-lysine, Hungary for l-threonine, Slovakia for l-tryptophan, and Germany for the other life cycle phases.

5. Calculation Methodology

The system boundaries for all scenarios equivalent to the 3 compound feed options follow the principle „from cradle to grave“, i. e. they start from providing the raw materials used for production of the supplemental amino acids, the cultivation of the basic feed ingredients, the manufacturing of the mineral fertilizer for agricultural production, the harvest and processing of the agricultural raw materials as well as all transport of all feed ingredients, raw materials and intermediates including all emissions relating to animal production and distribution of manure. Figure 2-7 provides insight into all levels of the life cycle analysis.

Figure 2–7
System boundaries for the options analysed in broiler and swine feeding



The current study focuses on a few, but important environmental categories for the specific application of amino acids in animal nutrition:

- Global warming potential (GWP100) [kg CO2- equiv.]
- Acidification potential (AP) [kg SO2- equiv.]
- Eutrophication potential (EP) [kg PO4-equiv.]
- Primary energy demand (PED) [MJ]
- Consumption of resources [kg Crude oil-equiv.]

The environmental impact categories GWP, AP and EP have been evaluated using the CML-methodology [CML 2001] with updated characterization factors of August 2007. In quantification of the global warming potential, the inclusion of land use change (LUC) for soya production in South America has a very strong influence on the results. That's why a sensitivity analysis was conducted. It was assumed for the evaluation that about 3.2 % (EcoInvent[1]) of soya in South America is grown on land that was originally rain forest. No land use change was considered for the 15 % of soy bean meal (SBM) imported from the US. The primary energy demand is calculated based on the lower heat value of all energy sources used in the model including the energy used for intermediates. All kinds of energy are considered including fossil and renewable energy. The consumption of resources was

[1] EcoInvent Report Nr. 17, Life Cycle Inventories for Bioenergy (2007), Seite 130

calculated using the methodology of the UBA[2]. This is restricted on the consumption of fossil energies such as crude oil, hard coal, soft coal and natural gas.

6. Results

Broiler production

Figure 4 – 1
Global warming potential GWP100 [CML 2001] of broiler production

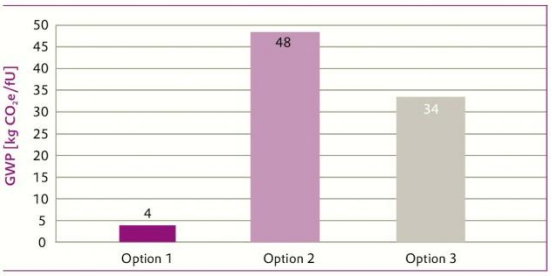


Figure 4 – 3
Acidification potential AP [CML 2001] of broiler production

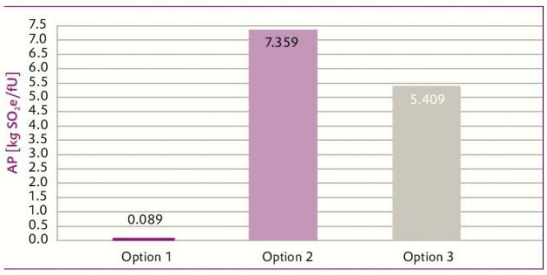


Figure 4 – 5
Eutrophication potential EP [CML 2001] of broiler production

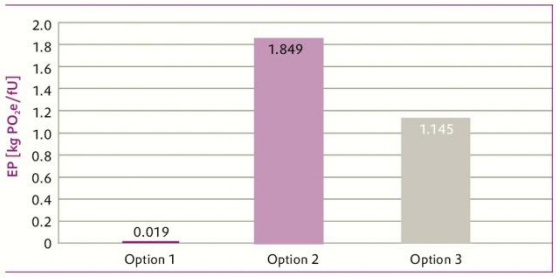


Figure 4 – 7
Primary energy demand (PED) of broiler production

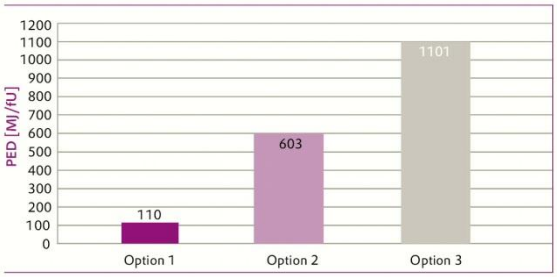
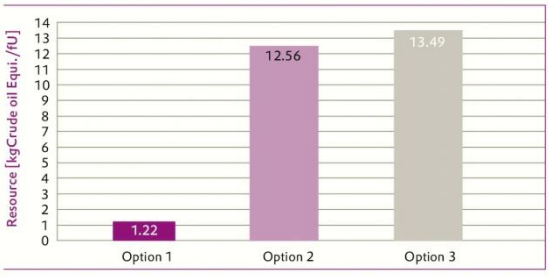


Figure 4 – 9
Resource consumption of broiler production



[2] UBA 1995, Ökobilanzen für Getränkeverpackungen, Teil A: Methode zur Berechnung und Bewertung von Ökobilanzen für Verpackungen, Berlin

Emissions	Option 1 (Evonik's solution)	Option 2 (Solution to compare)	Option 3 (Solution to compare)
Global warming potential GWP100 [CML 2001] in kg CO_2e/functional unit	4	48	34
Acidification potential AP [CML 2001] in kg SO_2e/functional unit	0.089	7.359	5.409
Eutrophication potential EP [CML 2001] in PO_4e/functional unit	0.019	1.849	1.145
Primary energy demand PED in MJ/functional unit	110	603	1101
Resource consumption in kg crude oil equi./functional unit	1.22	12.56	13.49

Avoided Emissions	Avoided Emissions (Option 2 – Option 1)	Avoided Emissions (Option 3 – Option 1)
Global warming potential GWP100 [CML 2001] in kg CO_2e/functional unit	44	30
Acidification potential AP [CML 2001] in kg SO_2e/functional unit	7.27	5.32
Eutrophication potential EP [CML 2001] in PO_4e/functional unit	1.83	1.126
Primary energy demand PED in MJ/functional unit	493	991
Resource consumption in kg crude oil equi./functional unit	11.34	12.27

Swine production

Figure 4 – 11
Global warming potential GWP100 [CML 2001] of swine production

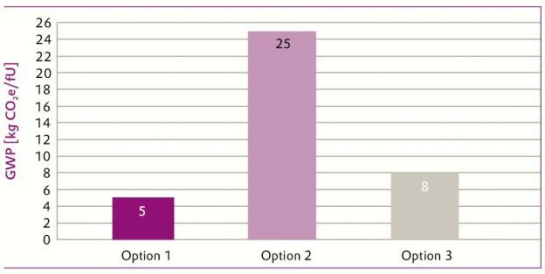


Figure 4 – 13
Acidification potential AP [CML 2001] of swine production

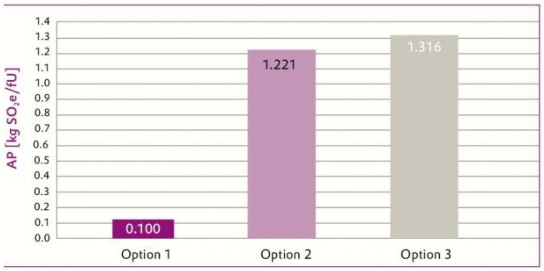


Figure 4 – 15
Eutrophication potential EP [CML 2001] of swine production

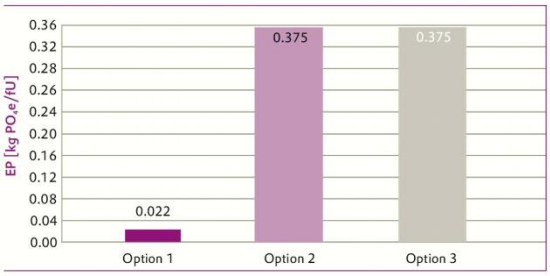
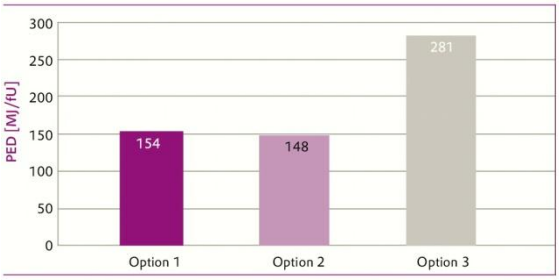
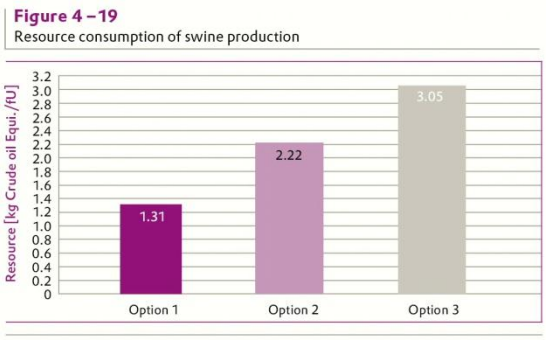


Figure 4 – 17
Primary energy demand (PED) of swine production





Emissions	Option 1 (Evonik's solution)	Option 2 (Solution to compare)	Option 3 (Solution to compare)
Global warming potential GWP100 [CML 2001] in kg CO_2e/functional unit	5	25	8
Acidification potential AP [CML 2001] in kg SO_2e/functional unit	0.1	1.221	1.316
Eutrophication potential EP [CML 2001] in PO_4e/functional unit	0.022	0.375	0.375
Primary energy demand PED in MJ/functional unit	154	148	281
Resource consumption in kg crude oil equi./functional unit	1.31	2.22	3.05

Avoided Emissions	Avoided Emissions (Option 2 – Option 1)	Avoided Emissions (Option 3 – Option 1)
Global warming potential GWP100 [CML 2001] in kg CO_2e/functional unit	20	3
Acidification potential AP [CML 2001] in kg SO_2e/functional unit	1.121	1.216
Eutrophication potential EP [CML 2001] in PO_4e/functional unit	0.353	0.353
Primary energy demand PED in MJ/functional unit	-6	127
Resource consumption in kg crude oil equi./functional unit	0.91	1.74

7. Significance of contribution

The significance of the contribution of the other value chain partners has been estimated as too small to communicate, because all contributions come from Evonik's products.

8. Attribution

No attribution methodologies have been applied in the study.

9. Review of Results

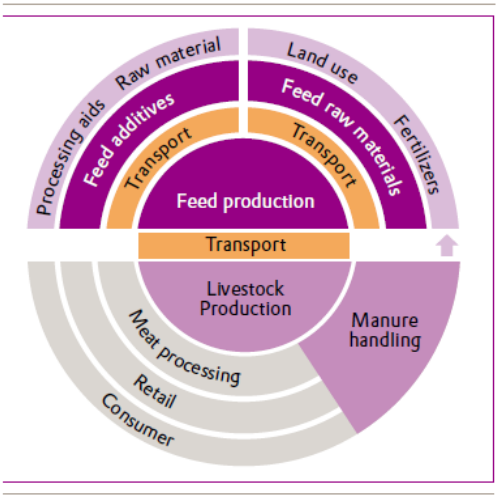
The study was reviewed by the German TÜV Rheinland in 2010 and recertified in 2012. Further information on the review can be found at http://www.tuv.com under the certificate number "0000027153".

10. Scenario analysis

No scenario analysis on future developments was performed in this study.

11. Study Limitations and Future Recommendations

The following figure indicates the system boundaries and the availability of primary data for modeling the individual scenarios for the functional unit (FU). The fields with grey background are not within the share of influence of the study sponsor. There is a need to use data from secondary sources for this. The darker colored segments highlight a close proximity of factors to the business of the sponsor. The darker the color the larger the influence. More primary data are available here.



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