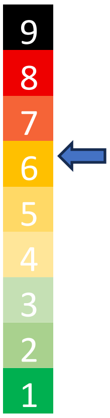
FACTSHEET VULNERABILITY - LYSINE

Economic vulnerability



Economic vulnerability score: 6/9

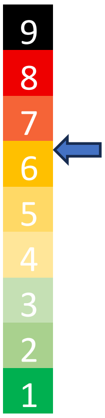
- Essentiality: High (3/3)
- Contribution to formulation cost: Medium (2/3).
- The vast majority of the lysine produced worldwide (more than 95%) is used to supplement animals' diets.
- Lysine is incorporated up to 0.5% in final feed for monogastrics and may contribute to up to 3% of the price of complete feed.

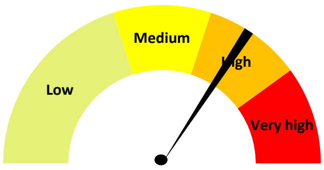
Lysine is among the essential amino acids that monogastric cannot synthetise. Amino acids are natural components of feed proteins but the balance of amino acids of the feed usually does not match exactly the animals' need. Free amino acids are added to balance the diet and thereby allow minimising the total nitrogen in the diet and minimise emissions in the environment. Lysine is the first limiting amino acid for pigs and the second one after sulphur amino acids (methionine + cystine) for poultry.

Geopolitical vulnerability score: 6,75/9

- Lysine is produced by fermentation in 7 countries/regions: China, South Korea, USA, Brazil, Indonesia, Russia, Belarus and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 0.65, due to the domination of China which has the capacity to produce more than twice the global demand. Imports from Russia and Belarus are not permitted.
- The EU-27 production is limited to one operator with a production capacity that does not exceed 20% of the demand.

Geopolitical vulnerability





0,67

Risk weighed concentration of EU imports

2%

EU self sufficiency

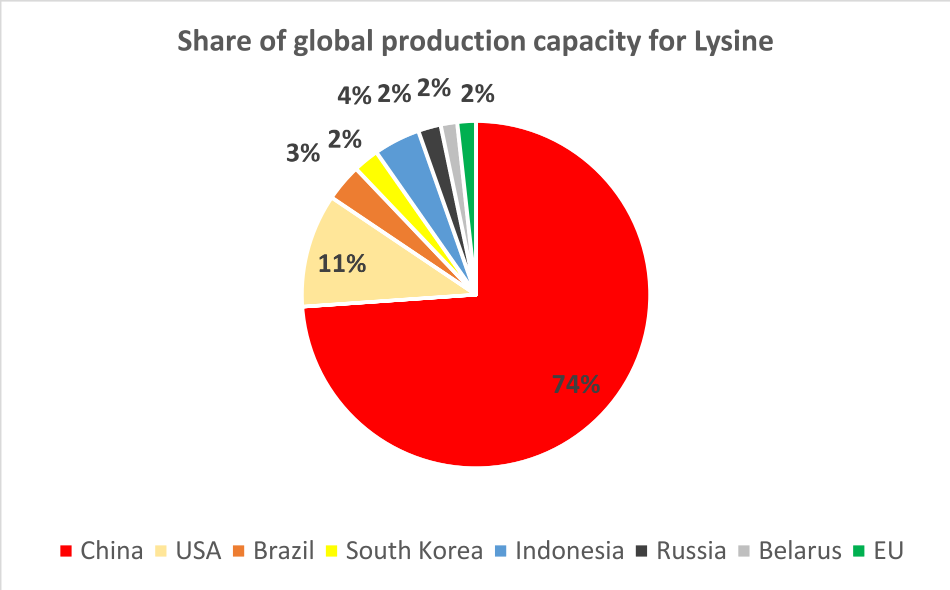
20%

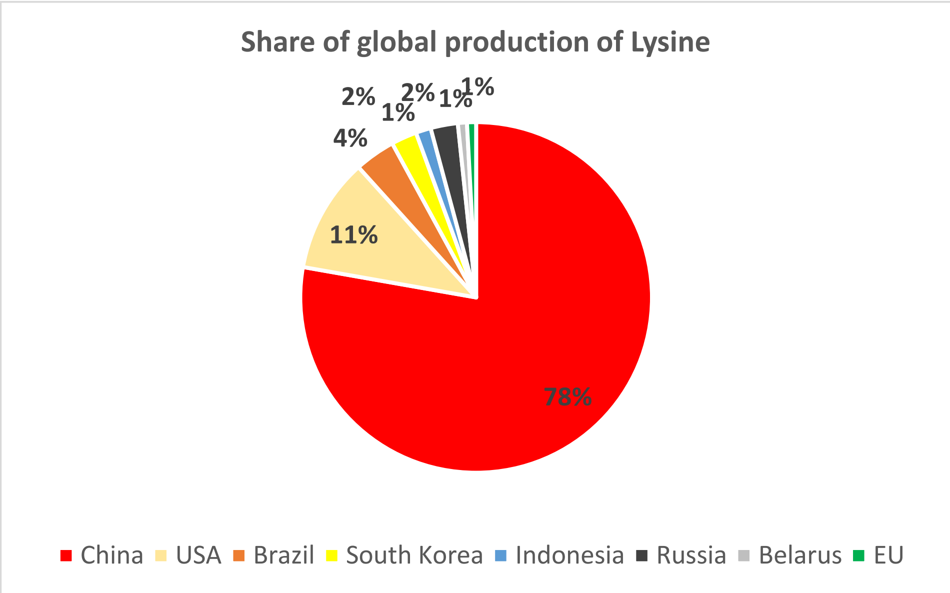
Independency capacity

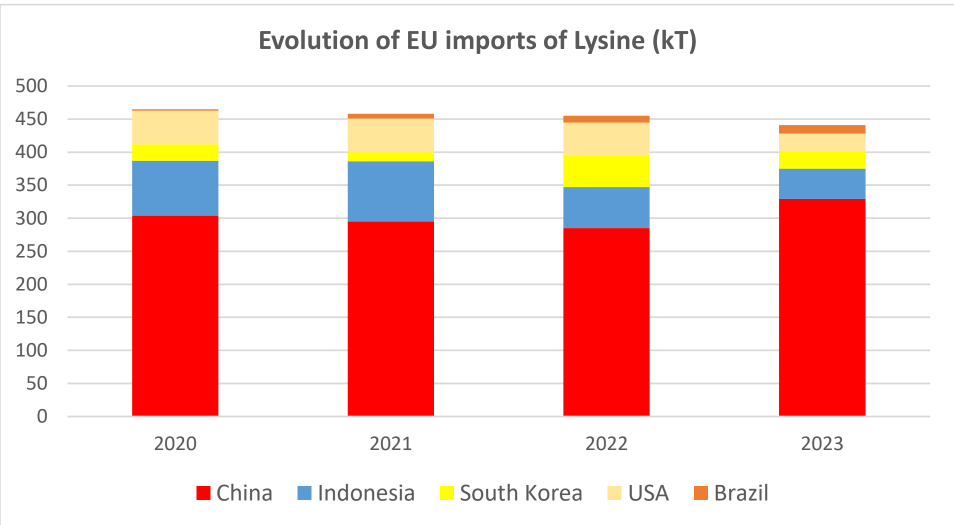
106%

Diversification capacity

Dependency: 95%, thereof 65% for China.

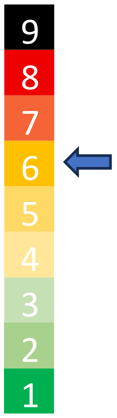

Share of global production capacity for Lysine
4%
2%
2%
2%
3%
2%
11%
74%
China
USA
Brazil
South Korea
Indonesia
Russia
Belarus
EU


Share of global production of Lysine
2%
2%
1%
1%
1%
4%
11%
78%
China
USA
Brazil
South Korea
Indonesia
Russia
Belarus
EU


Evolution of EU imports of Lysine (kT)
500
450
400
350
300
250
200
150
100
50
0
2020
2021
2022
2023
China
Indonesia
South Korea
USA
Brazil

FACTSHEET VULNERALIBITY – METHIONINE

Economic vulnerability



Economic vulnerability score: 6/9

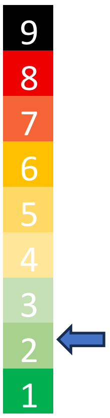
- Essentiality: High (3/3)
- Contribution to formulation cost: Medium (2/3).
- The vast majority of the methionine produced worldwide (more than 95%) is used to supplement animals' diets.
- Methionine is incorporated up to 0.4% in final feed for monogastrics and may contribute to up to 3% of the price of complete feed. It may be replaced by hydroxy analogue of methionine, produced mostly in the USA.

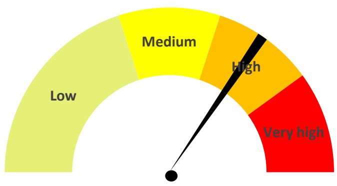
> Methionine is among the essential amino acids that monogastric cannot synthetise. Amino acids are natural components of feed proteins but the balance of amino acids of the feed usually does not match exactly the animals' need. Free amino acids are added to balance the diet and thereby allow minimising the total nitrogen in the diet and minimise emissions in the environment. Methionine is the first limiting amino acid for poultry and the second for pigs.

Geopolitical vulnerability score: 2.5/9

- Methionine is mostly produced by chemical synthesis in 7 countries/regions: China, USA, Singapore, Japan, Malaysia, Russia and the EU-27.
- The global production is well spread geographically between Europe, Asia and America, thus minimizing the potential logistical risks. However the trend is to a reduction of the EU-27 share of the global market.
- The EU-27 production still exceeds the demand, i.e. no immediate risk of shortage for the EU-27 livestock sector.

Geopolitical vulnerability





0,68

Risk weighed concentration of EU imports

147%

EU self sufficiency

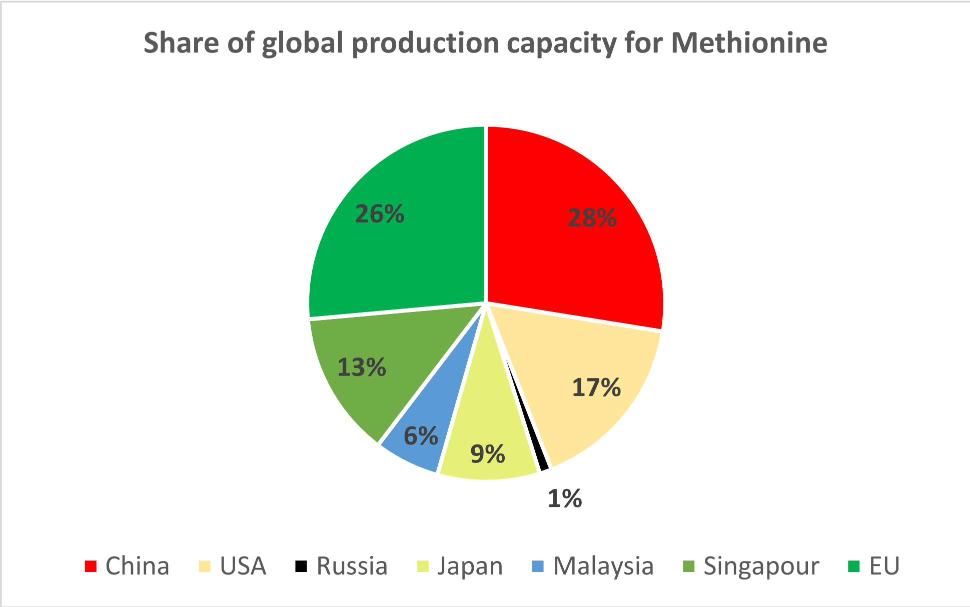
235%

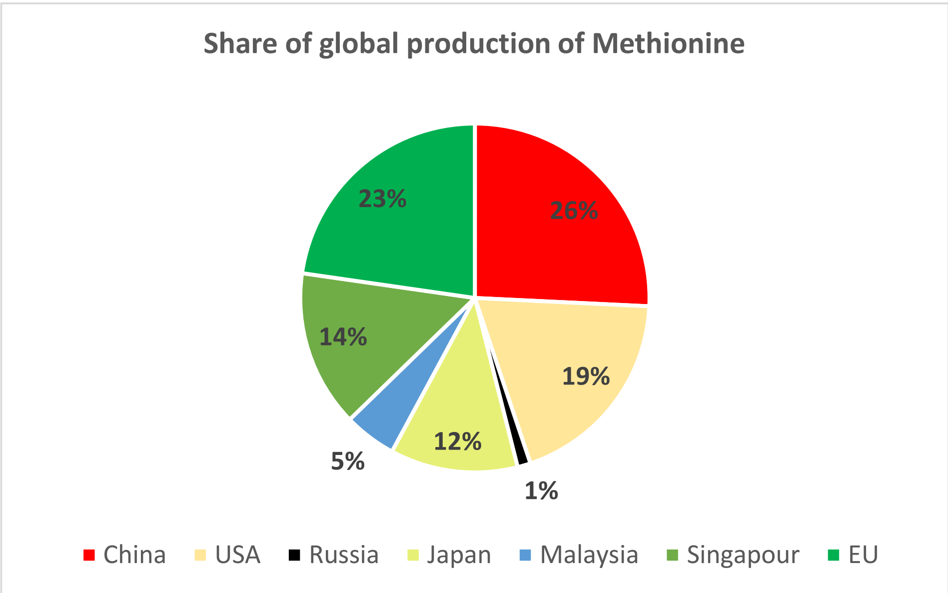
Autonomy potential

264%

Diversification capacity

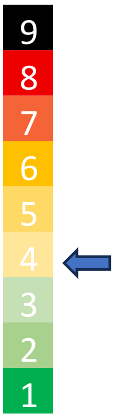
Dependency: 10%, thereof 6% for China.


Share of global production capacity for Methionine
28%
17%
1%
9%
6%
13%
26%
China
USA
Russia
Japan
Malaysia
Singapour
EU


Share of global production of Methionine
26%
19%
1%
12%
5%
14%
23%
China
USA
Russia
Japan
Malaysia
Singapour
EU

FACTSHEET VULNERALIBITY – THREONINE

Economic vulnerability



Economic vulnerability score: 4/9

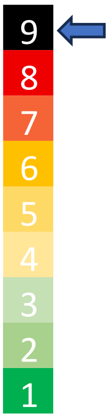
- Essentiality: Medium (2/3)
- Contribution to formulation cost: Medium (2/3).
- The vast majority of the threonine produced worldwide (more than 95%) is used to supplement animals' diets.
- Threonine is incorporated up to 0.3% in feed for piglets and to a lower extent in other feed for monogastrics in regions with strict restriction in terms of nitrogen emissions. It may contribute to up to 2% of the price of certain types of feed.

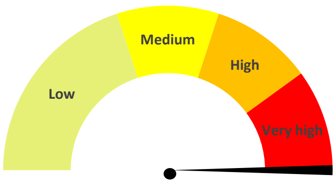
Threonine is among the essential amino acids that monogastric cannot synthetise. Amino acids are natural components of feed proteins but the balance of amino acids of the feed usually does not match exactly the animals' need. Free amino acids are added to balance the diet and thereby allow minimising the total nitrogen in the diet and minimise emissions in the environment. Threonine is usually the third limiting amino acid for monogastrics after lysine and methionine.

Geopolitical vulnerability score: 9/9

- Threonine is produced by fermentation in 4 countries/regions: China, USA, Brazil, and Belarus. It is not produced in the EU-27.
- China concentrates more than 90% of global production and there is no production in the EU-27 anymore.

Geopolitical vulnerability





1,00

Risk weighed concentration of EU imports

0%

EU self sufficiency

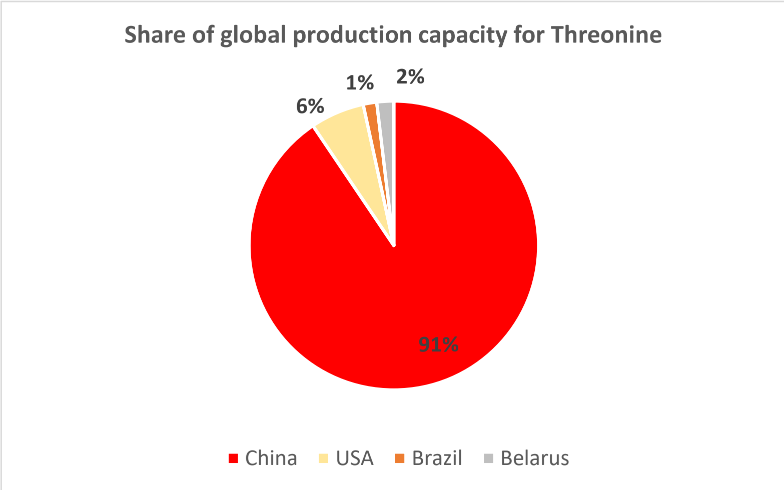
0%

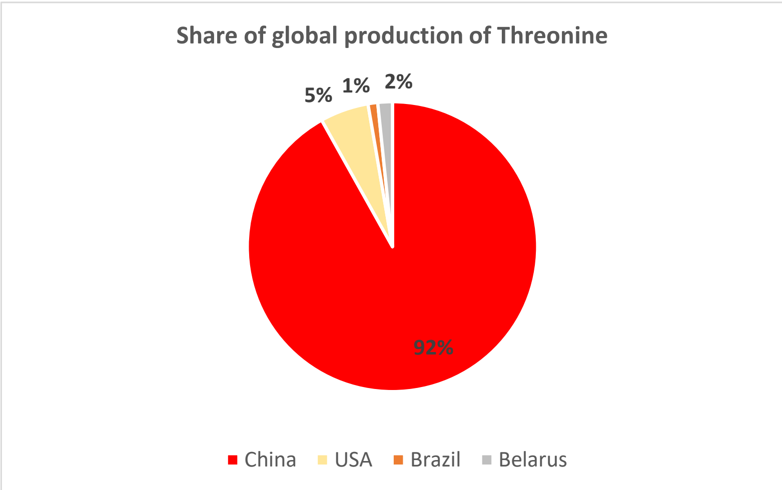
Autonomy potential

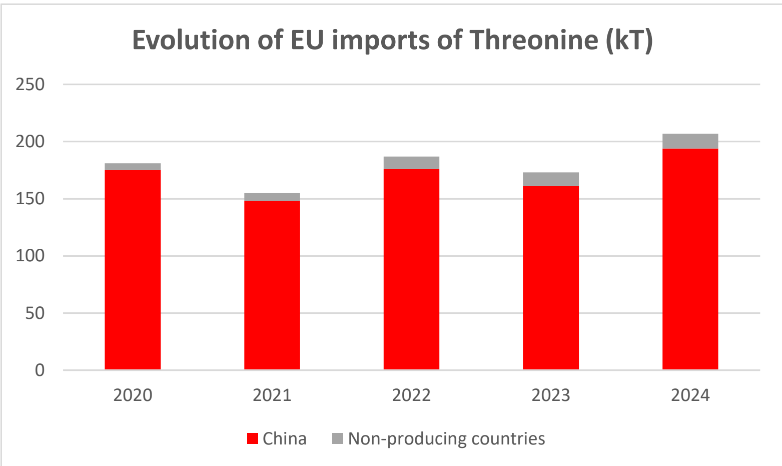
16%

Diversification capacity

Dependency: 100%, thereof 100% from China

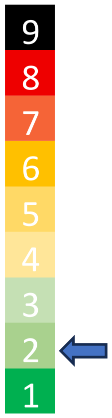

Share of global production capacity for Threonine
6%
1%
2%
91%
China
USA
Brazil
Belarus


Share of global production of Threonine
5%
1%
2%
92%
China
USA
Brazil
Belarus


Evolution of EU imports of Threonine (kT)
250
200
150
100
50
0
2020
2021
2022
2023
2024
China
Non-producing countries

FACTSHEET VULNERALIBITY – TRYPTOPHAN

Economic vulnerability



Economic vulnerability score: 2/9

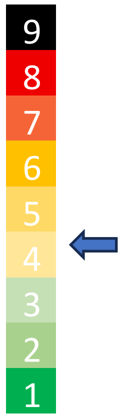
- Essentiality: Medium (2/3)
- Contribution to formulation cost: Low (1/3).
- The vast majority of the tryptophan produced worldwide (more than 95%) is used to supplement animals' diets.
- Tryptophan is incorporated up to 0.05% mostly in feed for piglets and to a lesser extent in fattening pigs. It may contribute to up to 0.5% of the price of piglet feed.

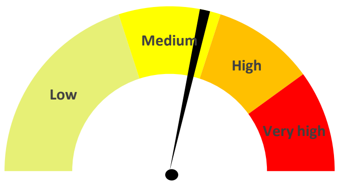
> Tryptophan is among the essential amino acids that monogastric cannot synthetise. Amino acids are natural components of feed proteins but the balance of amino acids of the feed usually does not match exactly the animals' need. Free amino acids are added to balance the diet and thereby allow minimising the total nitrogen in the diet and minimise emissions in the environment. Tryptophan is the fourth or fifth limiting amino acid in pigs

Geopolitical vulnerability score: 4,75/9[1]

- Tryptophan is produced by fermentation in 7 countries/regions: Indonesia, China, USA, Brazil, Russia, Belarus and the EU-27.
- Indonesia is the most important producer with 40% of the global market but should be overtaken by China which represents "only" 30% of the global market for the time being but is investing in more production capacity.
- The EU-27 production is limited to one operator with a production capacity lower than the demand.

Geopolitical vulnerability





0,56

Risk weighed concentration of EU imports

46%

EU self sufficiency

63%

Autonomy potential

212%

Diversification capacity

Dependency: 55%, thereof at least 20% from China.

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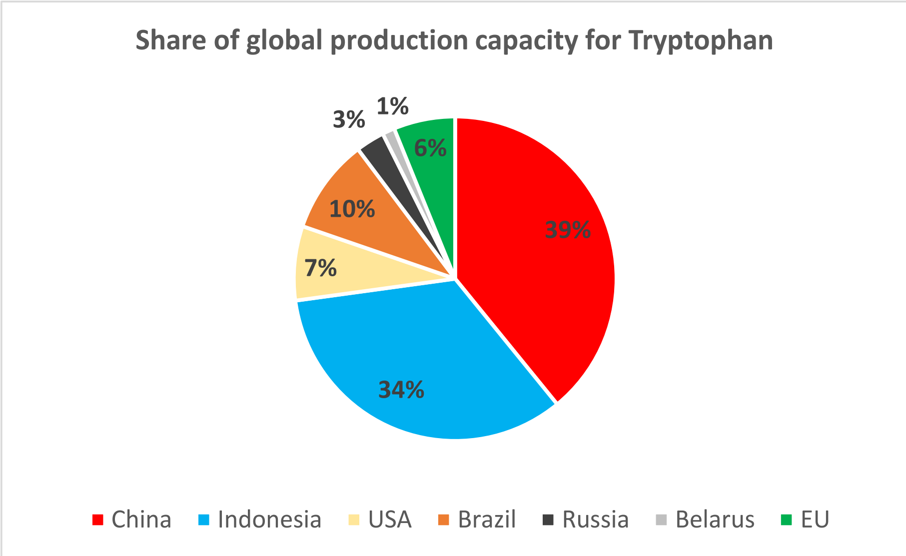
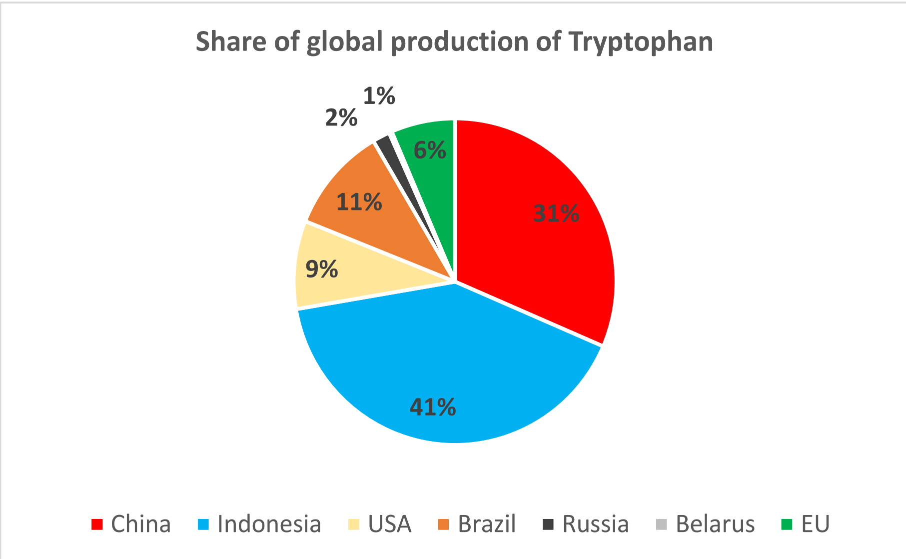
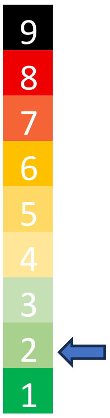
[1] For the determination of the diversification capacity, EU imports from China were considered conservatively as equivalent to the difference between EU consumption and EU production, considering the importance of China on the global market.


Share of global production capacity for Tryptophan
3%
1%
6%
10%
39%
7%
34%
China
Indonesia
USA
Brazil
Russia
Belarus
EU


Share of global production of Tryptophan
1%
2%
6%
11%
31%
9%
41%
China
Indonesia
USA
Brazil
Russia
Belarus
EU

FACTSHEET VULNERALIBITY – VALINE

Economic vulnerability



Economic vulnerability score: 2/9

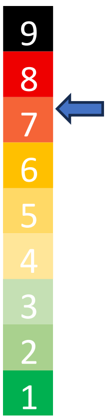
- Essentiality: Medium (2/3)
- Contribution to formulation cost: Low (1/3).
- The vast majority of the valine produced worldwide (more than 95%) is used to supplement animals' diets.
- Valine is incorporated up to 0.1% in feed for piglets and to a lower extent in other feed for monogastrics in regions with strict restriction in terms of nitrogen emissions. It may contribute to up to 1% of the price of certain types of feed.

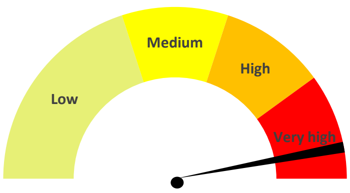
Valine is among the essential amino acids that monogastric cannot synthetise. Amino acids are natural components of feed proteins but the balance of amino acids of the feed usually does not match exactly the animals' need. Free amino acids are added to balance the diet and thereby allow minimising the total nitrogen in the diet and minimise emissions in the environment. Valine is the fourth or fifth limiting amino acid for monogastrics.

Geopolitical vulnerability score: 7,5/9

- Valine is produced by fermentation in 6 countries/regions: China, Indonesia, Brazil, South Korea, Russia and the zEU-27.
- China concentrates 84% of global production and invested recently in more production capacities.
- The EU-27 production is limited to one operator with a production capacity that does not exceed one third of the demand.

Geopolitical vulnerability





0,93

Risk weighed concentration of EU imports

18%

EU self sufficiency

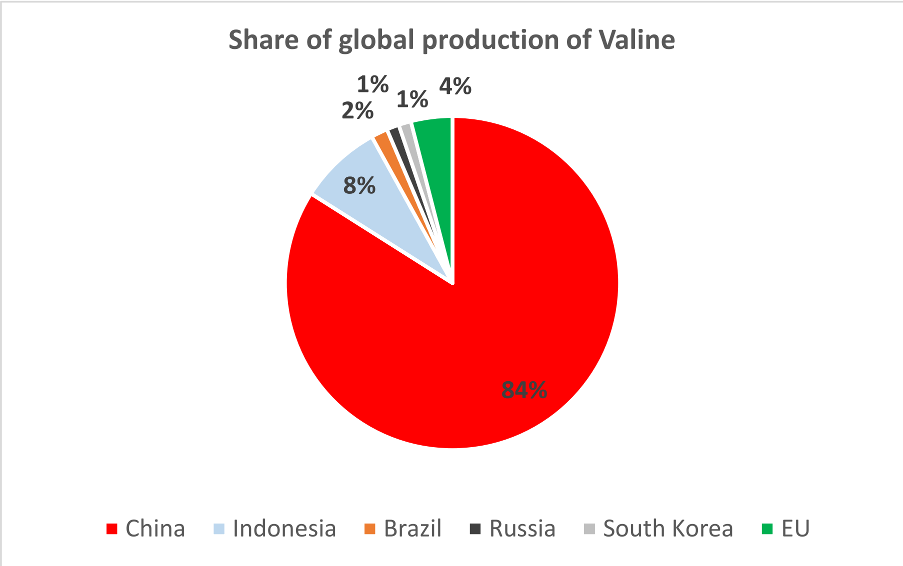
27%

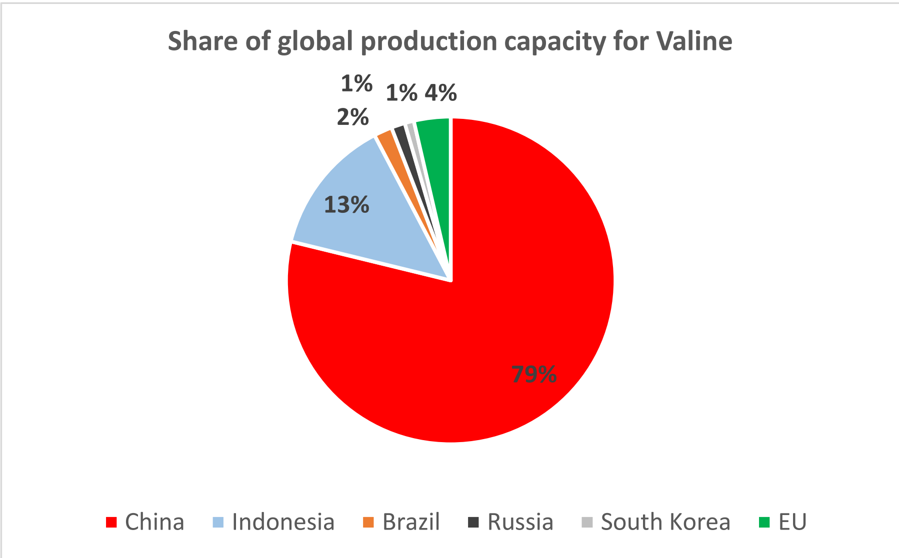
Autonomy potential

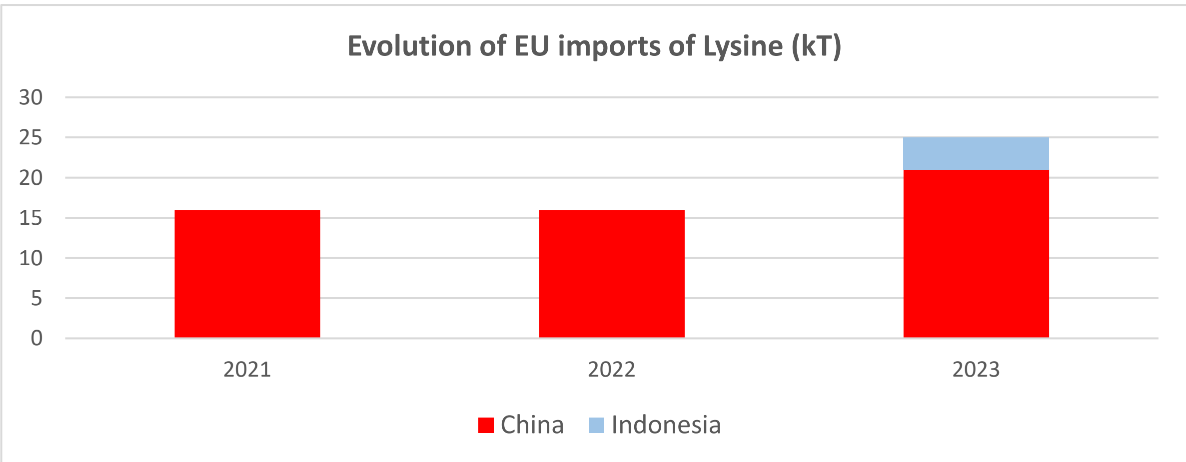
98%

Diversification capacity

Dependency: 60%, thereof at least 55% from China.


Share of global production of Valine
1%
2%
1%
4%
8%
84%
China
Indonesia
Brazil
Russia
South Korea
EU

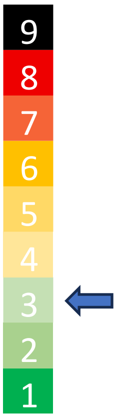

Share of global production capacity for Valine
1%
2%
1%
4%
13%
79%
China
Indonesia
Brazil
Russia
South Korea
EU


Evolution of EU imports of Lysine (kT)
30
25
20
15
10
5
0
2021
2022
2023
China
Indonesia

FACTSHEET VULNERALIBITY – VITAMIN A / RETINOL

Vitamin A or retinol is a fat-soluble nutrient. Vitamin A is essential for vision, growth differentiation and proliferation of a wide range of epithelial tissues, bone growth, reproduction and embryonic development. It is found in both preformed (animal sources) and provitamin A (plant sources) forms. Vitamin A is included in animal's diets as feed additive in the form of retinyl acetate, palmitate or propionate (see EFSA opinion).

Economic vulnerability



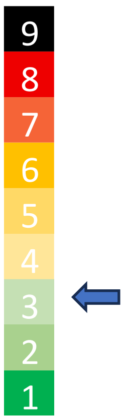
Economic vulnerability score: 3/9

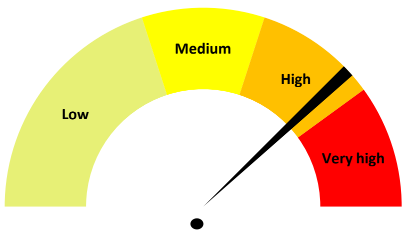
- Essentiality: High (3/3)
- Contribution to cost of formulation: Low (1/3)
- 83% of the vitamin A produced worldwide is used to supplement animals' diets.
- Vitamin A is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

Geopolitical vulnerability score: 3/9

- Vitamin A is produced by chemical synthesis in 3 countries/regions: China, Switzerland and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 0.75, i.e. well above the 0.4% threshold considered as critical.
- However, the EU-27 produces more vitamin A for feed use than it uses (self-sufficiency of 125%) and its production capacity "all-uses" is almost 4 times the feed demand. Therefore, there is no short-term concern regarding the supply of vitamin A to the EU-27. However, since the number of EU-27 producers is limited, any accident leading to closure of an EU-27 manufacturing plant may significantly impact on the market and increase the EU-27 vulnerability, although the diversification potential is good.

Geopolitical vulnerability





0,75

Risk weighed concentration of EU imports

125%

EU self sufficiency

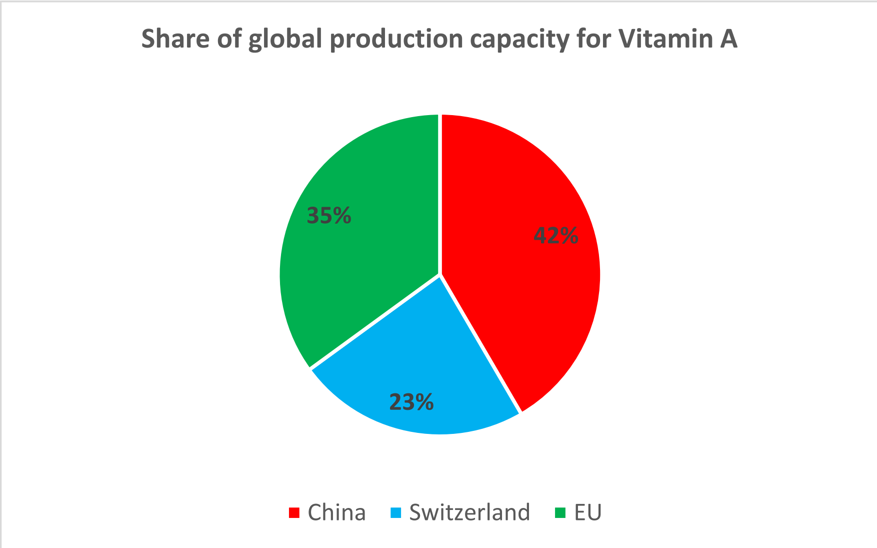
384%

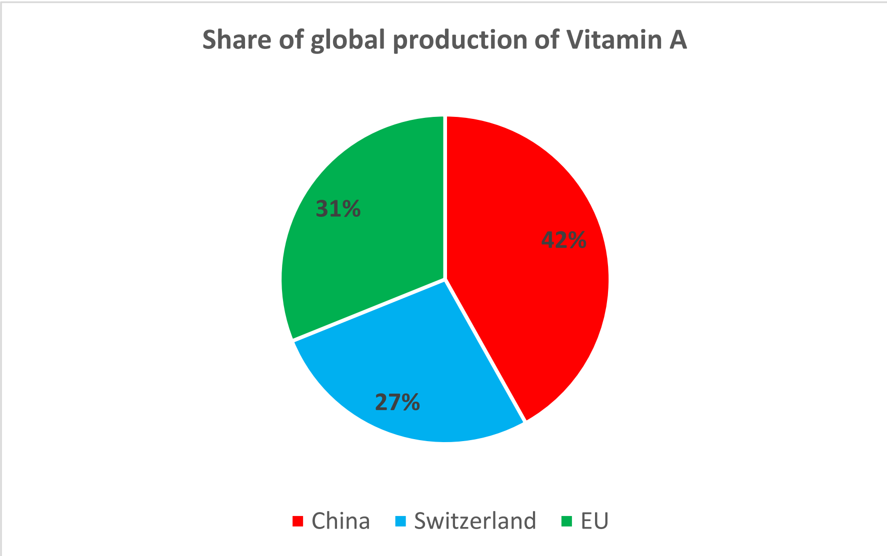
Autonomy potential

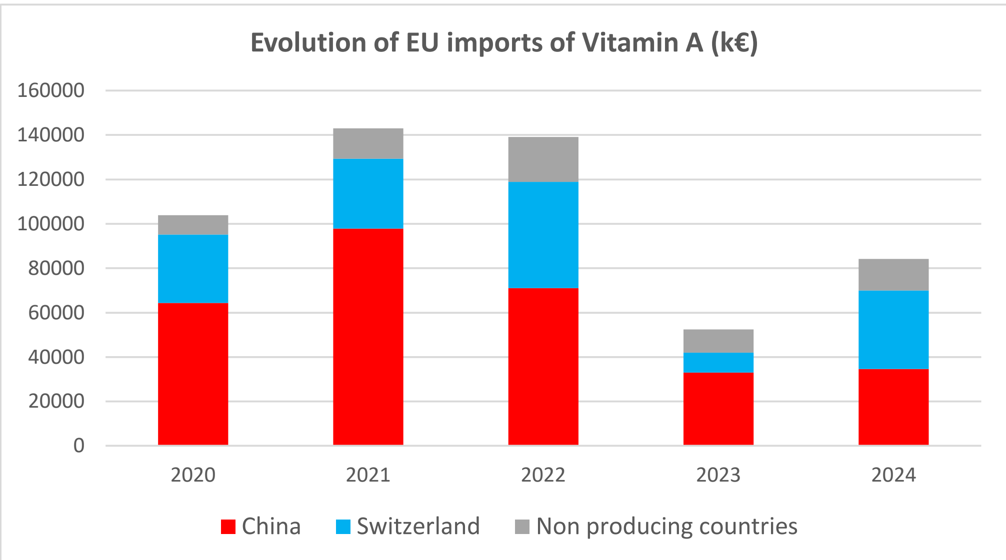
149%

Diversification capacity

Dependency: 50%, thereof 40% for China and 8% for Switzerland (calculated based on average quotation for vitamin A of 20 €/kg in 2023).

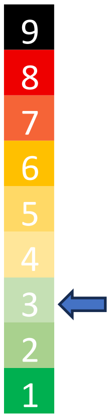

Share of global production capacity for Vitamin A
35%
42%
23%
China
Switzerland
EU


Share of global production of Vitamin A
31%
42%
27%
China
Switzerland
EU


Evolution of EU imports of Vitamin A (k€)
160000
140000
120000
100000
80000
60000
40000
20000
0
2020
2021
2022
2023
2024
China
Switzerland
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B1 / THIAMINE

Economic vulnerability



Economic vulnerability score: 3/9

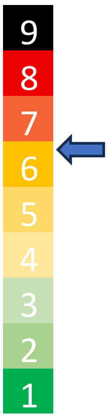
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 55% of the vitamin B1 produced worldwide is used to supplement animals' diets.
- Vitamin B1 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

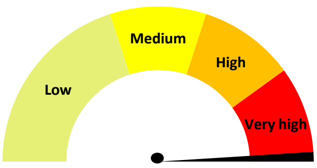
Vitamin B1 or thiamine is a water-soluble coenzyme essential in the production of energy from feed in the carbohydrate metabolism and maintaining a healthy nervous system. It is also a linking factor between carbohydrate, protein and fat metabolism. Main deficiency symptoms are characterised as disorders in neural function (see EFSA opinion).

Geopolitical vulnerability score: 6.5/9

- Vitamin B1 is produced by chemical synthesis in 2 countries/regions: China and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 1, since the only supplier to the EU-27 is China, whether directly or indirectly.
- The EU-27 produces less vitamin B1 than it uses (self-sufficiency of 75%). However, the situation should not be regarded as comfortable since a large part of the EU-27 production is actually exported to Third Countries for which the EU-27 is the only alternative origin to China. and the EU-27 production capacity is insufficient to meet the global demand.

Geopolitical vulnerability





1,00

Risk weighed concentration of EU imports

40%

EU self sufficiency

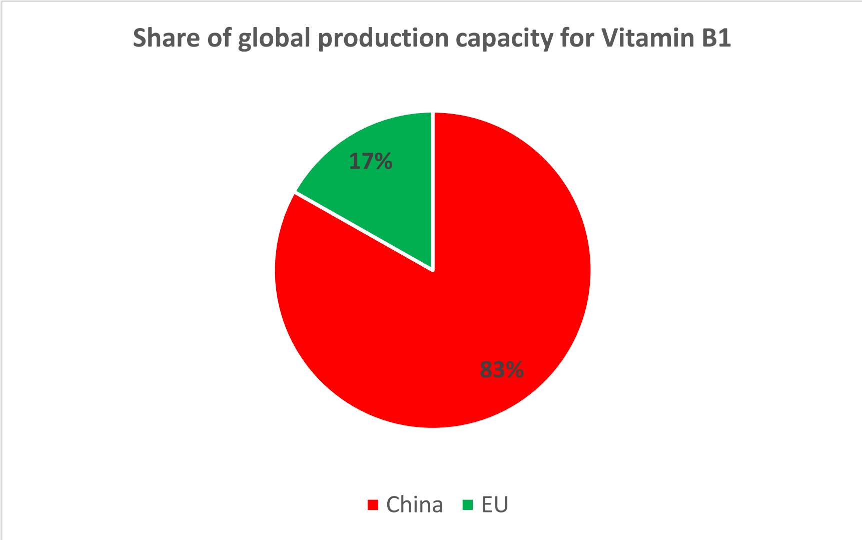
172%

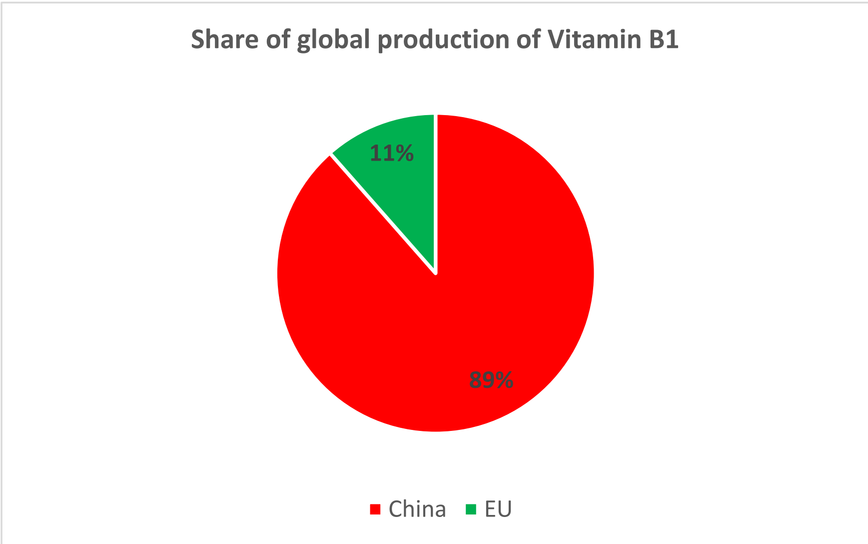
Autonomy potential

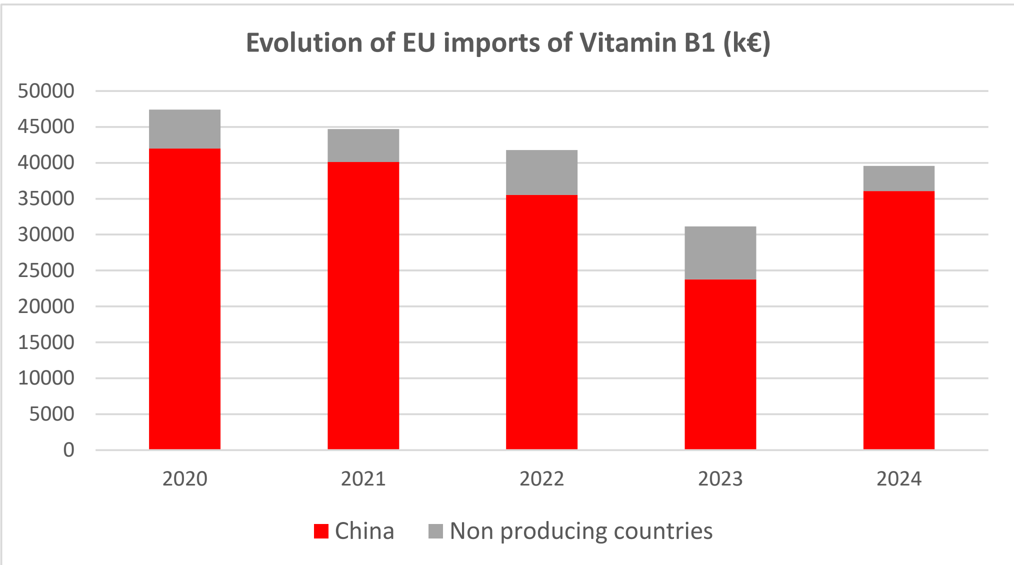
0%

Diversification capacity

Dependency: 65%, all from China (calculated based on average quotation for Vitamin B1 of 15 €/kg in 2023).

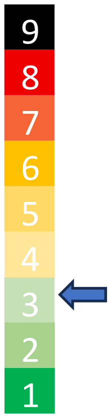

Share of global production capacity for Vitamin B1
17%
83%
China
EU


Share of global production of Vitamin B1
11%
89%
China
EU


Evolution of EU imports of Vitamin B1 (k€)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2020
2021
2022
2023
2024
China
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B2 / RIBOFLAVIN

Economic vulnerability



Economic vulnerability score: 3/9

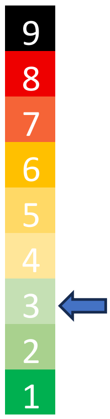
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 66% of the vitamin B2 produced worldwide is used to supplement animals' diets.
- Vitamin B2 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

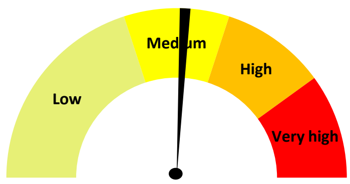
Vitamin B2 or riboflavin is a water-soluble vitamin that plays a crucial role in energy production, cell growth, and overall health. It is essential for converting food into energy and is involved in various bodily functions, including the development of skin, the lining of the digestive tract, blood cells, and brain function. Vitamin B2 is included as feed additive in feed for all species, especially monogastrics and fish.

Geopolitical vulnerability score: 3/9

- Vitamin B2 is produced by fermentation in 3 countries/regions: China, South Korea and the EU-27.
- The level of concentration of imports, based on the Herfindahl-Hirschman Index corrected by a risk-based weighing factor is 0.5, i.e. well above 0.40. The EU imported primarily from South Korea during recent years, mostly because the strain used by the largest Chinese producer was not authorized in the EU-27.
- The EU-27 produces more vitamin B2 for feed use than needed. However, the situation should not be regarded as comfortable since part of EU-27 production is exported to third countries and it is produced in the EU-27 in a single plant.

Geopolitical vulnerability





0,51

Risk weighed concentration of EU imports

127%

EU self sufficiency

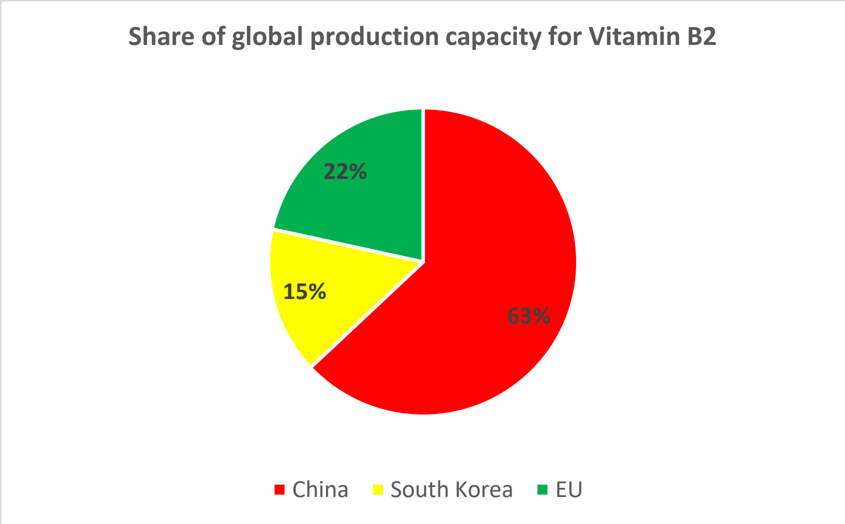
280%

Autonomy potential

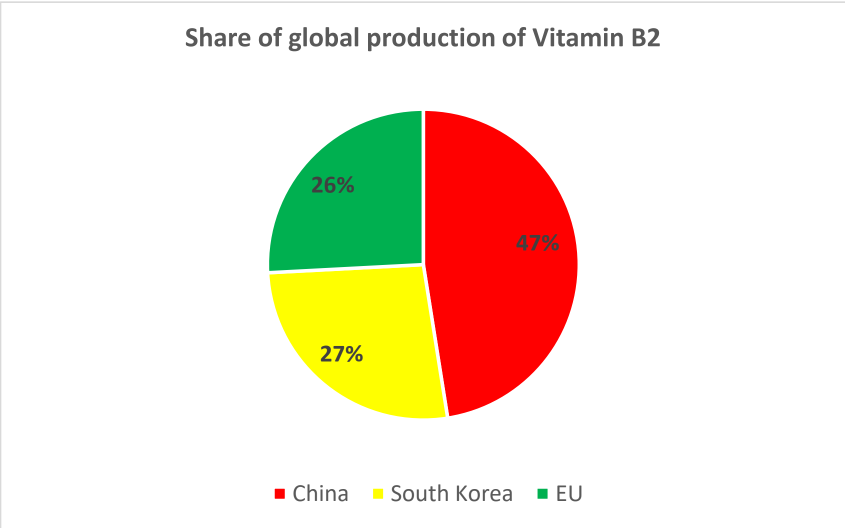
330%

Diversification capacity

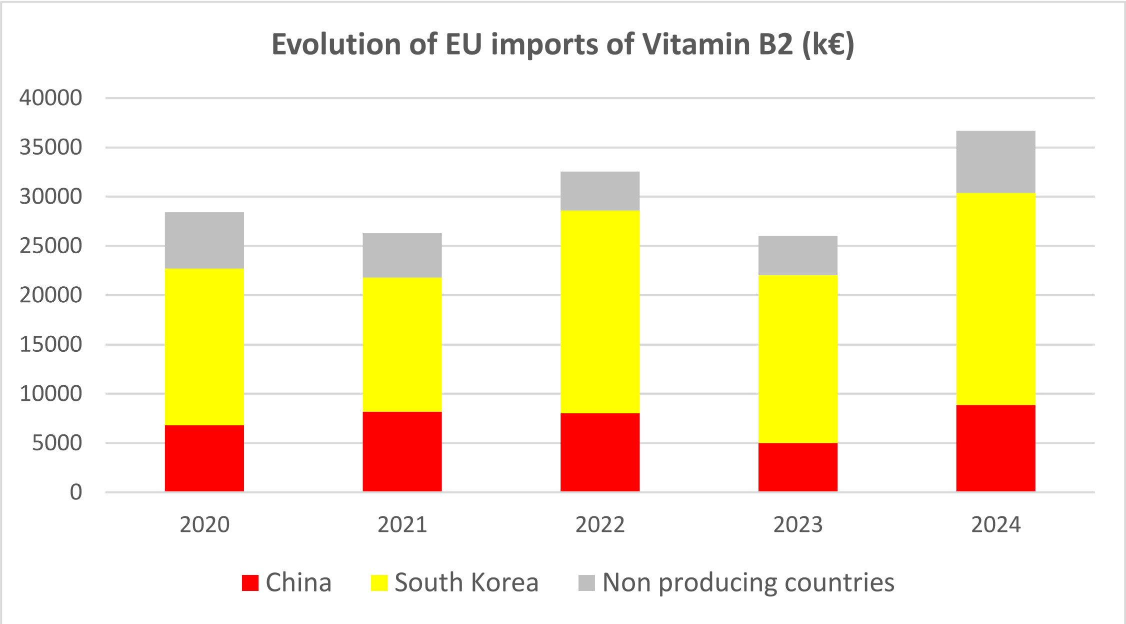
Dependency: 60%, thereof 15% for China (calculated based on average quotation for Vitamin B2 of 20 €/kg of active substance in 2023). China's share as from 2024 will increase since all strains used in China are now "EU-approved".



Share of global production capacity for Vitamin B2
22%
15%
63%
China
South Korea
EU



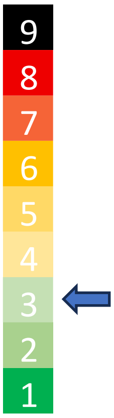
Share of global production of Vitamin B2
26%
47%
27%
China
South Korea
EU



Evolution of EU imports of Vitamin B2 (k€)
40000
35000
30000
25000
20000
15000
10000
5000
0
2020
2021
2022
2023
2024
China
South Korea
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B3 / NIACIN

Economic vulnerability



The term 'niacin' is used as a generic description of nicotinic acid and nicotinamide with pyridine as the basic structure. Niacin has physiologically critical roles in mitochondrial respiration and in the metabolism of carbohydrates, lipids, and amino acids (see EFSA opinion).

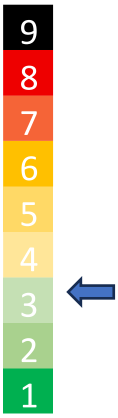
Economic vulnerability score: 3/9

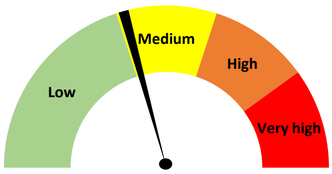
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 78% of the vitamin B3 produced worldwide is used to supplement animals' diets.
- Vitamin B3 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

Geopolitical vulnerability score: 3,8/9[2]

- Vitamin B3 is produced by chemical synthesis in 4 countries/regions: China, India, Switzerland and the EU-27. However, the production on the EU-27 is insignificant and the global market is equally shared among the 3 other countries.
- The EU-27 produces hardly a few percents of its needs and even when making full use of its production capacity to produce for the EU-27 feed market, only one quarter of the demand can be met. The production capacity of Switzerland if used to its full extent may meet the EU-27 demand and is a mitigation factor to EU-27 vulnerability.

Geopolitical vulnerability





0,40

Risk weighed concentration of EU imports

2%

EU self sufficiency

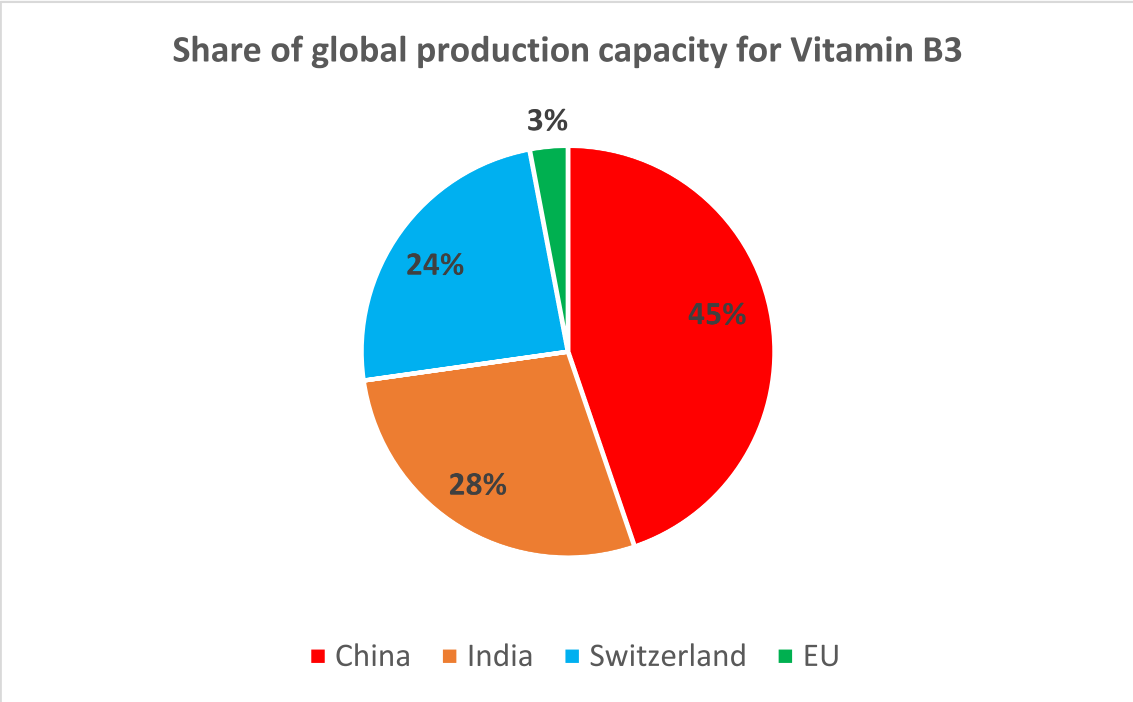
246%

Autonomy potential

379%

Diversification capacity

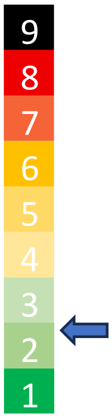
[2] For the calculation of EU diversification capacity, a proxy for imports from China is set at 33% of EU consumption


Share of global production capacity for Vitamin B3
3%
24%
45%
28%
China
India
Switzerland
EU

FACTSHEET VULNERALIBITY – VITAMIN B4 / CHOLINE CHLORIDE

Vitamin B4 or choline chloride is a source of choline, an essential nutrient that plays a vital role in various bodily functions, including liver health, cell membrane formation, and neurotransmitter synthesis. Choline chloride is used mostly in poultry's diets as feed additive (see EFSA opinion).

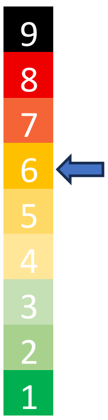
Economic vulnerability



Economic vulnerability score: 2/9

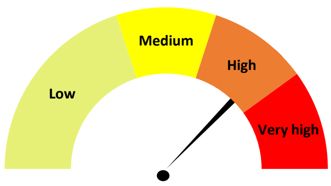
- Essentiality: Medium (2/3)
- Contribution to formulation cost: Low (1/3).
- 94% of the choline chloride produced worldwide is used to supplement animals' diets.
- Choline chloride is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

Geopolitical vulnerability



Geopolitical vulnerability score: 6/9

- Vitamin B4, more known as choline chloride is produced by chemical synthesis in 5 countries/regions: China, the USA, Vietnam, India and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 0.74, i.e. well above the 0.4 threshold considered as critical.
- The EU-27 produces almost as much choline chloride for feed use as it needs (self-sufficiency of 93%) and its production capacity for all uses is almost 2 times the feed demand. So there is no short-term concern regarding the supply of choline chloride to the EU-27. However, since the number of EU-27 producers is limited, any accident leading to closure of an EU-27 manufacturing plant may significantly impact on the market and increase the EU-27 vulnerability, although the diversification potential is good.



0,74

Risk weighed concentration of EU imports

93%

EU self sufficiency

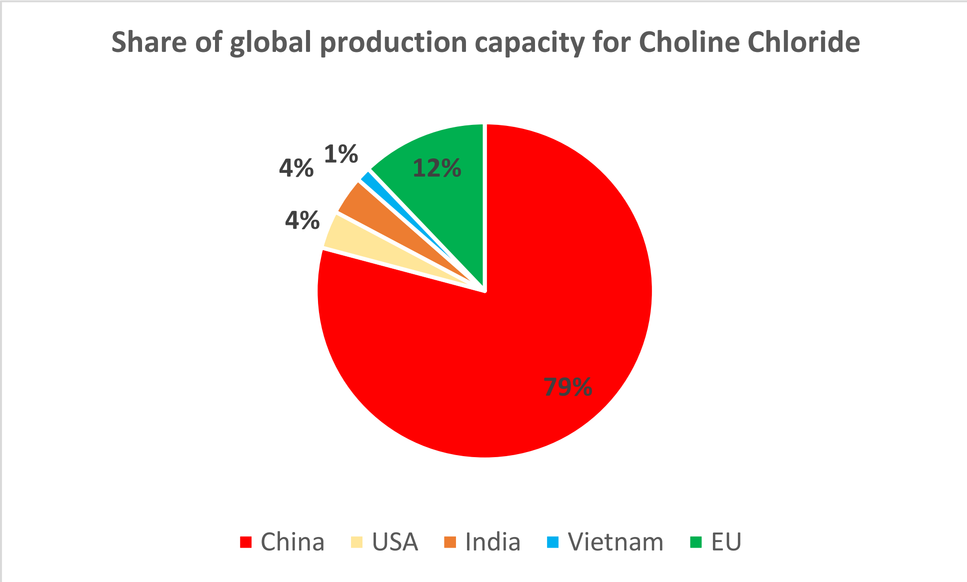
193%

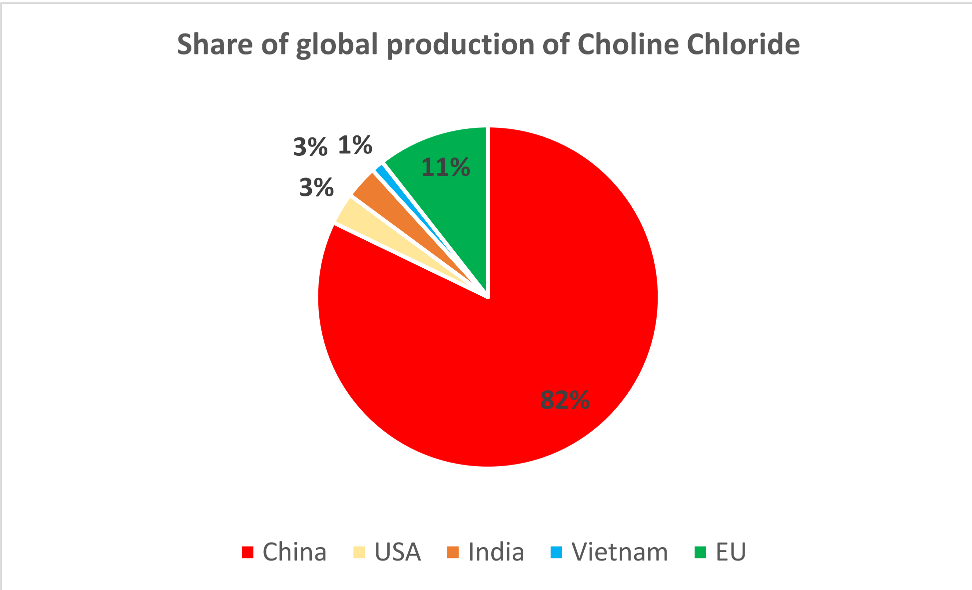
Autonomy potential

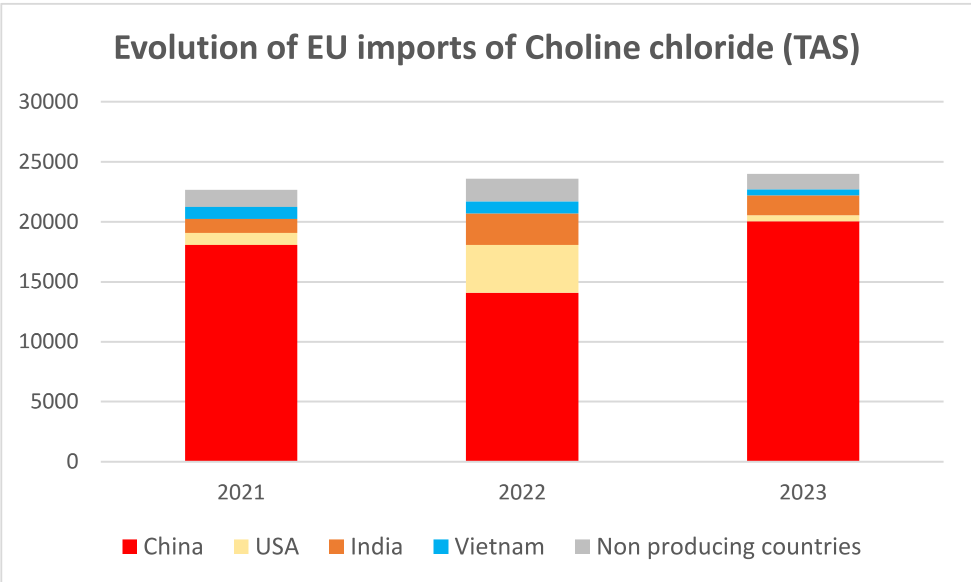
100%

Diversification capacity

Dependency: 35%, thereof 25% for China.

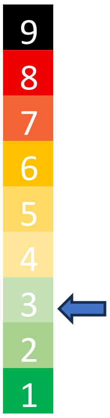

Share of global production capacity for Choline Chloride
4%
1%
12%
4%
79%
China
USA
India
Vietnam
EU


Share of global production of Choline Chloride
3%
1%
11%
3%
82%
China
USA
India
Vietnam
EU


Evolution of EU imports of Choline chloride (TAS)
30000
25000
20000
15000
10000
5000
0
2021
2022
2023
China
USA
India
Vietnam
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B5 / PANTOTHENIC ACID

Economic vulnerability



Economic vulnerability score: 3/9

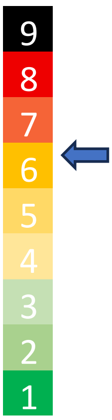
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 80% of the vitamin B5 produced worldwide is used to supplement animals' diets.
- Vitamin B5 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

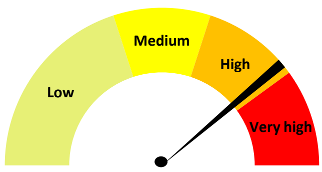
> D-Pantothenic acid is a component of coenzyme A, an essential coenzyme in a variety of chemical reactions involved in the energy metabolism; in particular, coenzyme A is required in the synthesis of essential fatty acids, carbohydrates, cholesterol, porphyrins and acetylcholine (See EFSA opinion).

Geopolitical vulnerability score: 6,5/9[3]

- Vitamin B5 is produced by chemical synthesis in 3 countries/regions: China, the United Kingdom and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index corrected for risk profile of the supplying countries is 0.77, by far above the concern threshold of 0.4.
- The production capacity of both the United Kingdom and the EU-27 may just cover their combined feed demand and is a mitigation element.

Geopolitical vulnerability





0,77

Risk weighed concentration of EU imports

32%

EU self sufficiency

47%

Autonomy potential

109%

Diversification capacity

Dependency: 80% of imports come from China

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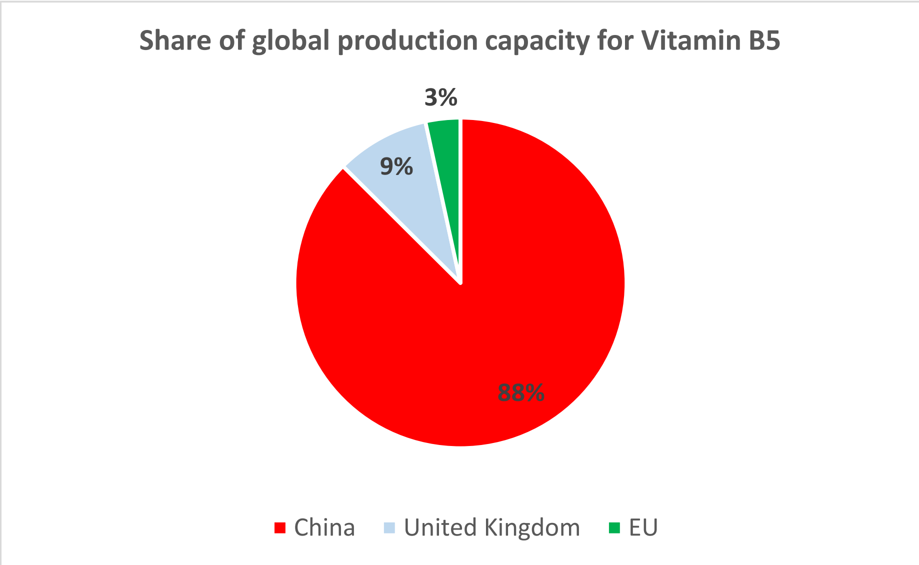
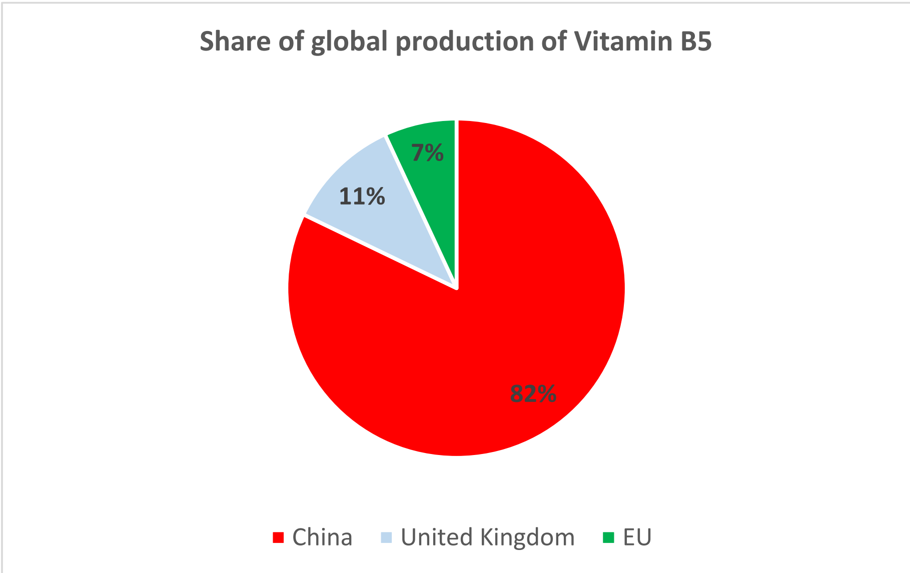
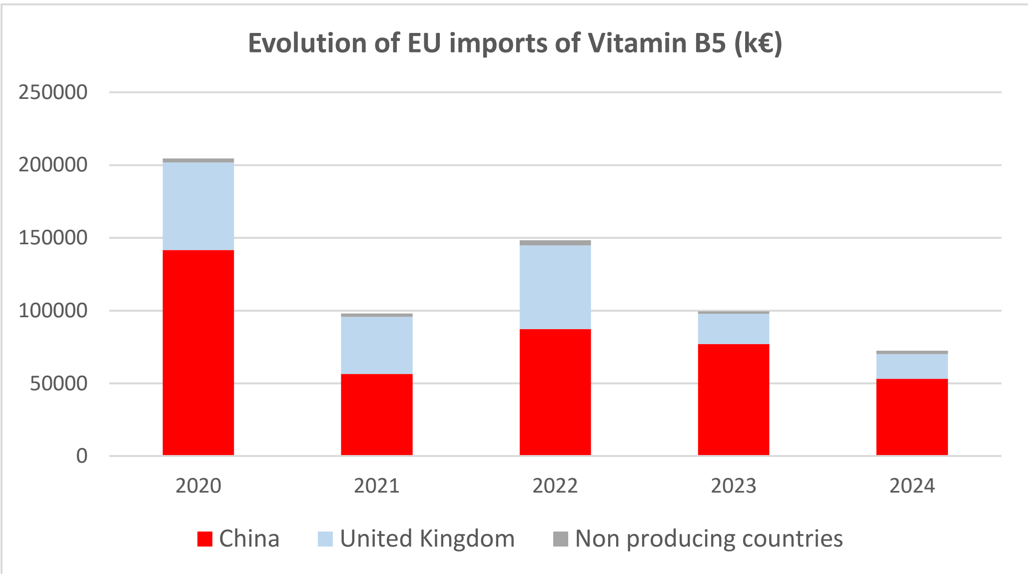
[3] For the determination of the diversification capacity, EU imports from China were considered as equivalent to the difference between EU consumption and EU production, considering the domination of China on the global market.

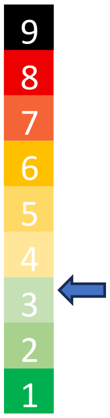

Share of global production capacity for Vitamin B5
3%
9%
88%
China
United Kingdom
EU


Share of global production of Vitamin B5
7%
11%
82%
China
United Kingdom
EU


Evolution of EU imports of Vitamin B5 (k€)
250000
200000
150000
100000
50000
0
2020
2021
2022
2023
2024
China
United Kingdom
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B6 / PYRIDOXINE

Economic vulnerability



Economic vulnerability score: 3/9

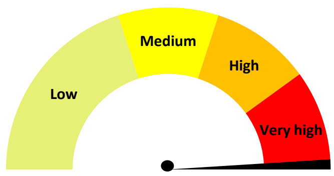
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 70% of the vitamin B6 produced worldwide is used to supplement animals' diets.
- Vitamin B6 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

> Vitamin B6 serves as coenzyme in more than 100 enzymes catalysing biochemical reaction in the body and is essential for carbohydrate, protein and fat metabolism. Pyridoxine is also involved in the conversion of tryptophan into niacin and serotonin in the brain (see EFSA opinion).

Geopolitical vulnerability

Geopolitical vulnerability score: 6.75/9

- Vitamin B6 is produced by chemical synthesis in 2 countries/regions: China and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 1, since the only EU-27 supplier is China.
- The EU-27 produces less vitamin B6 than it uses (self-sufficiency of 33%). However, the production capacity is more than 4 times the feed demand, suggesting that there is possibility for the EU-27 to be self-sufficient with existing infrastructures, although, increasing production may take time and the short-term vulnerability remains worrying.



1,00

Risk weighed concentration of EU imports

33%

EU self sufficiency

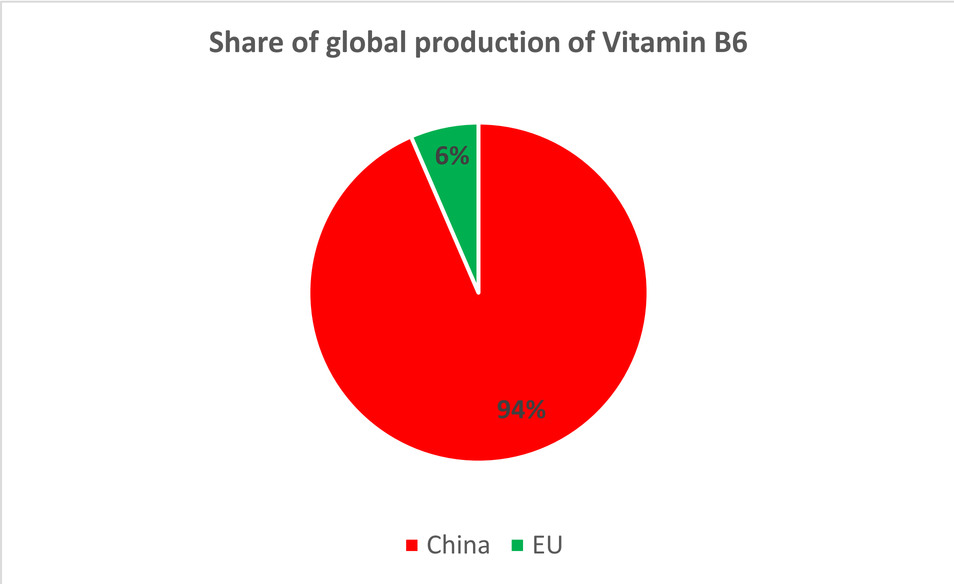
455%

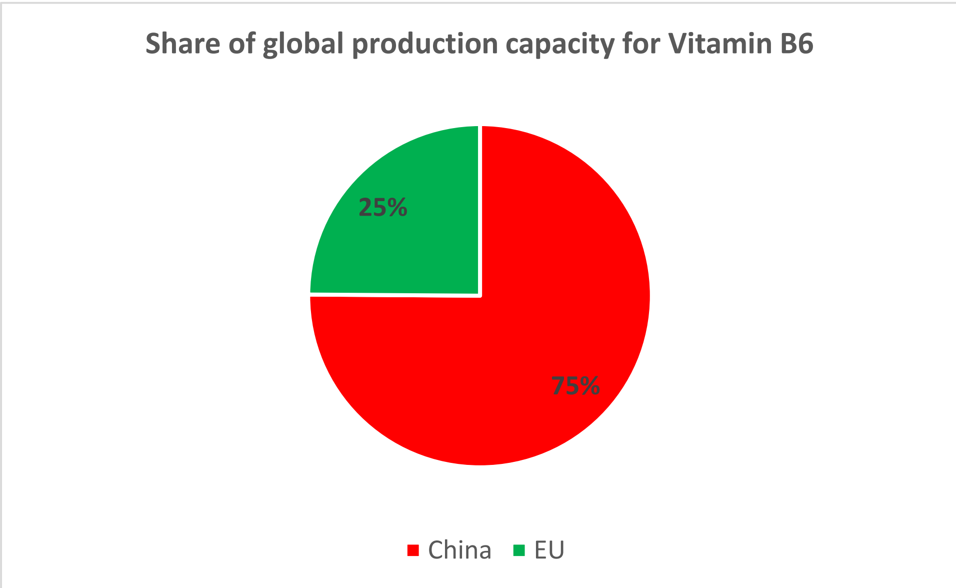
Autonomy potential

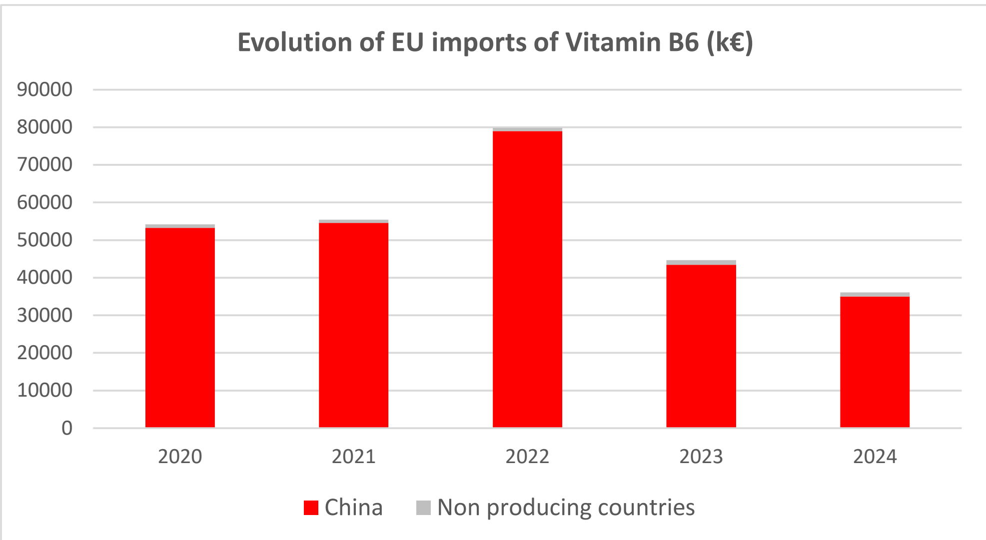
0%

Diversification capacity

Dependency: 100% of imports come from China

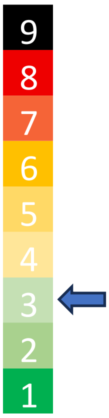

Share of global production of Vitamin B6
6%
94%
China
EU


Share of global production capacity for Vitamin B6
25%
75%
China
EU


Evolution of EU imports of Vitamin B6 (k€)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2020
2021
2022
2023
2024
China
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN B9 / FOLIC ACID

Economic vulnerability



Economic vulnerability score: 3/9

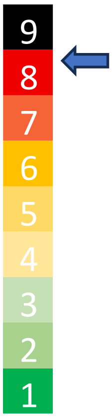
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 85% of the vitamin B9 produced worldwide is used to supplement animals' diets.
- Vitamin B9 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

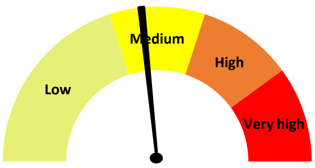
Vitamin B9 or folic acid is the synthetic form of the naturally occurring folates. The synthesis of both DNA and RNA depends on folic acid and folate coenzymes play an important role in the metabolism of several amino acids. Folate deficiency during pregnancy can cause severe consequences in the foetus (see EFSA opinion).

Geopolitical vulnerability score: 8,8/9[4]

- Vitamin B9 is produced by chemical synthesis in 3 countries/regions: China, India and Switzerland.
- In absence of trade data, the Herfindahl-Hirschman Index was calculated assuming an equal share of EU-27 imports among the three global producing countries, corrected for risk profile. It is therefore likely underestimated.
- Switzerland does not use its production capacity to a full extent but would not be in a position to meet the EU-27 feed demand and cannot therefore be regarded as a mitigation option.

Geopolitical vulnerability





0,92

Risk weighed concentration of EU imports

0%

EU self sufficiency

0%

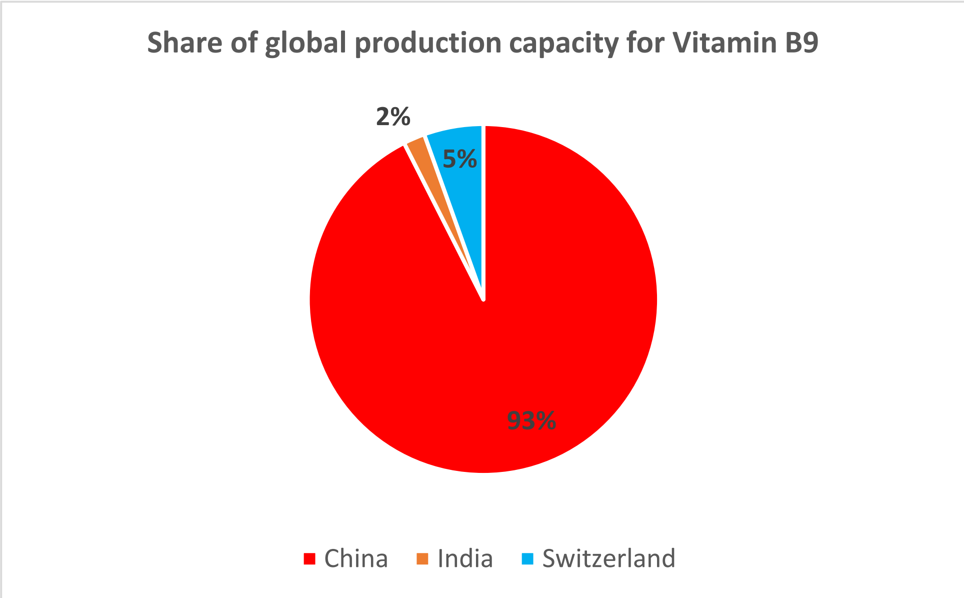
Autonomy potential

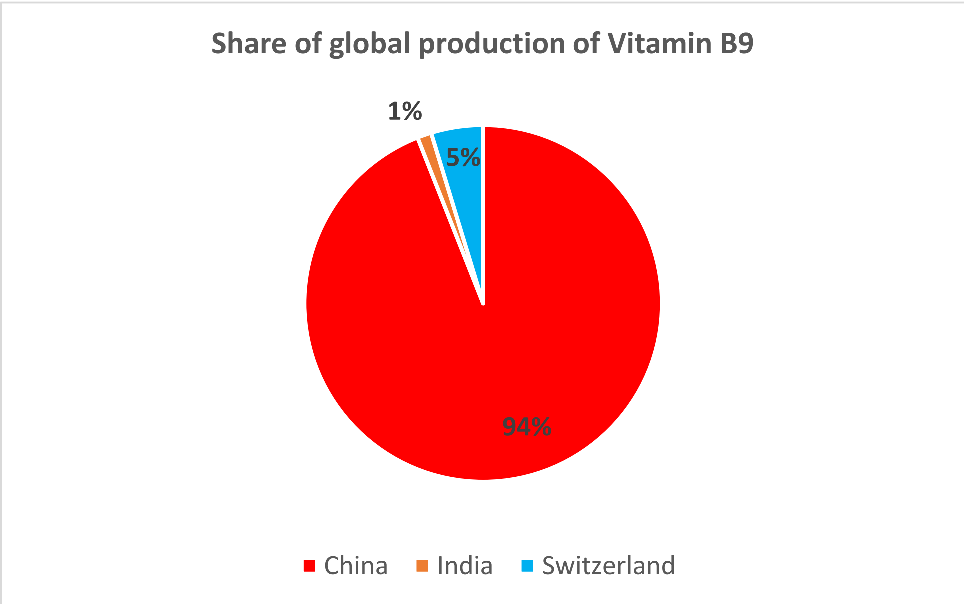
26%

Diversification capacity

Dependency: 100%, thereof 90% for China (calculated based on average quotation for Vitamin B9 of 45 €/kg in 2023

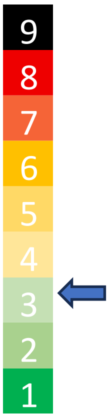
[4] For the determination of the diversification capacity, EU imports from China were considered as equivalent to the EU consumption, considering the domination of China on the global market and the absence of production in the EU.


Share of global production capacity for Vitamin B9
2%
5%
93%
China
India
Switzerland


Share of global production of Vitamin B9
1%
5%
94%
China
India
Switzerland

FACTSHEET VULNERALIBITY – VITAMIN B12 / CYANOCOBALAMIN

Economic vulnerability



Vitamin B12 or cyanocobalamin is a coenzyme in intermediate metabolism. However, its main known functionality is its role in blood cell formation and the ability to prevent certain forms of anaemia and neurological disturbances.

Vitamin B12 is present naturally only in feed materials of animal origin.

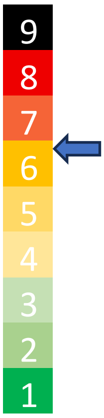
Economic vulnerability score: 3/9

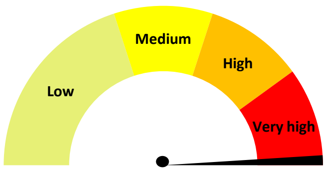
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 30% of the vitamin B12 produced worldwide is used to supplement animals' diets.
- Vitamin B12 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

Geopolitical vulnerability score: 6.75/9

- Vitamin B12 is produced by fermentation in 2 countries/regions: China and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 1, since the only EU-27 supplier is China.
- The EU-27 produces only the equivalent of 25% of its needs. However, it should be possible for the EU-27 to meet its own demand when making full use of its production capacity.

Geopolitical vulnerability





1,00

Risk weighed concentration of EU imports

183%

EU self sufficiency

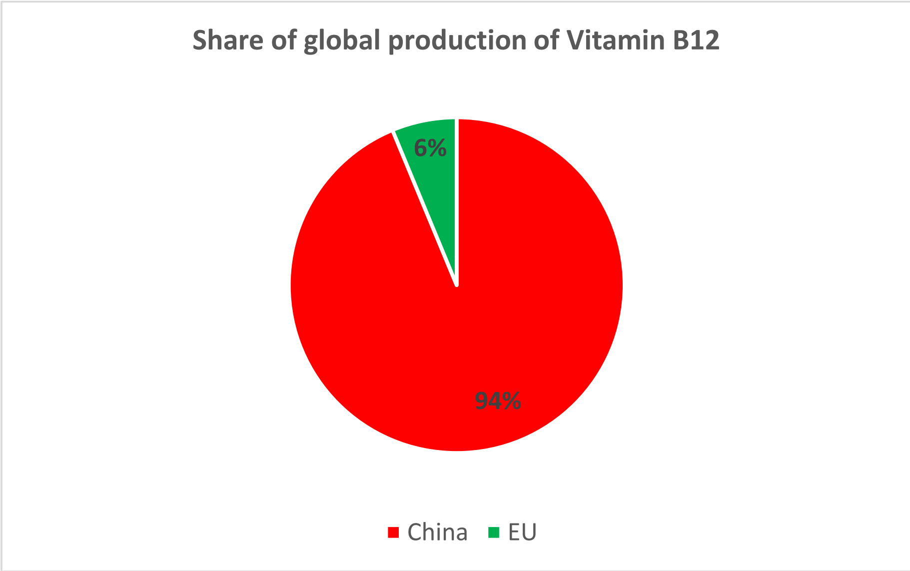
183%

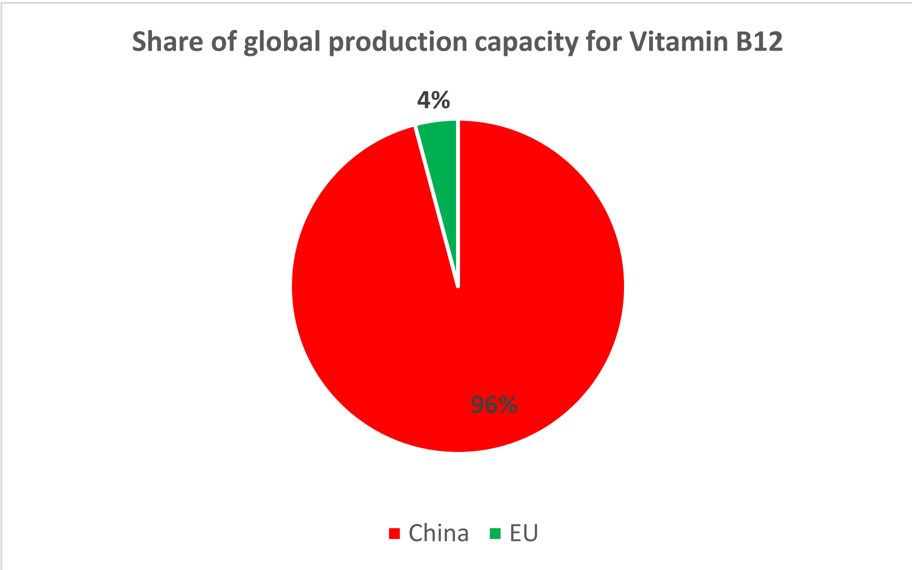
Autonomy potential

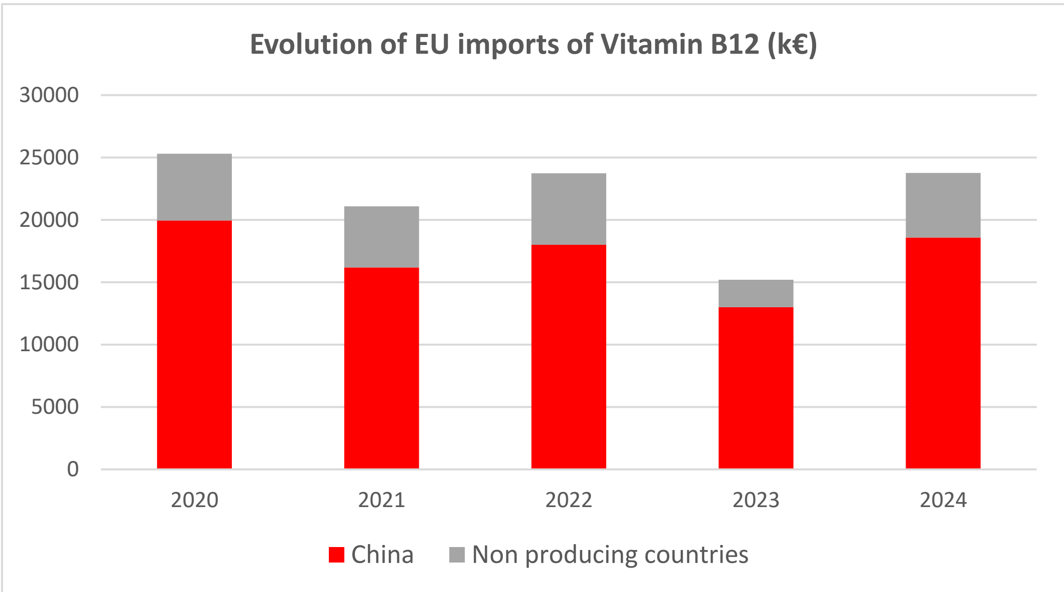
0%

Diversification capacity

Dependency: 75%, all from China (calculated based on average quotation for Vitamin B12 of 14 €/kg of preparation 1% in 2023).

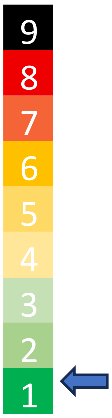

Share of global production of Vitamin B12
6%
94%
China
EU


Share of global production capacity for Vitamin B12
4%
96%
China
EU


Evolution of EU imports of Vitamin B12 (k€)
30000
25000
20000
15000
10000
5000
0
2020
2021
2022
2023
2024
China
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN C / ASCORBIC ACID

Economic vulnerability



Economic vulnerability score: 1/9

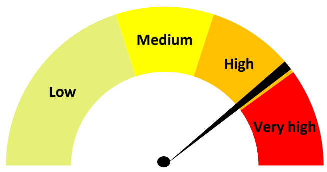
- Essentiality: High (1/3)
- Contribution to formulation cost: Low (1/3).
- 8% of the vitamin C produced worldwide is used to supplement animals' diets.
- Vitamin C is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average. Its essentiality is low, except for fish.

> The term vitamin C includes compounds with L-ascorbic acid activity. The functions of ascorbic acid are related to its redox properties, it is a cofactor and protector of different enzymes, it is involved in the reduction of trace minerals and acts as an antioxidant (see EFSA opinion).

Geopolitical vulnerability

Geopolitical vulnerability score: 6.75/9

- Vitamin C is produced by a combination of fermentation and chemical synthesis in 2 countries/regions: China and the UK.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 0.76, i.e. well above the concern threshold of 0.4.
- The share of the feed demand is extremely low compared to use in food supplements. The UK would have the capacity to meet the whole of the EU-27 feed demand but it is likely that the food demand would be served first. So the UK cannot be an effective vulnerability mitigating factor.



0,77

Risk weighed concentration of EU imports

0%

EU self sufficiency

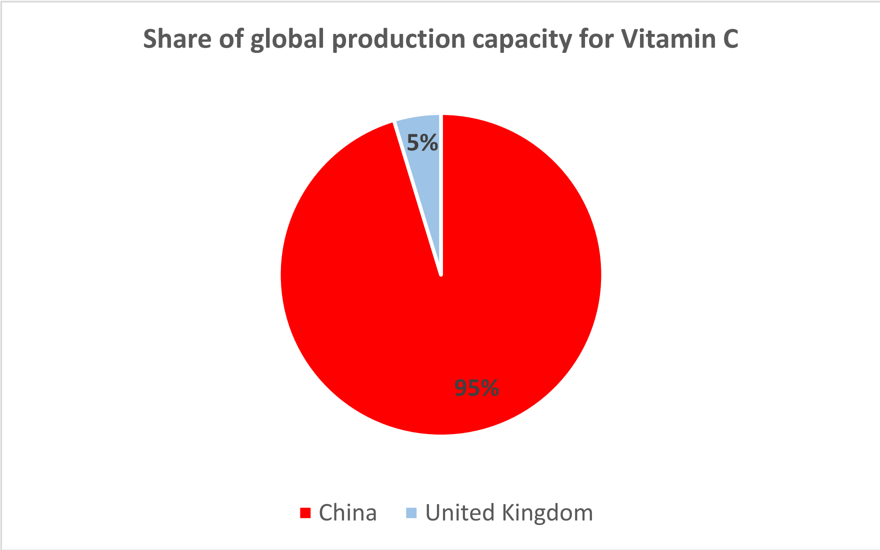
0%

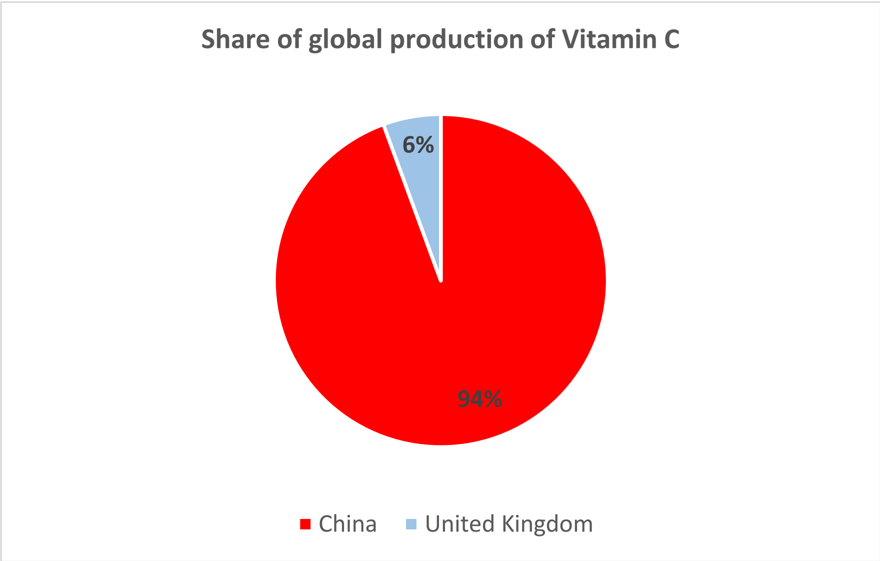
Autonomy potential

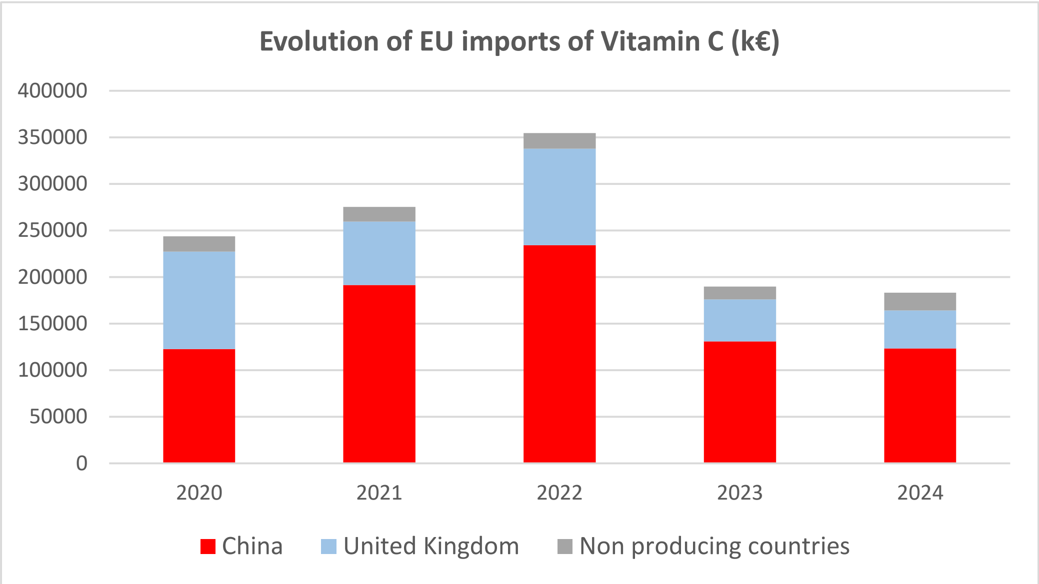
31%

Diversification capacity

Dependency: 100%, thereof 75% from China.

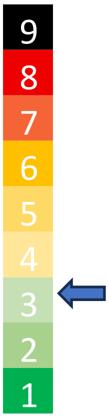

Share of global production capacity for Vitamin C
5%
95%
China
United Kingdom


Share of global production of Vitamin C
6%
94%
China
United Kingdom


Evolution of EU imports of Vitamin C (k€)
400000
350000
300000
250000
200000
150000
100000
50000
0
2020
2021
2022
2023
2024
China
United Kingdom
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN D3 / CHOLECALCIFEROL

Economic vulnerability

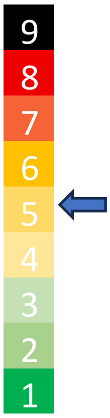


Economic vulnerability score: 3/9

- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 75% of the vitamin D3 produced worldwide is used to supplement animals' diets.
- Vitamin D3 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

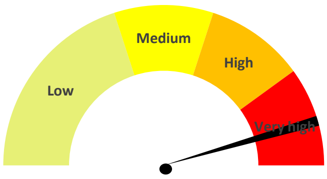
The classical Vitamin D3 function is in the regulation of calcium absorption in the gut, the homeostasis of serum calcium and phosphorus as well as by its action on bone growth. Novel roles of vitamin D have been identified and they include, amongst others, the regulation of both the innate and adaptive immune system and the cell proliferation and differentiation, with implications in muscle formation. (see EFSA opinion).

Geopolitical vulnerability



Geopolitical vulnerability score: 5.25/9[5]

- Vitamin D3 is produced by chemical synthesis using mostly lanoline as starting material, in 3 countries/regions: China, India and the EU-27.
- The global production capacity is 5 times higher than the needs and China concentrates 83% of it.
- The EU-27 has two times the capacity to meet its feed demand. However, in reality, third countries rely also on the EU-27 to meet their demand and is the only relevant alternative to China since the production capacity of India is not sufficient.



0,90

Risk weighed concentration of imports

71%

EU self sufficiency

221%

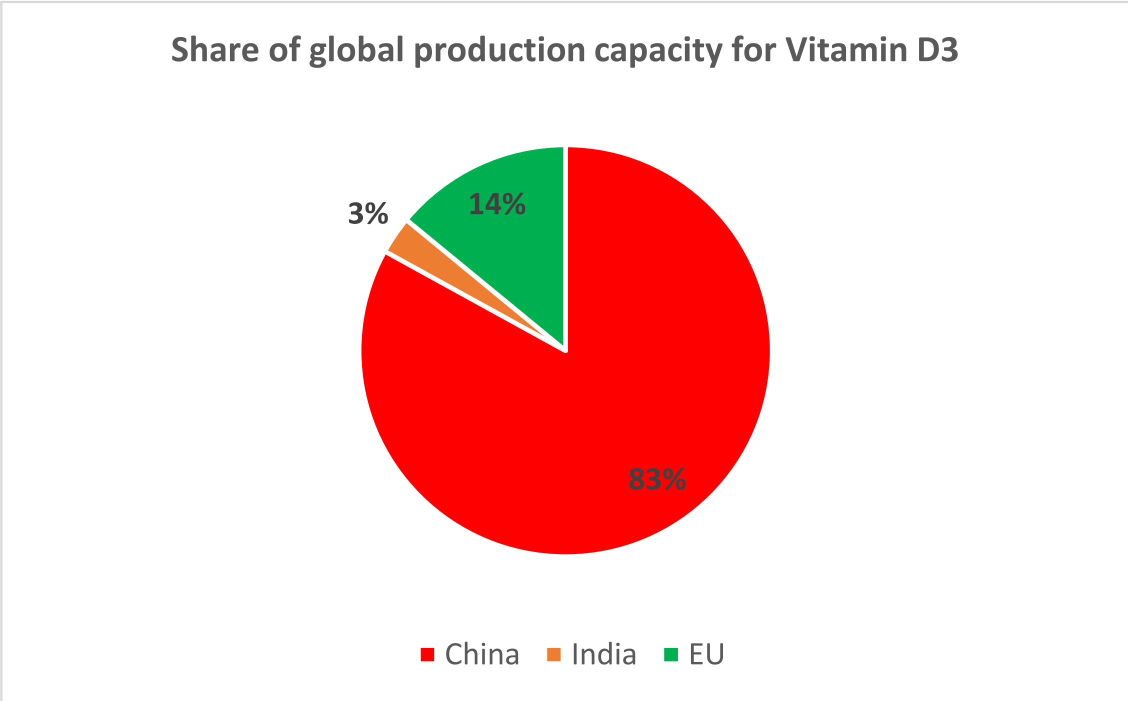
Autonomy potential

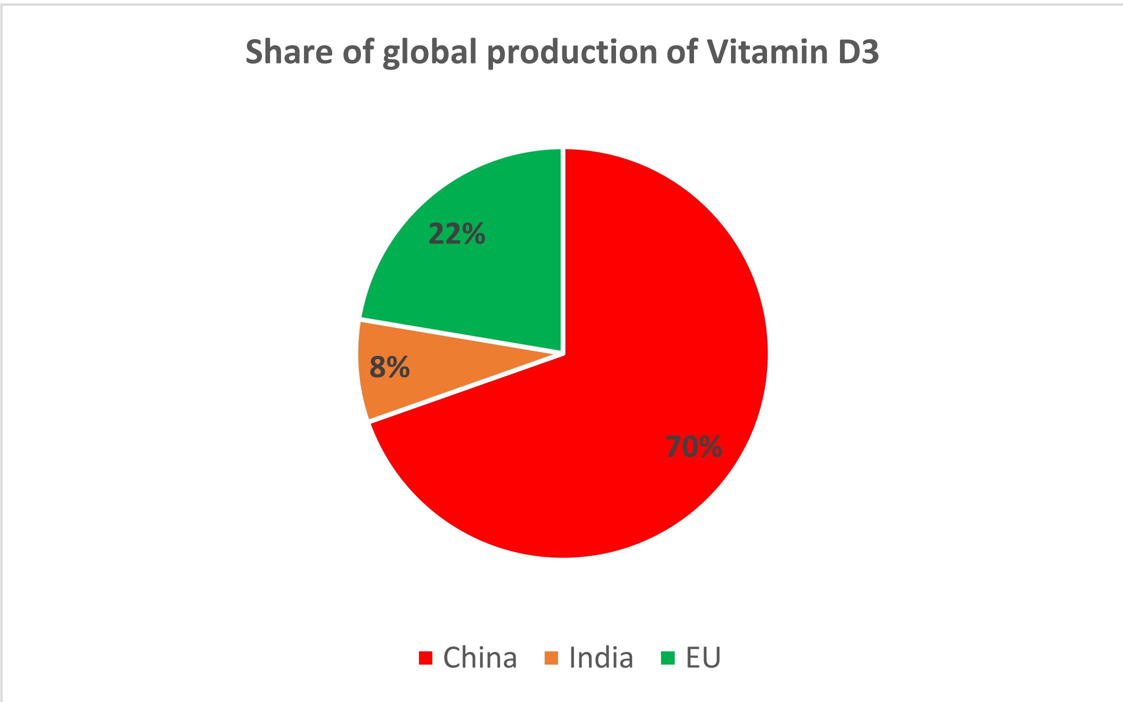
36%

Diversification capacity

Dependency: at least 80% of imports originate from China.

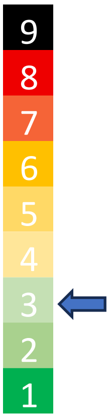
[5] For the determination of the diversification capacity, EU imports from China were considered as equivalent to the difference between EU consumption and EU production, considering the domination of China on the global market.


Share of global production capacity for Vitamin D3
3%
14%
83%
China
India
EU


Share of global production of Vitamin D3
22%
8%
70%
China
India
EU

FACTSHEET VULNERALIBITY – VITAMIN E / TOCOPHEROL

Economic vulnerability



Economic vulnerability score: 3/9

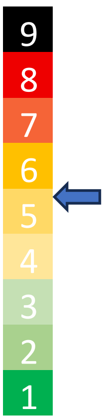
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 70% of the vitamin E produced worldwide is used to supplement animals' diets.
- Vitamin E is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

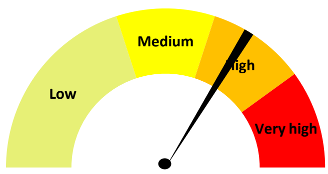
> Vitamin E is a chain-breaking antioxidant and protects cellular membranes from being attacked by lipid peroxyl radicals. This unique function of vitamin E cannot be fulfilled by any other dietary substance with antioxidant-like properties. In addition, vitamin E maintains tissue's structural integrity to supporting neural growth and reproduction as well as modulating immunity (see EFSA opinion).

Geopolitical vulnerability score: 5.8/9

- Vitamin E is produced through both chemical synthesis and extraction from natural sources, primarily plant oils. It is produced in 3 countries/regions: China, Switzerland and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 0.67, i.e. well above the concern threshold of 0.4.
- The EU-27 produces less feed grade vitamin E than it uses as feed (self-sufficiency of 43%). However, the combined production capacity of the EU-27 and Switzerland represents 3 times the EU-27 feed demand and therefore the vulnerability may be mitigated.

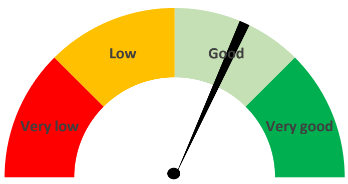
Geopolitical vulnerability





0,67

Risk weighted concentration of EU imports



125%

EU self sufficiency

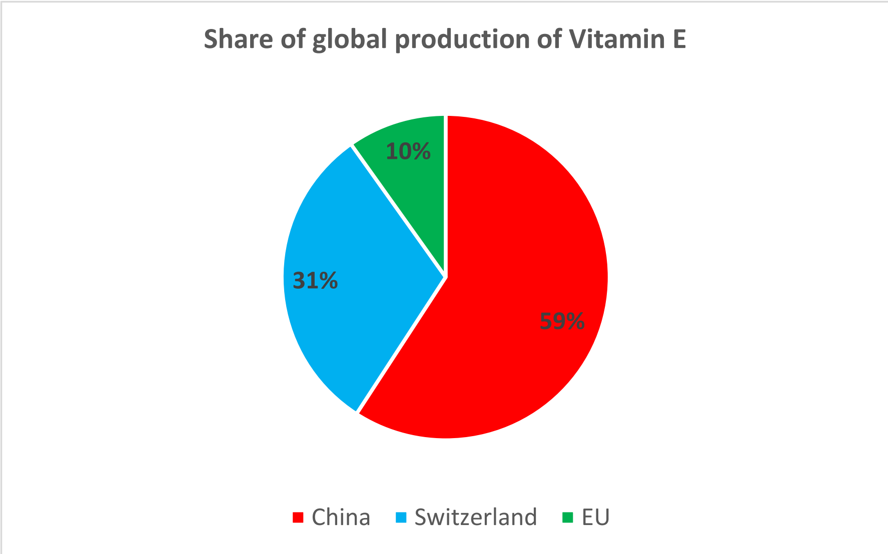
125%

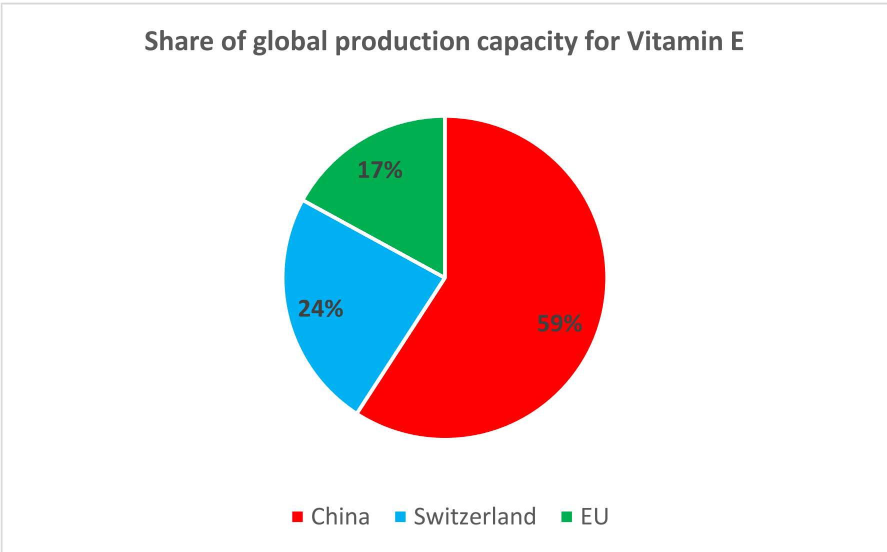
Autonomy potential

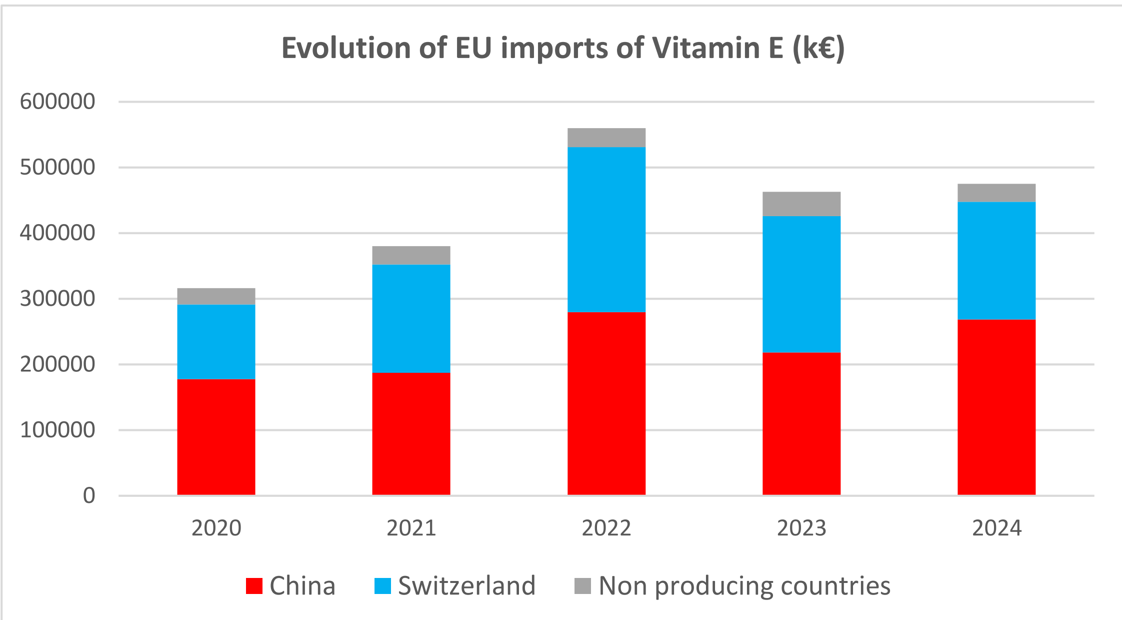
46%

Diversification capacity

Dependency: at least 50% of imports originate from China.

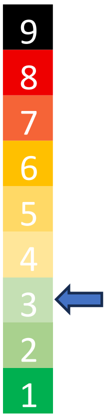

Share of global production of Vitamin E
10%
31%
59%
China
Switzerland
EU


Share of global production capacity for Vitamin E
17%
24%
59%
China
Switzerland
EU


Evolution of EU imports of Vitamin E (k€)
600000
500000
400000
300000
200000
100000
0
2020
2021
2022
2023
2024
China
Switzerland
Non producing countries

FACTSHEET VULNERALIBITY – VITAMIN H / BIOTIN

Economic vulnerability



Economic vulnerability score: 3/9

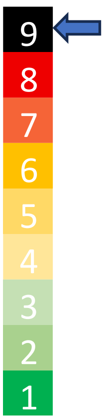
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 70% of the vitamin H produced worldwide is used to supplement animals' diets.
- Vitamin H is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

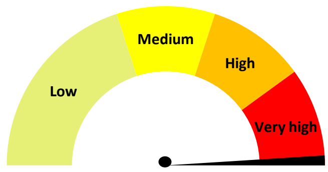
Biotin, known as vitamin H (and also B7 or B8) is a coenzyme essential for gluconeogenesis, lipogenesis and the elongation of essential fatty acids. It is important for the normal functioning of the reproductive and nervous systems and of the thyroid and adrenal glands. Biotin reduces foot disorders in poultry and builds stronger hooves in pigs and ruminants (see EFSA opinion).

Geopolitical vulnerability score: 9/9

- Vitamin H is produced by chemical synthesis in 2 countries/regions: China and the EU-27.
- The level of concentration of imports based on the Herfindahl-Hirschman Index is 1, since the only EU-27 supplier is China.
- The EU-27 production and production capacity of Vitamin H is not significant enough, meaning that the EU-27 vulnerability is extremely high, with no real perspective of improvement in middle to long term.

Geopolitical vulnerability





1,00

Risk weighed concentration of EU imports

4%

EU self sufficiency

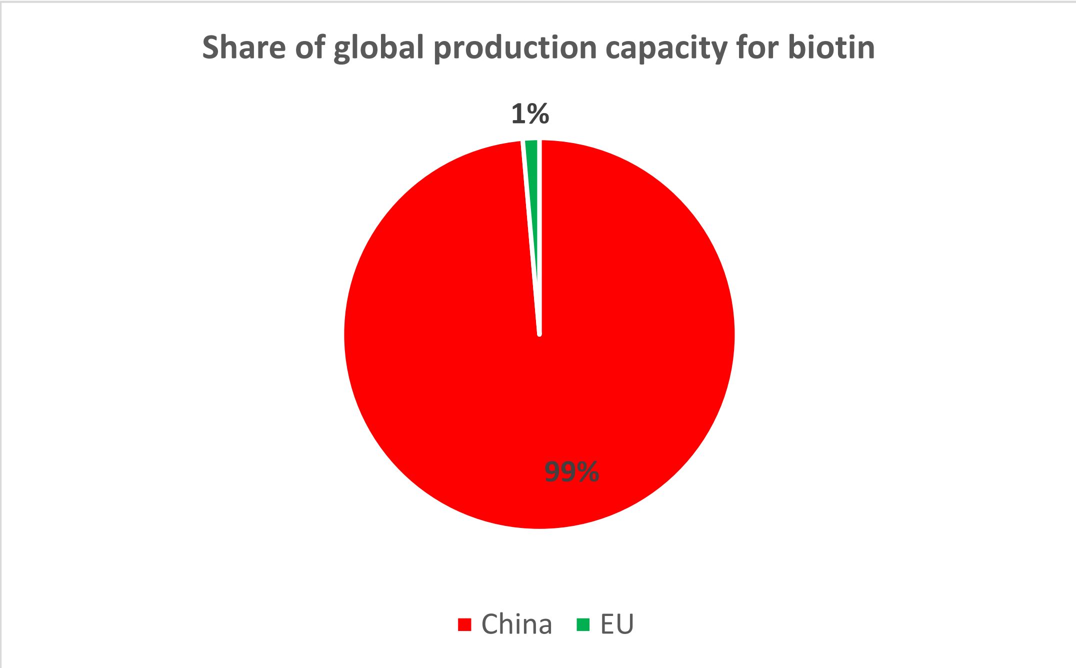
13%

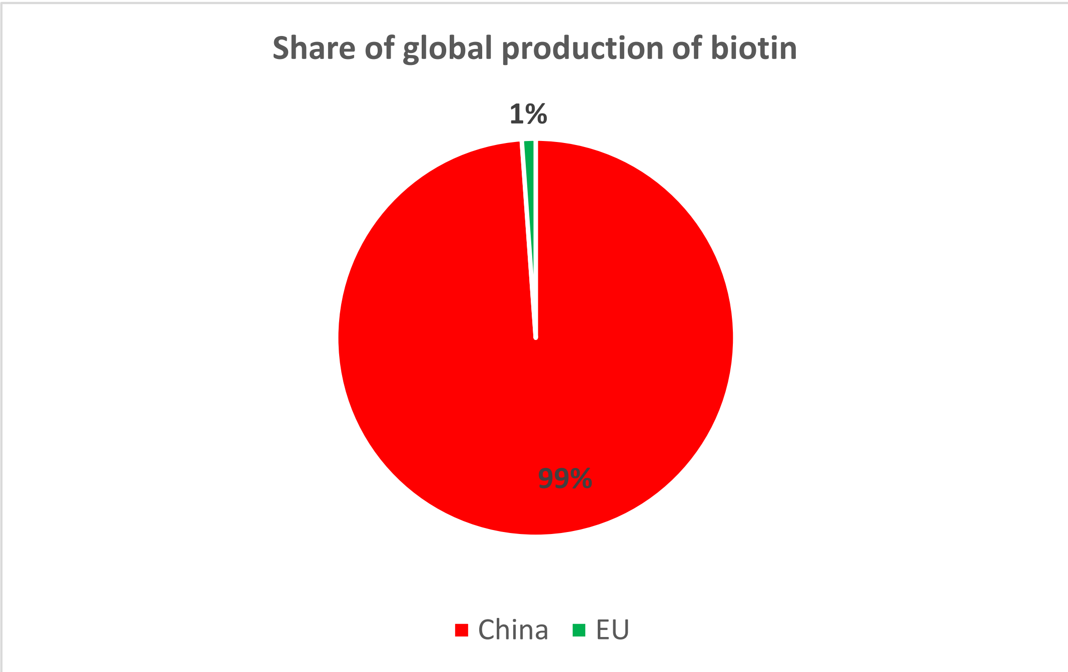
Autonomy potential

0%

Diversification capacity

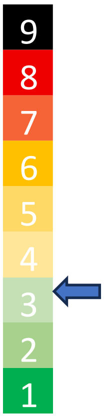
Dependency: 95%, all from China (calculated based on average quotation of 20 €/kg for biotin preparation 2% in 2023).


Share of global production capacity for biotin
1%
99%
China
EU


Share of global production of biotin
1%
99%
China
EU

FACTSHEET VULNERALIBITY – VITAMIN K3 / MENADIONE

Economic vulnerability



Economic vulnerability score: 3/9

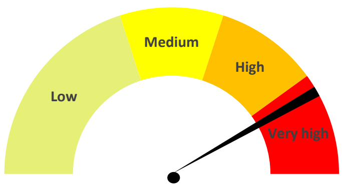
- Essentiality: High (3/3)
- Contribution to formulation cost: Low (1/3).
- 95% of the vitamin K3 produced worldwide is used to supplement animals' diets.
- Vitamin K3 is incorporated in small quantities in final feed and contributes to less than 0.1% of the price of complete feed on average.

The principal function of vitamin K3 or menadione is the control of the blood coagulation period. A large number of proteins with different metabolic functions require vitamin K3 for their biosynthesis. The majority of tissues have relationships depending on vitamin K3, in particular in bone tissue two proteins K-dependent are involved in calcium and bone metabolism (see EFSA opinion).

Geopolitical vulnerability score: 6,8/9[6]

- Vitamin K3 is produced by chemical synthesis in 3 countries: China, Uruguay and Turkey.
- The production is dominated by China with 74% of the production and 80% of the production capacity worldwide.
- Turkey and Uruguay have the production capacity to serve the EU-27 market if needed, which is a clear vulnerability mitigation factor.

Geopolitical vulnerability



0,82

Risk weighed concentration of EU imports

0%

EU self sufficiency

0%

Autonomy potential

350%

Diversification capacity

Dependency: 100%.

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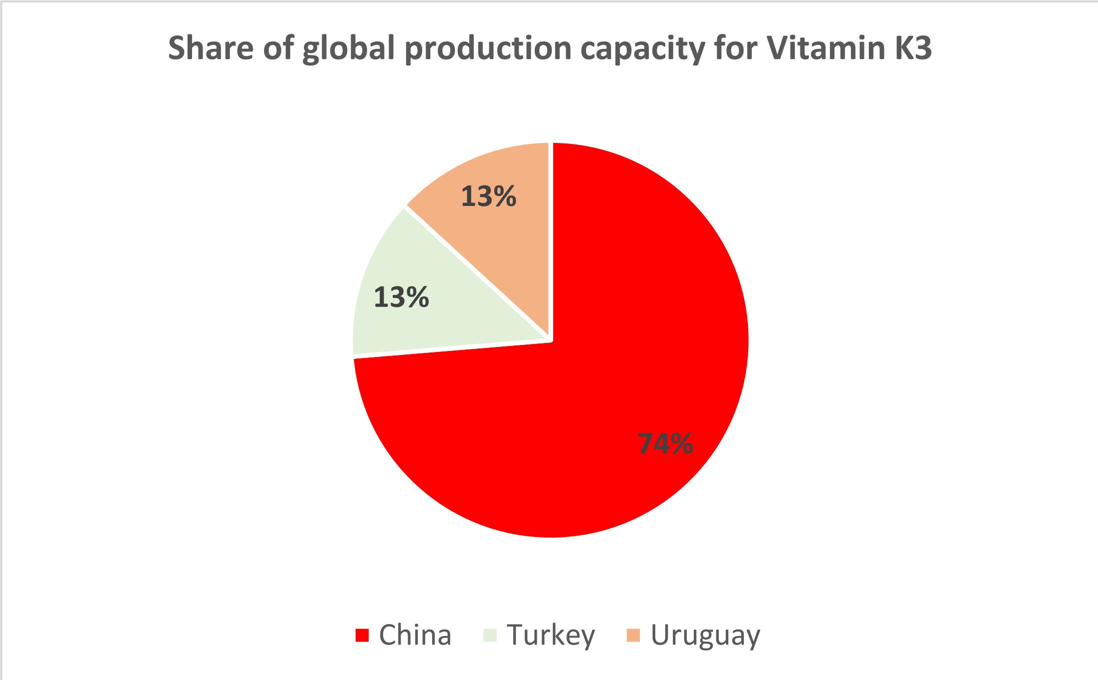
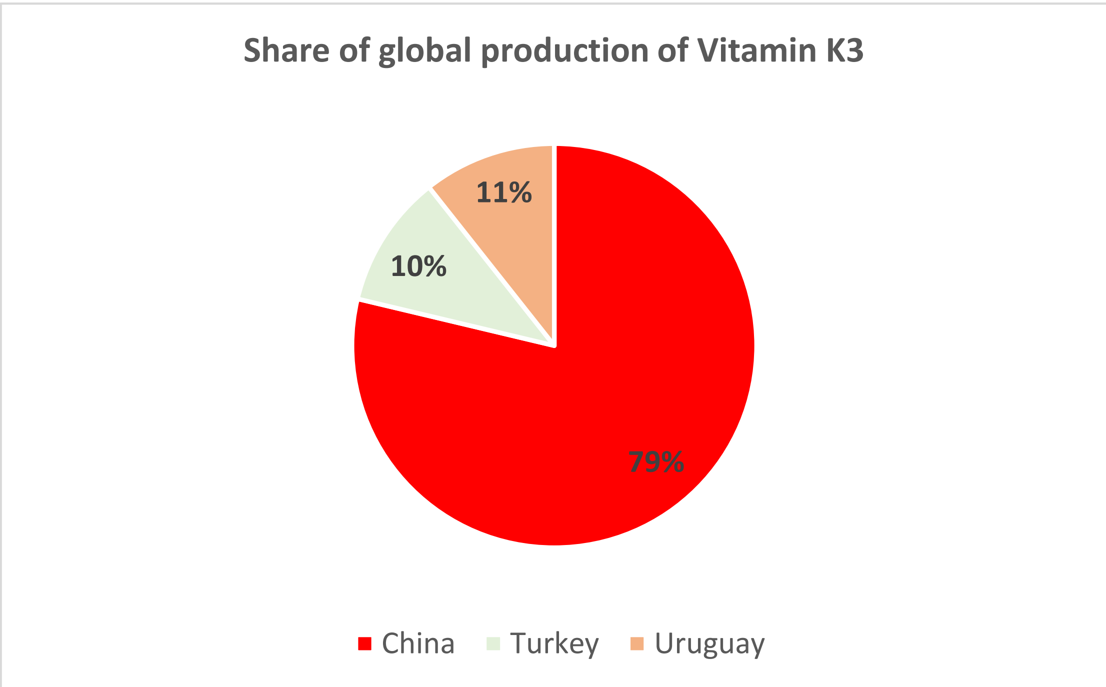
[6] For the determination of the diversification capacity, EU imports from China were considered as equivalent to the EU consumption, considering the domination of China on the global market and the absence of production in the EU.


Share of global production capacity for Vitamin K3
13%
13%
74%
China
Turkey
Uruguay


Share of global production of Vitamin K3
11%
10%
79%
China
Turkey
Uruguay