Factsheet

Fish sticks vs. plant-based sticks

Life cycle assessment (LCA) of fish sticks and their plant-based alternatives

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Summary

Seafood is often presented as a climate-friendlier and healthier alternative to meat. But this fails to consider the impacts of fishing activities. Indeed, as global seafood production keeps rising, overfishing has become the main cause of biodiversity loss in the oceans. Therefore, a reduction of seafood consumption is necessary, particularly in higher income countries such as Switzerland. This can amongst others be achieved by replacing seafood with plant-based alternatives. But are these processed alternatives ecologically preferable?

WWF issued a Life-Cycle-Assessment comparing the environmental impacts of fish sticks – the second most popular fish product in Swiss supermarkets – with their plant-based alternatives. 17 different (fish) sticks available in Switzerland were analysed using the ecological scarcity method, which considers numerous environmental criteria, including overfishing.

The results are clear: plant-based sticks perform significantly better ecologically than their animal-based equivalents. For the same amount of product, fish sticks have a 3.6 times higher environmental impact than plant-based sticks. When accounting for nutritional value, plant-sticks still score 3.4 times better than fish sticks.

Environmental impact of animal products

The production of animal-based foods is one of the biggest drivers of deforestation, habitat loss, water use and greenhouse gas emissions. The way we eat is significantly affecting our planet's health and fueling climate change.

Seafood is often presented as a climate-friendlier and healthier alternative to meat. However, studies supporting this statement mostly focus on greenhouse gas emissions and fail to include overfishing and further ecosystem impacts caused by fishing activities[1,2]. The latter have been identified as the greatest threat to ocean biodiversity[3].

As the worldwide production and consumption of seafood keeps rising[4], we catch more fish than what the oceans can sustainably provide[5]. Not only does this put the oceans under increasing pressure, but it also threatens the livelihood and food security of coastal communities that rely on fish for protein intake[6]. Reducing our consumption of seafood is therefore both necessary and urgent, particularly in higher income countries such as Switzerland. But are there more responsible, yet convenient and nutritious alternatives?

Plant-based alternatives

In response to the growing awareness of consumers with regards to the environmental degradation caused by the food production industry, a myriad of plant-based alternatives to meat, seafood and dairy products have emerged on the market. The consumer often faces the question of whether the environmental impact of these processed, plant-based alternatives is truly lower than that of the animal-based products.

In Switzerland, an average 8.85 kg of seafood was consumed per person in 2021[7]. This makes it the 4th most popular animal product right after pork, chicken, and beef. Fish sticks are the second most sold seafood product in Swiss retail after salmon, representing 10% of seafood sales. Over 2600 tons of fish sticks are sold in supermarkets every year in Switzerland[8].

WWF Switzerland commissioned Carbotech AG to conduct a Life Cycle Assessment (LCA) study comparing the environmental impacts of animal-based fish sticks with those of plant-based sticks.

Did you know?

Fish sticks were invented in the US during the 1950s. With stronger diesel engines, bigger boats, and new equipment, fishers started catching more fish from the ocean than ever before, and production quickly outpaced consumer demand[9].

New advances in freezing, processing and transportation technologies allowed fishing companies to skin, debone, and freeze the excess fish to keep it from spoiling[10].

Consumers, however, were not attracted by these frozen fillets, and the demand for fish products remained low. To increase sales, manufacturers started to bread and cut the fish into standardized sticks and advertised them as the new, modern, and precooked convenience food.

Fish sticks quickly gained popularity, also beyond the US borders, and soon established themselves as a regular part of the post-war diet.

Yet, what started as a way to valorize surpluses of fish now contributes to the overexploitation of fish stocks (see fact box on overfishing on page 6).

Procedure

Desktop research was conducted to identify the fish sticks and plant-based sticks most commonly sold in Swiss retail markets and their composition. A list of the 17 assessed stick variants can be found in the appendix A1.

The majority of animal-based sticks contain Alaska pollock (*Gadus chalcogrammus*, also labelled as *Theragra chalcogramma*) or Atlantic cod (*Gadus morhua*), and most plant-based sticks contain wheat or soy as the main ingredient. Therefore, the following variants were considered for the study:

- Fish sticks, frozen, breaded with Alaska pollock[A]
- Fish sticks, frozen, breaded, with Atlantic cod[B]
- Plant-based fish sticks, frozen, breaded, soy-based
- Plant-based fish sticks, frozen, breaded, wheat-based

The environmental impact of the whole supply chain for 100 g of each of the four variants was assessed based on nine different impact categories shown in **Table 1**. Additionally, the LCA also assessed the environmental impact per equal nutritional value for fish sticks and their plant-based counterparts.

Table 1 Impact categories

Water resources	Consumptive use of surface water, groundwater and fossil water from aquifers
Energy resources	Consumption of non-renewable and renewable energy
Land use	Incl. loss of biodiversity
Global warming	Substances that contribute to climate change (greenhouse gases such as CO_2 and Methane)
Other air emissions	Ozone layer depletion, main air pollutants (e.g. SO_2 and NO_X), particulate matter, carcinogenic substances, heavy metals and radioactive substances into air
Water pollutants	Water pollutants (e.g. nitrogen and nitrate from fertilisation, endocrine disruptors), persistent organic pollutants (POP), heavy metals and radioactive substances into water
Emissions to soil	Pesticides and heavy metals into soil
Biotic resources	Overfishing incl. bycatch
Other	Mineral resources, non-radioactive and radioactive waste

Methodology

Life cycle assessment (LCA) is a comprehensive method to assess and compare multiple environmental impacts of products and systems, including raw materials, across their entire life cycle.

For this study, all processes from the extraction of raw materials up to the store were considered. Neither the use phase (same for all variants) nor the end-of-life phase (not relevant) were considered. The study follows the ISO 14040 standard; and goes beyond the standard in individual points, such as the use of overall aggregating methods.

The assessment was performed using the ecological scarcity method, which was developed in cooperation with the Federal Office for the Environment and is well established in Switzerland[11]. The results are expressed in eco-points. Acceptable levels are based on statutory Swiss targets or on international targets supported by Switzerland. In 2021, eco-factors for marine fish resources were newly included. They allow considering (over)fishing and bycatch in LCAs of wild-caught fish products. These were used for the present study[12].

[A] Assumption: *Gadus chalcogrammus caught in FAO 61 & 67, bycatch rate of non-target species: 3%, excl. bycatch of juveniles*
[B] Assumption: *Gadus morhua caught in FAO 27, bycatch rate of non-target species: 5%, excl. bycatch of juveniles*

Results

Environmental impact results

The results of the LCA are clear and significant: The environmental impact of animal-based fish sticks per 100g exceeds that of plant-based variants by a factor of 3.6 (Figure 1).

Fish sticks score significantly worse than the plant-based sticks in all categories. The biggest environmental impact of fish sticks is caused by global warming and other air emissions, followed by overfishing. These emissions stem from the primary fishing activities including diesel combustion of the vessels.

In the case of plant-based sticks, the main environmental impacts were linked to global warming mainly caused by plant cultivation and processing, water pollution due to fertilization, emissions to soil due to the use of pesticides in cultivation as well as land use.

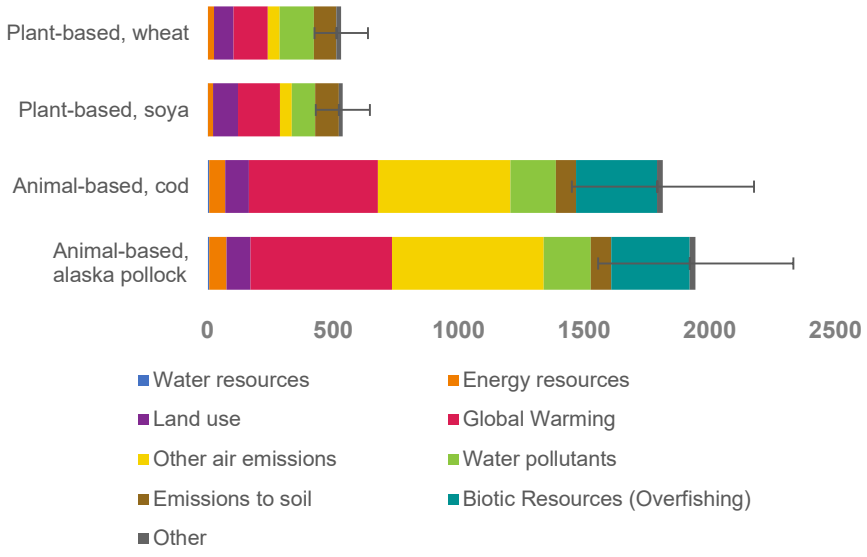

Figure 1. Environmental impact of animal-based and plant-based fish sticks, breaded, deep-frozen, at Swiss stores per 100g in eco-points.

The methodology of the study does not consider ecosystem impacts caused by fishing gear, such as seabed damage and irreversible erosion from bottom trawling[13], or discarded fishing nets remaining in the sea as plastic waste and death traps for marine life. If these were also considered, the environmental impact of the fish sticks would be considerably worse.

Process contribution

Figure 2 shows the environmental impact of each process step, indicating that the highest environmental impact of animal-based sticks stems from the fish and the fishing itself. Over 60% of the environmental impact can be attributed to this primary activity.

The second biggest impact of fish sticks is caused by the production of the other ingredients which are part of the sticks such as eggs. This is closely followed by the third biggest impact, the processing of the product. Compared to the impact of fishing, packaging and transportation are of low relevance.

As for plant-based variants, the impact of the plant, which is the main ingredient, the plant cultivation, other ingredients, and processing are evenly distributed. Here, too, packaging and transport are of little importance.

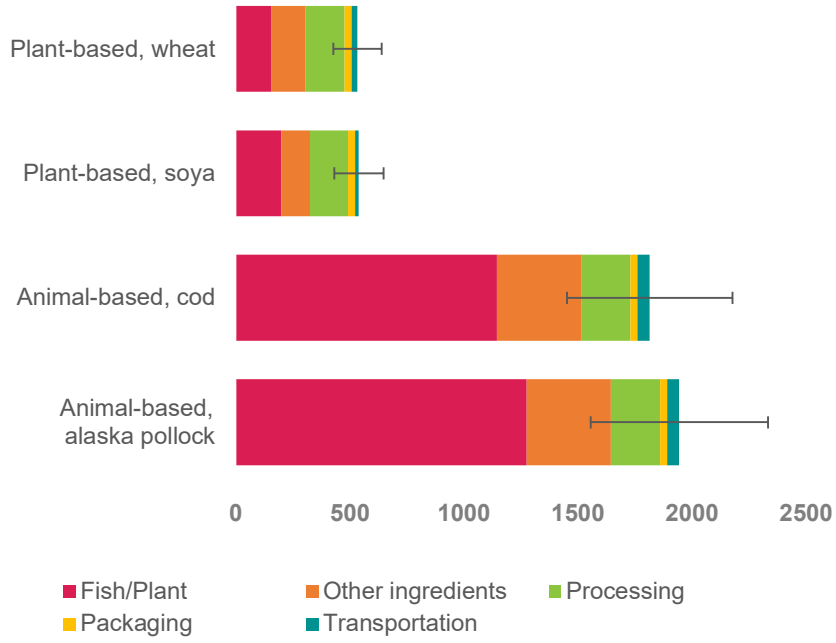

Figure 2. Process contribution to the environmental impact of animal-based and plant-based fish sticks at Swiss stores per 100g in eco-points.

Overfishing for fish sticks

Not too long ago, we viewed the oceans as an inexhaustible resource. But over the past 50 years, the number of overexploited fish stocks worldwide has tripled from 10% to 34%. Some 4 million fishing vessels now ply the oceans, many with increasing capacity and efficiency to catch more fish[4].

Atlantic cod used to be the most common fish species used in fish sticks. But due to overfishing, most Atlantic cod stocks plummeted in the 1990s, some to the point of collapse, and rebuilding efforts have not succeeded so far. Currently, only the Northeast Arctic and Icelandic stocks are in a healthy condition[14].

As an alternative to diminishing cod availability, **Alaska pollock** has become increasingly popular in the last few decades[15]. Nowadays, it is the second most caught fish worldwide, representing 5% of global catches[4] – and the most common fish species used in fish sticks[14]. But catches of Alaska pollock have significantly declined in the last 25 years[4]. While most stocks are currently in a healthy condition, continued stringent management will be necessary to maintain them.

Nutrition

The LCA also assessed the nutritional value of fish sticks and their plant-based counterparts.

Nutrient-rich food (NRF) indexes rank foods based on their nutritional value: The higher the nutrient density, the "more valuable" the food[16]. The well-established Nutrient Rich Food 9.3 (NRF9.3) score[17] is based on 9 nutrients to encourage (protein, fibre, vitamins A, C, E and calcium, iron, potassium, magnesium) and 3 nutrients to limit (saturated fat, added sugar, sodium).

The NRF9.3 value of the average fish-sticks and average plant-based sticks is very similar. Therefore, for the same nutrient value, the environmental impact of animal-based sticks is 3.4 times higher than that of plant-based sticks (see appendix A2).

Fish is often promoted as a valuable source of omega-3 fatty acids. However, fish sticks are hardly an adequate source of these fatty acids, as they are made up of lean fish. To reach the intake of omega-3 recommended by the Swiss Food Safety and Veterinary Office[18], at least 172 g of fish sticks would have to be eaten every day – or an impressive 40 sticks per week[19].

Consumption recommendations

The results of the life cycle assessment clearly show that replacing fish sticks with plant-based sticks is the better choice for the planet. The environmental impact of an animal-based fish stick exceeds that of a plant-based stick many times over.

The wheat- and soy-based sticks are also ecologically preferable when controlled for nutrient density. Consumers in Switzerland are not dependent on fish as a protein source and have access to an abundance of protein- and nutrient rich plant-based products. Making an environmentally conscious choice is therefore becoming easier – in supermarkets, but also at school or in work canteens.

So next time you feel like fish sticks, why not give plant-based sticks a try?

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Appendix

A1 Stick variants available in Swiss stores

animal-based

Product	Brand	Retailer	Label	Frozen	Ingredients	Production	Picture
Fischstäbchen	ALMARE SEAFOOD	Aldi	MSC	Yes	Alaska-Seelachs Filet (Theragra chalcogramma), 65% Panade: Weizenmehl, Sonnenblumenöl, Kartoffelstärke, Wasser, Speisesalz, Hefe, Gewürze (Paprika).	Germany	
Fishsticks MSC	Findus	Coop	MSC	Yes	ALASKA-SEELACHSFILET 65% (THERAGRA CHALCOGRAMMA), Panade: Weizenmehl, Sonnenblumenöl, Wasser, Kartoffelstärke, Kochsalz, Gewürze, Hefe.	Germany	
Fish Sticks MSC	Coop Qualité & Prix	Coop	MSC	Yes	Alaska-Seelachsfilets 65% (Theragra chalcogramma), Panade: Weizenmehl, Rapsöl, Wasser, Kartoffelstärke, Kochsalz, Hefe, Gewürze.	Germany	
Crack-Sticks MSC	Findus	Coop	MSC	Yes	Alaska-Seelachs Filet 57%, Panade (Weizenmehl, Weizenfasern, Stärke, Kochsalz, Glucose, Senfpulver, Hühnereiweisspulver, Pfefferextrakt), Pflanzenöl.	Denmark	
Prix Garantie Fischsticks MSC	Coop Prix Garantie	Coop	MSC	Yes	ALASKA-SEELACHSFILETS (Theragra chalcogramma), 65%, Panade: Weizenmehl, Rapsöl, Wasser, Kartoffelstärke, Kochsalz, Hefe, Gewürze.	Germany	
Bio Fish Sticks	Naturaplan	Coop	Naturaplan, Bio	Yes	PANGASIUSFILETS 65% (Pangasius hypophthalmus). Paanade: WEIZENMEHL, Wasser, Sonnenblumenöl, WEIZENSTÄRKE, Meersalz, Paprika, Kochsalz, Hefe. Alle landwirtschaftlichen Zutaten stammen aus biologischer Produktion.	Sweden	
Fisch-Sticks paniert	Findus	Migros	MSC	Yes	Alaska-Seelachs-Filet (Theragra chalcogramma) 65%, Panade (Weizenmehl, Wasser, Stärke, Salz, Gewürze) 27%, Sojaöl, Kochsalz.	n/a	
Fischstäbchen Atlantischer Dorsch	Pelican	Migros	MSC	Yes	Dorsch (Gadus morhua morhua) 66 %, Panade: Weizenmehl, Rapsöl, Weizenstärke, Wasser, Kochsalz, Kurkumawurzel gemahlen, Paprika, Hefe.	n/a	
Fischstäbchen	M-Budget	Migros	MSC	Yes	Alaska-Seelachs-Püree (Theragra chalcogramma), 65%, Panade: Weizenmehl, Sonnenblumenöl, Wasser, Kartoffelstärke, Kochsalz, Hefe, Paprikapulver	n/a	
Fisch Stäbchen	Alnatura	Migros	Bio	Yes	Seelachsfilet (Pollachius virens) 65%, Panade: Weizenmehl*, Wasser, Sonnenblumenöl*, Weizenstärke*, Speisesalz, Hefe* (*aus biologischer Landwirtschaft 28% der Zutaten stammen aus biologischer Landwirtschaft)	n/a	

plant-based

Product	Brand	Retailer	Label	Frozen	Ingredients	Production	Picture
Vegane Knusperstäbchen	Just Veg!	Aldi	Vegan	No	Trinkwasser, Sojaproteinkonzentrat 17%, Weizenmehl, Rapsöl, Kartoffelstärke, Aromen, Meersalz, Leinsamenöl, Maismehl, Leinsamenmehl, Gewürze, Dextrose, Speisesalz, Hefe, Verdickungsmittel (Methylcellulose)	n/a	
Vivera Vissticks wie Fischstäbchen (Vegane knusprige Stäbchen Meeres-Art)	Vivera	Coop, mrvegan.ch	Vegan	No	59% rehydriertes WEIZENEIWEISS, WEIZENMEHL, Sonnenblumenöl, Salz, Verdickungsmittel [Methylcellulose], natürliche Aromen, WEIZENSTÄRKE, Kräuter und Gewürze, Leinöl, Kartoffelfasern, Maltodextrin, Maisstärke, Eisen-[II] Gluconat, Vitamin B12.	Holland	
Yolo Vish Sticks	Yolo	Coop		Yes	Wasser, SOJAPROTEINKONZENTRAT texturiert 16%, Getreidemehle (WEIZEN, Mais), Rapsöl, Kartoffelstärke, Aroma, Meersalz, Leinsamenöl, Verdickungsmittel (E 461), Gewürze, Kochsalz, Hefe, Glucose, Leinsamenmehl.	n/a	
Sea Style Sticks	V-Love	Migros	Vegan	No	Wasser, Brotkrümel (Weizenmehl, Hefe, Kochsalz, Paprikapulver), Sojabohnen 17%, Nasspanade (Wasser, Weizenmehl), Sonnenblumenöl, Verdickungsmittel: Calciumchlorid, Natriumalginat und Methylcellulose, Kartoffelstärke, natürliches Aroma, Tafelessig.	France	
Plant based Stick	V-Love	Migros	Vegan	Yes	Wasser, Brotkrümel 20% (Weizenmehl 96%, Hefe, Kochsalz, Paprikapulver), Sojabohnen 17%, Panade (Wasser, Weizenmehl), Verdickungsmittel: Calciumchlorid, Natriumalginat und Methylcellulose, Sonnenblumenöl, Kartoffelstärke, natürliches Aroma, Kräuter.	Holland	
Schlemmerstäbchen Meeresart	Cornatur	Migros	Vegan	No	Wasser, SOJABOHNEN 20%, Verdickungsmittel (Calciumchlorid, Natriumalginat und Methylcellulose), Sonnenblumenöl, WEIZENSTÄRKE, natürliches Aroma, Dextrose, Kochsalz, Vitamine (Vitamin B2 und Vitamin B12), Farbstoff: E 172, Kurkuma.	Holland	
Käpt'n Tofus Knusperstäbchen	Viana	mrvegan.ch	Bio	No	Tofu* (25%), Möhren*, Vollkornreis*, Sonnenblumenkerne*, Haferflocken*, Weizenpaniermehl* (6%), Sonnenblumenöl*, Sojasauce (Trinkwasser, Sojabohnen*, Weizen*), Meersalz, Lauch*, Gewürze*	n/a	

A2 Nutrient profile NRF9.3

The NRF9.3 algorithm developed by Adam Drewnowski (2009) is the unweighted sum of percentage daily values (DVs) for 9 nutrients to encourage (protein, fibre, vitamins A, C, E and calcium, iron, potassium, magnesium), minus the sum of percentage maximum recommended values (MRVs) for 3 nutrients to limit (saturated fat, added sugar, sodium), calculated per reference amount and capped at 100% DV.

The NRF9.3 values of the average fish-sticks and plant-based sticks are very similar:

NRF9.3 per 100 g of sticks	**Animal-based sticks, average**	**Plant-based sticks, average**
Nutrient density (NRF9.3)	22.1	21.5
Impact (eco-points)	1'878	535
Impact per equal Nutrient density	1'878	549
Impact per equal Nutrient density normalized to animal based sticks	100%	29%

When comparing the ecological impact of animal-based fish sticks and plant-based sticks per equal nutritional value, plant-based sticks also perform significantly better under these criteria than their animal counterpart.

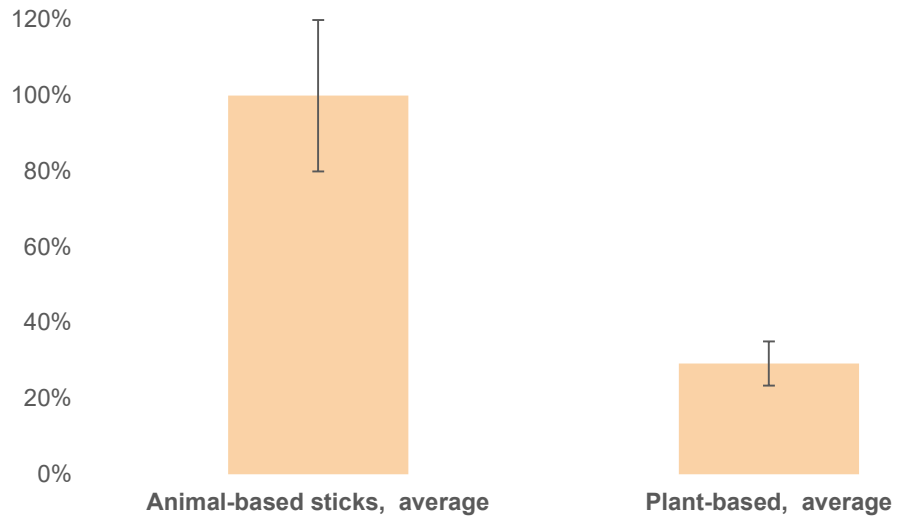

Figure 3: Environmental impact per equal nutrient density normalized to animal-based sticks.

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