

Safety of algal meal from *Haematococcus pluvialis* containing astaxanthin as a novel food pursuant to Regulation (EU) 2015/2283

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The declarations of interest of all scientific experts active in EFSA's work are available at <https://open.efsa.europa.eu/experts>.

Abstract

Following a request from the European Commission, the EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA) was asked to deliver an opinion on the safety of the Novel Food (NF) 'algal meal from *Haematococcus* (*H.*) *pluvialis* containing astaxanthin (ATX)' pursuant to Regulation (EU) 2015/2283. The NF is produced by homogenising, crushing and spray-drying of the biomass of cultivated *H. pluvialis* and contains approximately 5% w/w ATX. It has been marketed in food supplements (FS) since the 90s. With the present dossier, the applicant seeks authorisation as a NF for its use in dairy analogues, including beverage whiteners and fruit juices as defined by Directive 2001/112/EC. The NF has been already assessed by the Panel in 2014. The applicant performed an intake assessment for ATX, which covered combined exposure from the background diet with the consumption of fish and crustacea plus intakes of the NF from the intended new uses. In such a scenario, the exposure for all population groups is below or at the acceptable daily intake (ADI) of 0.2 mg/kg bw per day. When adding also potential intake of ATX from FS, for children of 3 years of age and older and adolescents, the combined exposure from all three sources exceeds the ADI. For adults, the combined estimated intake is at the level of the ADI. The Panel concludes that the NF is safe at the intended new uses (dairy analogues, including beverage whiteners and fruit juices), provided that FS containing ATX are not consumed on the same day by children and adolescents.

KEY WORDS

astaxanthin, dairy analogues, food supplements, fruit juices, *Haematococcus pluvialis*, microalgae, novel foods

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1 | INTRODUCTION

1.1 | Background and Terms of Reference as provided by the requestor

On 25 March 2021, the company “AstaReal AB” submitted a request to the European Commission in accordance with Article 10 of Regulation (EU) 2015/2283¹ to authorise the placing on the market of algal meal and oleoresin of *Haematococcus (H.) pluvialis* containing astaxanthin (ATX) as a novel food (NF).

The applicant requests to authorise the use of algal meal and oleoresin of *H. pluvialis* containing ATX in a number of foods including dairy analogues, unflavoured milk pasteurised, unflavoured and flavoured fermented milk, fruit juices and fruit and vegetables nectars as defined in Directive 2001/112/EC,² intended only for adults. Pursuant to Article 5 (6) of Commission Implementing Regulation (EU) 2017/2469, which states that “where it cannot be excluded that a NF intended for a particular group of the population would be also consumed by other groups of the population the safety data provided shall also cover those groups”, EFSA is requested to assess the safety for all age groups within the general population.

The applicant has requested data protection under Article 26 of Regulation (EU) 2015/2283.

In accordance with Article 10(3) of Regulation (EU) 2015/2283, the European Commission asks the European Food Safety Authority to provide a scientific opinion on the safety of Algal meal and oleoresin of *H. pluvialis* containing ATX as a NF.

In its opinion on algal meal and oleoresin of *H. pluvialis* containing astaxanthin, the European Food Safety Authority should also document whether and to what extent the requirements of Article 26(2)(c) of Regulation (EU) 2015/2283 are fulfilled regarding the data for which the applicant is requesting data protection.

1.2 | Additional information

The first authorisation of ATX containing the dried biomass from *Haematococcus pluvialis* in the EU in food supplements (FS) was granted in Sweden in 1995, with a maximum intake level of 8 mg/day. This was before the cut-off date of 15 May 1997 when the first EU NF Regulation (EC) No 258/1997 came into effect. That application was made by the company AstaReal AB (formerly named ‘Astacarotene AB’), who is also the applicant of the present application and concerned an ATX containing powder of *H. pluvialis* biomass. Subsequently, several notifications of ATX containing ingredients produced from this microalga were notified to the Commission pursuant to Article 5 of former Regulation (EC) No 258/1997 for their use in FS based on substantial equivalence to the authorisation granted in 1995 (European Commission, 2018). These authorisations as NFs included an ATX containing oleoresin obtained by supercritical carbon dioxide extraction from the microalgal biomass produced by AstaReal AB, which received a favourable opinion from the Swedish National Food Administration and was approved in 2006.

In 2014, the EFSA NDA Panel³ assessed the safety of three formulations obtained from the cultivated microalga *H. pluvialis* from the same applicant: (1) an algal powder with a specification range of 5.0%–5.6% w/w ATX, (2) a red viscous oleoresin with a specification range of 10%–12% w/w ATX, and (3) a water-dispersible formulation containing 2.5%–2.7% w/w ATX under Regulation (EC) No 258/1997. The Panel considered that the production process and the composition of these three formulations were sufficiently described and that they, and the proposed specifications, did not raise safety concerns. The intended uses were for fermented liquid dairy products, non-fermented liquid dairy products, fermented soya products and fruit drinks. When considering the acceptable daily intake (ADI) of 0.034 mg/kg bw per day, established by the FEEDAP Panel in its 2014 opinion on ATX as a feed additive,⁴ the NDA Panel concluded that the intake of ATX from these uses would exceed that ADI at least two-fold. Consequently, the Panel concluded that the safety of ATX for these proposed uses and use levels could not be established. As a result of that unfavourable Opinion, the use of the ATX containing algal meal and oleoresin from *H. pluvialis* remained restricted to FS.

Under Commission Implementing Regulation (EU) 2017/2470⁵ establishing the initial Union list of NF in accordance with Regulation (EU) 2015/2283, ‘ATX-rich oleoresin from *H. pluvialis* algae’ was authorised in FS at levels of up to 40–80 mg/day, which correspond to a maximum authorised level of 8 mg ATX per day. Because this authorised maximum use level of 8 mg/day of ATX in FS exceeded the ADI established by EFSA and because food business operators (FBOs) who have been placing ATX on the market claimed that there was a substantial body of evidence on the safety of ATX, the European Commission (EC) in 2018 tasked EFSA to evaluate whether the safety of ATX used as a NF in FS at maximum levels of 8 mg/day was in accordance with the requirements of Regulation (EU) 2015/2283.⁶ In 2019, the FEEDAP Panel adopted an opinion on the safety and efficacy of synthetic ATX-DMDS (dimethyldisuccinate) (EFSA FEEDAP Panel, 2019), a colouring feed

¹Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods, amending Regulation (EU) No 1169/2011 of the European Parliament and of the Council and repealing Regulation (EC) No 258/97 of the European Parliament and of the Council and Commission Regulation (EC) No 1852/2001 (OJ L 327, 11.12.2015, pp. 1–22).

²Council Directive 2001/112/EC of 20 December 2001 relating to fruit juices and certain similar products intended for human consumption (OJ L 10, 12.1.2002, pp. 58–66).

³EFSA Journal 2014; 12(7):3757. <https://www.efsa.europa.eu/it/efsajournal/pub/3757>.

⁴EFSA Journal 2014; 12(6):3274. <https://www.efsa.europa.eu/it/efsajournal/pub/3724>.

⁵<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017R2470&from=EN>.

⁶<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32015R2283&from=EN>.

additive, for salmonids, crustaceans and other fish. This Opinion addressed the renewal of the authorisation of ATX-DMDS⁷ (aimed at demonstrating that the additive remains safe for the target species, consumer, user⁸ and environment) and the new use of the additive for crustaceans and other fish than salmonids. The FEEDAP Panel confirmed that ATX was neither mutagenic nor carcinogenic. The FEEDAP Panel repealed the ADI of 0.034 mg/kg bw from 2014 and established a new ADI of 0.2 mg ATX/kg bw per day by applying an uncertainty factor of 200 to a lowest observed adverse effect level (LOAEL) of 40 mg/kg bw per day for the increased incidence of multinucleated hepatocytes observed in a 2-year carcinogenicity study in rats. In that Opinion from 2019, the FEEDAP Panel also updated their consumer exposure assessment for ATX residues in fish (including consumption of salmon and trout) and crustaceans, following the methodology described in the Guidance on the safety of feed additives for consumers (EFSA FEEDAP Panel, 2017).

In 2020, the EFSA NDA Panel considered that the updated ADI of 0.2 mg/kg bw derived by the FEEDAP Panel in 2019, was also applicable to ATX from *H. pluvialis* and addressed the safety of the use of 8 mg ATX per day in FS, taking into account also the updated exposure estimate of the FEEDAP Panel for ATX coming from the consumption of fish and crustacea (EFSA NDA Panel, 2020). The NDA Panel concluded that an intake of 8 mg ATX per day from FS is safe for adults even in combination with the high exposure estimate to ATX from the background diet; however, adolescents at 14 to < 18 years of age could reach the ADI in such a combined exposure scenario and children below 14 years of age would exceed the ADI.

Commission Implementing Regulation (EU) 2021/1377 amended Commission Implementing Regulation (EU) 2017/2470 by imposing a labelling requirement for the NF when used in FS. The labelling must indicate that FS containing the NF should not be consumed by children younger than 14 years of age. According to that legislation, the maximum daily intake of ATX from the NF added to FS should not exceed 8 mg. Commission Implementing Regulation (EU) 2023/1581⁹ authorised the use of the NF in FS also for children of 3 to 10 years of age at a daily maximum intake of up to 2.3 mg ATX, up to 5.7 mg per day for children between 10 and 14 years of age and maintained the authorisation of a daily maximum intake of 8 mg ATX with FS for individuals older than 14 years. The labelling of FS containing 'ATX-rich oleoresin from *H. pluvialis* algae' shall also bear a statement that they should not be consumed by infants and young children under 3 years of age'. Furthermore, the legislation also introduced a labelling requirement stating that the NF should not be consumed on a day, when other ATX containing FS are consumed that day.

In 2023, the EFSA NDA Panel assessed the proposed change of the specifications for the NF ATX-rich oleoresin from *H. pluvialis* algae which increased the maximum specification limit for 9-*cis*-ATX and for ATX diesters. As a result, these specification changes were authorised by Commission Implementing Regulation (EU) 2024/1026.

2 | DATA AND METHODOLOGIES

2.1 | Data

The safety assessment of this NF is based on data supplied in the application and information submitted by the applicant following EFSA requests for supplementary information including a request from the EFSA cross-cutting Working Group on Nanotechnologies (now WG Particle Risk Assessment).

Administrative and scientific requirements for NF applications referred to in Article 10 of Regulation (EU) 2015/2283 are listed in Commission Implementing Regulation (EU) 2017/2469.¹⁰

A common and structured format on the presentation of NF applications is described in the EFSA guidance on the preparation and presentation of a NF application (EFSA NDA Panel, 2016). As indicated in this guidance, it is the duty of the applicant to provide all of the available (proprietary, confidential and published) scientific data, (including both data in favour and not in favour) that are pertinent to the safety of the NF.

This NF application includes a request for protection of proprietary data in accordance with Article 26 of Regulation (EU) 2015/2283. The data requested by the applicant to be protected comprise: Annex 33 (a 2D cell culture model with primary hepatocytes from rat, mouse and human performed in 2019) and Annex 34 (Transcriptomic analysis of gene expression changes after ATX exposure in 2D cultures of rat and human primary hepatocytes performed in 2020).

2.2 | Methodologies

The assessment follows the methodology set out in the EFSA guidance on NF applications (EFSA NDA Panel, 2016) and the principles described in the relevant existing guidance documents from the EFSA Scientific Committee. The legal provisions for the assessment are laid down in Article 11 of Regulation (EU) 2015/2283 and in Article 7 of Commission Implementing Regulation (EU) 2017/2469.

⁷Commission Regulation (EC) No 393/2008 of 30 April 2008 concerning the authorisation of astaxanthin dimethyldisuccinate as a feed additive. OJ L 117, 1.5.2008, p. 20.

⁸'Users' are defined as the persons who may be exposed to the additive while handling it, when incorporating it into premixtures or feeding stuffs or using a feeding stuff supplemented with the additive. <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2012.2539>.

⁹<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32023R1581>.

¹⁰Commission Implementing Regulation (EU) 2017/2469 of 20 December 2017 laying down administrative and scientific requirements for applications referred to in Article 10 of Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. OJ L 351, 30.12.2017, pp. 64–71

This assessment concerns only the risks that might be associated with the consumption of the NF under the proposed conditions of use and is not an assessment of the efficacy of the NF regarding any claimed benefit.

3 | ASSESSMENT

3.1 | Introduction

The application and mandate concern two NFs:

1. an algal powder (containing approximately 5.0%–5.6% w/w ATX) from the crushed and spray-dried biomass of cultivated *H. pluvialis*. In EFSA's Opinion from 2014 it was called 'AstaREAL A1010' (EFSA NDA Panel, 2014). This product has a history of use in FS in the EU since 1995 and is therefore not a NF when used in FS. It falls, however, under the NF category (x) i.e. food used exclusively in FS within the Union before 15 May 1997, where it is intended to be used in foods other than FS as defined in point (a) of Article 2 of Directive 2002/46/EC. It may also fall under category (ii) i.e. food consisting of, isolated from or produced from microorganisms, fungi or algae according to article 3 of the NF Regulation (EU) 2015/2283; and
2. a red viscous oleoresin (containing 10.0%–11.1% w/w ATX) obtained by supercritical CO₂ extraction of the homogenised and spray-dried biomass of cultivated *H. pluvialis*. In EFSA's Opinion from 2014 it was called 'AstaREAL L10 (oil)' (EFSA NDA Panel, 2014) and hereafter also called '10% ATX oleoresin'. This product was authorised under Article 5 ('substantial equivalence') of the former NF Regulation (EC) No 258/1997. According to Article 3 of the existing NF Regulation (EU) 2015/2283, it falls under category (ii) food consisting of, isolated from or produced from microorganisms, fungi or algae.

The applicant has provided also information on a third formulation, i.e. a water-dispersible formulation (containing 2.5%–2.7% w/w ATX), which is produced from (2), i.e. the '10% ATX oleoresin' by adding ascorbyl palmitate, dl- α -tocopherol and modified maize starch (at 73.5% of the final mixture) followed by intensive stirring. In EFSA's Opinion from 2014 that formulation was called 'AstaREAL L10, (modified starch) encapsulated oil' (EFSA NDA Panel, 2014). Since this formulation is prepared by mixing (2) with non-novel ingredients, which are not essential to ensure the safety or stability of the ATX oleoresin, this formulation is not considered as a separate NF, but its safety is covered by the safety assessment of (2), i.e. the oleoresin including the available toxicological data for ATX.

Subject of this application is the applicant's proposal for new uses, i.e. dairy analogues, including beverage whiteners (e.g. fermented soya products) and fruit juices as defined by Directive 2001/112/EC.

The present Opinion is limited to the safety assessment of the algal meal (biomass) containing 5.0–5.6 w/w% ATX. The safety of the oleoresin containing 10.0%–11.1% w/w ATX for the same intended uses is assessed in a separate Opinion.

This opinion focuses on new data which were not available for the EFSA NDA Panel in 2014.

3.2 | Identity

The 5.0%–5.6% w/w ATX containing algal meal is the homogenised, crushed, pasteurised and spray-dried biomass obtained from cultivated *H. pluvialis*, a microalga naturally containing the carotenoid ATX. Astaxanthin, 3,3'-dihydroxy- β,β -carotene-4,4'-dione, has a molecular weight of 596.85 Da. Its Chemical Abstracts Service (CAS) number is 472-61-7. *H. pluvialis* is member of the phylum *Chlorophyta*, class *Chlorophyceae*, order *Volvocales* and family *Haematococcaceae*, is a ubiquitous green alga found in fresh and brackish waters. Upon environmental stress such as drying in rock pools and nutrient limitation, the individual algal cells accumulate lipids and ATX to protect against oxidation and turn into dark-red highly resistant aplanospores with thick cell walls.

3.3 | Production process

According to the applicant, only two minor changes have been applied in the production process as compared to the application assessed by the EFSA NDA Panel in 2014. These two changes concern the use of a naturally sourced vitamin E (instead of a synthetic one) and the pasteurisation step which is now applied right after crushing and before spray-drying (while previously the pasteurisation was employed after spray-drying). These small changes were already considered by the EFSA NDA Panel (2023) when assessing the safety of the applicant's request to change the specifications of the NF.

The applicant noted that after the previous EFSA assessment from 2014, the applicant passed the audit of a Food Safety System Certification 22000.

Noting the addition of silica (E 551) before the spray-drying, EFSA requested the applicant to address potential formation of silicon dioxide nanoparticles coated with ATX by applying the EFSA Guidance on technical requirements for regulated food and feed product applications to establish the presence of small particles including nanoparticles (EFSA, 2021). In response, the applicant performed a transmission electron microscopy energy-dispersive X-ray spectroscopy (TEM-EDX) analysis. Although the applicant's analyses did not allow to entirely rule out the presence of coated material, the Panel

notes that the provided evidence does not confirm the formation of ATX-coated silica nanoparticles and considers that the concerns regarding nanoparticles were sufficiently addressed by the applicant

3.4 | Compositional data

In 2014 the EFSA NDA Panel did not raise concern with regards to the composition of the NF. The Panel notes that since then, only minor changes, noted in Section 3.3, have been applied in the processing of biomass from the cultivated microalgae (EFSA NDA Panel, 2023).

For the present application, the applicant provided comprehensive compositional information on five batches of the NF produced in 2019–2020. That information includes proximate analytes, carotenoids, the fatty acid- and amino acid profile, minerals as well as contaminants including heavy metals (As, Pb, Cd, Hg), aflatoxins (B1, B2, G1, G2), polycyclic aromatic carbohydrates (PAHs) and dioxin-like polychlorinated biphenyls (PCBs), polychlorinated dibenzo-paradioxins (PCDDs), microcystins (LR, RR, YR, LA, LF, LW, LY), nodularine, pheophorbides, pesticides and microbiological parameters (aerobic plate count, *Escherichia coli*, coliforms, *Enterobacteriaceae*, coagulase-positive *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens*, spore-forming aerobic mesophilic count, anaerobic beta-haemolytic spores, *Salmonella*, yeasts, moulds).

Noting the previous assessments by the Panel, the description of the compositional information of these five batches from 2019 and 2020 is therefore limited the proximate analytes (Table 1), carotenoids (Tables 2 and 3) and microbiological parameters (Table 4).

TABLE 1 Batch to batch analysis of proximate analytes of the NF.

Parameter	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Method/reference
Fat [g/100 g]	43.6	45.5	47.2	43.8	47.4	NMKL 160 mod.
Protein [g/100 g]	9.3	8.4	7.9	8.9	8.4	NMKL 6
Carbohydrates [g/100 g]	34.1	33.0	31.0	30.7	31.1	Calculated (EU(No)1169/2011)
Total sugar [g/100 g]	2.6	2.2	2.1	2.5	2.3	Sum of individual sugars employing AOAC 982.14, mod
Dietary fibre ¹¹ [g/100 g]	9.1	10.0	9.5	12.3	9.0	AOAC 991.43 mod.
Ash [g/100 g]	2.9	2.1	3.0	3.1	2.7	NMKL 173
Moisture [g/100 g]	1.0	1.0	1.4	1.2	1.5	NMKL23

Abbreviations: AOAC, Association of Official Analytical Collaboration; NMKL, Nordic-Baltic Committee on Food Analysis.

TABLE 2 Batch to batch analysis of carotenoids expressed in % of the NF.

Carotenoid (% of the NF)	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Total carotenoids	5.39	5.43	5.13	5.16	5.35
Total ATX	5.26	5.29	5.04	5.04	5.24
<i>Trans</i> -ATX	3.78	3.94	3.86	3.78	3.94
9- <i>cis</i> -ATX	1.29	1.19	1.0	1.1	1.14
13- <i>cis</i> -ATX	0.19	0.16	0.18	0.16	0.16
Beta-carotene	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lutein	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Canthaxanthin	0.01	0.01	0.01	0.01	0.01

Upon EFSA's request to analyse also the concentration of ATX present in mono- and diesters, the applicant provided analyses for additional five batches which included these parameters (Table 3).

¹¹In the context of this opinion, EFSA's definition of dietary fibre (i.e. non-digestible carbohydrates plus lignin; EFSA NDA Panel, 2010) does not reflect the additional requirement of having a beneficial physiological effect demonstrated by generally accepted scientific evidence laid down in Annex I of Regulation (EC) 1169/2011 for: (a) edible carbohydrate polymers which have been obtained from food raw material by physical, enzymatic or chemical means and, (b) edible synthetic carbohydrate polymers. It is out of the scope of this opinion to establish whether the fraction of non-digestible carbohydrates present in the NF meets the legal definition of dietary fibre in the EU or not.

TABLE 3 Batch to batch analysis of carotenoids expressed in % of the NF including analyses of ATX-mono- and -diesters and presenting these esters, 9-*cis*- and 13-*cis*-ATX also in % of total ATX (in brackets).

Carotenoid % of the NF	Batch 6	Batch 7	Batch 8	Batch 9	Batch 10
Total carotenoids	5.23	5.32	5.10	5.16	5.39
Total ATX	5.14	5.25	5.04	5.09	5.27
Trans-ATX	3.92	4.13	3.87	3.83	4.13
9- <i>cis</i> -ATX	1.0 (19.8)*	0.9 (17.9)	1.0 (19.6)	1.1 (20.9)	0.9 (17.6)
13- <i>cis</i> -ATX	0.21 (4.1)	0.18 (3.4)	0.18 (3.5)	0.18 (3.5)	0.22 (4.2)
ATX monoesters	3.96 (77.1)	4.12 (78.6)	3.97 (78.8)	4.04 (79.4)	4.00 (75.8)
ATX diesters	1.15 (22.3)	1.09 (20.7)	1.03 (20.4)	1.02 (20.0)	1.25 (17.6)
Beta-carotene	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lutein	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Canthaxanthin	0.01	0.01	0.01	0.01	0.01

*All values in brackets () of the table represent the concentration (%) of total ATX.

The safety of an increase of 9-*cis*-ATX at the expense of 13-*cis*-ATX has been assessed by the Panel in 2023 (EFSA NDA Panel, 2023), when the applicant asked for authorisation for an increase of the maximum specification limit for 9-*cis*-ATX for ATX containing oleoresin.

TABLE 4 Batch to batch analysis of microbiological parameters of the NF.

Microbiological parameter	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Methods
Aerobic plate count 30°C cfu/g	< 100	< 100	< 100	< 100	< 100	NMKL 86
<i>Escherichia coli</i> cfu/g	ND	ND	ND	ND	ND	ISO 7251
Coliforms 37°C cfu/g	< 10	< 10	< 10	< 10	< 10	NMKL 44
Coliforms 44°C cfu/g	< 1	< 1	< 1	< 1	< 1	NMKL 125
Enterobacteriaceae 37°C cfu/g	< 10	< 10	< 10	< 10	< 10	NMKL 144
Coagulase positive	ND	ND	ND	ND	ND	NMKL 66-M
<i>Staphylococcus</i> cfu/g						
Bacillus cereus cfu/g	< 10	< 10	< 10	< 10	< 10	NMKL 67
Spore-forming	< 10	< 10	< 10	< 10	< 10	NMKL 95
<i>Clostridium perfringens</i>						
Salmonella/25 g	ND	ND	ND	ND	ND	NMKL 71
Yeasts cfu/g	< 10	< 10	< 10	< 10	< 1	NMKL 98
Moulds cfu/g	< 10	< 10	< 10	< 10	20	NMKL 98

Abbreviations: cfu, colony forming units; ISO, International Organization for Standardization; ND, not detected; NMKL, Nordic-Baltic Committee on Food Analysis.

The analyses for ATX and other carotenoids were performed by the laboratory of the applicant, which is not accredited. The applicant notes that there is no official analytical method in EU for astaxanthin, at least not for the esterified form of ATX. The applicant provided detailed information on the in-house HPLC method with spectrophotometric detection at a wavelength of 474 nm; for total carotenoid analysis, spectrophotometry was used.

3.4.1 | Stability

In 2014, the Panel considered that the data provided sufficient information with respect to the stability of both NFs, the algal powder and the oleoresin, in various food matrices (EFSA NDA Panel, 2014). The stability studies were carried out with a 5% ATX algal powder (named 'AstaREAL A1010' in the Opinion of 2014) or a 2.5% ATX containing water-dispersible formulation made from the NF (named 'AstaREAL L10, (modified starch) encapsulated oil' in the 2014 Opinion). They lasted for 6 to 9 weeks at the temperature of +5°C (for cow milk yoghurt and drinks, and soy drinks), and for ultra-high temperature (UHT)-processed and pasteurised products (e.g. UHT-processed milk drink, pasteurised fruit drink) at +23°C. Astaxanthin content was measured by HPLC and a maximum 10% reduction was detected.

Because of the two small changes of the production process noted in the section production process (concerning the source of vitamin E and the pasteurisation), the applicant performed an accelerated stability testing (40°C/75% RH with the 5% ATX algal powder stored in low-density polyethylene (LDPE) sachets or aluminium sachets) and compared the stability with the product produced with the prior-production process. After 400 days, no relevant difference to the prior-production

process (with synthetic vitamin E) was observed. Also, no relevant difference of the stability at the accelerated conditions after 30 days was noted for the 5% ATX algal powder after introducing the pasteurisation change.

The Panel affirms that the data provided are sufficient with respect to the stability of the NF.

3.5 | Specifications

The proposed specifications consider the same parameters which have been authorised by (Commission Implementing Regulation (EU) 2024/1026) for the NF ‘Astaxanthin-rich oleoresin from *H. pluvialis* algae’ (Table 5):

TABLE 5 Proposed specifications.

Parameter	Specification limits
Fat (%)	40–50
Protein (%)	7–10
Carbohydrates (%)	30–40
Fibre (%)	8–13
Ash (%)	1.0–3.4
Specification of carotenoids %w/w	
Total astaxanthin	5.0–5.6
9- <i>cis</i> ^a	13–30
13- <i>cis</i> ^a	2–6
ATX monoesters ^b	70–80
ATX diesters ^b	15–28
β-Carotene	< 0.05
Lutein	< 0.05
Canthaxanthin	< 0.05
Microbiological criteria	
Total aerobic bacteria (plate count)	< 10.000 CFU/g
Yeast	< 100 CFU/g
Moulds	< 100 CFU/g
Coliforms	< 1 CFU/g
<i>E. coli</i>	Negative
<i>Salmonella</i>	Negative
<i>Staphylococcus</i>	Negative

Abbreviation: CFU, colony forming units.

^a% of total ATX (covering all ATX isomers; note: all trans-ATX, which is not among specification parameters, is the predominant isomer with more than 60% of total ATX. Thus, the sum of 9-*cis* and 13-*cis* is below 40%).

^b% of total ATX (covering all esterified and free ATX, only small quantities of free ATX are present in the NF).

3.6 | Proposed uses and use levels and anticipated intake

3.6.1 | Target population

The target population proposed by the applicant is the general population.

3.6.2 | Proposed uses and use levels

The applicant performed an intake assessment of the anticipated daily intake of the NF based on their proposed uses and maximum proposed use levels, using the EFSA FAIM tool which is a tool for estimating chronic dietary exposure to food additives.¹² The FAIM tool is based on individual data from the EFSA Comprehensive European Food Consumption Database (EFSA, 2011). The lowest and highest means and 95th percentiles (P95) anticipated daily intake of the NF (on a mg/kg bw basis), among the EU dietary surveys, are presented in Table 6. The highest P95 ATX intake per kg bw from the NF at the intended new uses, was estimated for children aged between 3 and < 10 years at 0.074 mg, which represents 37% of the ADI

¹²<https://www.efsa.europa.eu/it/applications/food-improvement-agents/tools>.

of 0.2 mg/kg per day. The highest mean intake was estimated for children between 1 and <3 years of age at 0.06 mg/kg per day which corresponds to 30% of the ADI.

TABLE 6 ATX intake estimate resulting from the use of the NF as an ingredient in the intended food categories at the maximum proposed use levels expressed as mg/kg bw per day.

Population group	Age (years)	Mean intake (mg/kg bw per day)		P95 intake (mg/kg bw per day)	
		Lowest ^a	Highest ^a	Lowest ^b	Highest ^b
Infants	< 1	0.000	0.009	0.000	0.041
Young children	1 to < 3	0.003	0.060	0.000	0.062
Other children	3 to < 10	0.001	0.030	0.001	0.074
Adolescents	10 to < 18	0.002	0.013	0.000	0.046
Adults ^c	≥ 18	0.000	0.008	0.000	0.033

Abbreviations: bw, body weight; FAIM, Food Additives Intake Model; the FAIM tool exposure estimate was generated on 29/3/2025.
^aThe lowest and the highest mean observed among covered EU surveys are reported in these columns.
^bThe lowest and the highest P95 observed among covered EU surveys are reported in these columns (P95 based on < 60 individuals are not considered).
^cIncludes elderly, very elderly, pregnant and lactating women.

3.6.3 | Combined intake from the NF and other sources (if applicable, otherwise delete)

Table 7 presents combined total exposure estimates for ATX from the background diet, from FS containing ATX, plus the estimates presented in Table 6 for the intended new uses of the NF (presented in Table 4).

For the exposure to ATX from the background diet, the applicant referred to and used the exposure assessment for ATX consumed as residues in fish (salmon and trout) and crustaceans performed by EFSA FEEDAP Panel (2019) and as applied by EFSA NDA Panel (2020).

For the exposure to ATX from FS, the Panel considered maximum daily ATX intake levels authorised for the NF ‘ATX-rich oleoresin from *H. pluvialis* algae’ in accordance with Commission Implementing Regulation (EU) 2017/2470,¹³ which corresponds to a maximum daily intake of 2.3 mg ATX for children between 3 and < 10 years of age, 5.7 mg for adolescents aged 10–< 14 years and 8 mg for individuals 14 years of age and older (Commission Implementing Regulation (EU) 2024/1026). When considering the default mean body weight (2nd column of Table 7) as recommended by the EFSA Scientific Committee (2012), the maximum authorised ATX intake from FS per kg bw intake can be calculated (6th column of Table 7).

TABLE 7 Combined intake estimates resulting from the uses of the NF as an ingredient and as a FS.

Population group (years of age)	Default mean body weight ^a (kg)	Highest P95 exposure estimate from background diet (mg/kg bw per day) ^b	Highest P95 intake ^c from the NF at the intended new uses (mg/kg bw per day)	Combined exposure from the background diet + highest P95 from new intended uses (mg/kg bw per day)	Maximum authorised ATX intake from FS (mg/kg bw per day) ^d	Total intake (mg/kg bw per day)
Infants < 1	5	0.053	0.041	0.094	Not authorised	0.094
Toddlers 1 to < 3	12	0.146	0.062	0.208	Not authorised	0.208
Other children 3 to < 10	23	0.101	0.074	0.175	0.100	0.275
Adolescents 10 to < 14	43	0.071	0.046	0.117	0.133	0.250
Adolescents 14 to < 18	61				0.131	0.248
Adults ≥ 18 ^e	70	0.060	0.033	0.093	0.114	0.207

^aDefault and average body weights as suggested by the EFSA Scientific Committee (2012).
^bATX exposure from consumption of fish and crustaceans (EFSA FEEDAP Panel, 2019).
^cIntakes are assessed for all EU dietary surveys available in the food comprehensive database. The highest P95 observed among all surveys is reported in this column (P95 calculated based on less than 60 individuals are not considered).
^dThe maximum ATX intake per day from FS authorised for children (3 to < 10 years): 2.3 mg; adolescents (10 to < 14 years): 5.7 mg; adolescents (> 14 years): 8 mg; divided by the default average body weight indicated in the 2nd column.
^eIntakes are assessed separately for adults (18 to < 65 years), elderly (65 to < 75 years) and very elderly (≥ 75 years); the maximum intake among these three sub-populations is reported here under ‘adults’.

¹³<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017R2470&from=EN>.

When combining the highest P95 estimate for the background intake of ATX from the consumption of fish and crustacea and the highest P95 intake estimate among the covered European countries for the intended new uses of the NF in dairy analogues and fruit juices, the resulting combined ATX exposure estimates for the population groups is below the ADI of 0.2 mg/kg bw per day except for toddlers. For that age group, the combined estimate is at the level of the ADI.

When adding also potential intake of ATX from FS in children 3 years of age and older, the combined exposure from all three sources (background intake, intended new uses in dairy analogues and fruit juices, and FS), exceeds their ADI. For adults, the combined estimated intake is at the level of the ADI.

3.7 | Nutritional information

Noting the composition of the NF as presented in Tables 1–3, and the proposed maximum use levels of the NF (i.e. approximately 15 mg NF per 100 g or 100 mL dairy analogues and 5 mg NF per 100 mL fruit juices as defined by Directive 2001/112/EC), the Panel considers that the NF is nutritionally not disadvantageous.

3.8 | Toxicological information

The NF has been toxicologically assessed in 2014 (EFSA NDA Panel, 2014). The toxicological data set included three genotoxicity studies under Good Laboratory Practice (GLP), i.e. a bacterial reverse mutation assay following OECD Test Guidance (TG) 471, an in vitro mammalian cell gene mutation test following OECD TG 476, an in vivo mammalian erythrocyte micronucleus test following OECD 474 and subchronic toxicity study in rats following OECD TG 408 and performed under GLP. In that Opinion the Panel considered that the NF was not genotoxic and that there is no indication that the NF would be more toxic than ATX and for that reason the ADI for ATX should apply when determining safe intake levels for the NF.

The toxicity of ATX, both synthetic and of biological origin has been extensively assessed by EFSA (2004, 2006, 2007a, 2007b; EFSA FEEDAP Panel, 2010, 2014a, 2014b, 2019, 2022; EFSA NDA Panel, 2014, 2020, 2023). The Panel notes the ADI of 0.2 mg/kg bw established by EFSA (EFSA FEED Panel, 2019; EFSA NDA Panel, 2020).

3.9 | Allergenicity

In 2014, the Panel concluded that the likelihood of allergic reactions to the NF was low. For the current application, the applicant submitted a 2021 literature review on the allergenicity of *H. pluvialis* and ATX, in which no studies or case reports indicating possible allergenicity were identified.

4 | DISCUSSION

The NF concerns an algal meal which contains 5.0%–5.6% ATX and which is obtained from homogenised, crushed, pasteurised and spray-dried biomass of cultivated *H. pluvialis*, a microalga naturally containing the carotenoid pigment ATX. The ATX containing biomass from *H. pluvialis* produced by the applicant was placed on the EU market in 1995 for FS. Since this was before the cut-off date of 15 May 1997 when the first EU NF Regulation (EC) No 258/1997 came into effect, it is not a NF when used in FS, but it is a NF for the new uses proposed by the applicant, i.e. for dairy analogues, including beverage whiteners, and fruit juices at proposed maximum use levels of 0.75 and 0.25 mg ATX per 100 g or mL, respectively.

The exposure assessment for ATX covers combined exposure from the background diet with the consumption of fish and crustacea plus intakes of the NF from the intended new uses. In such a scenario the exposure for all population groups is below or at the ADI of 0.2 mg/kg bw per day.

When adding also potential intake of ATX from FS, for children of 3 years of age and older and adolescents, the combined exposure from all three sources exceeds the ADI. For adults, the combined estimated intake is at the level of the ADI.

5 | CONCLUSIONS

The Panel concludes that the NF is safe at the intended new uses (dairy analogues, including beverage whiteners and fruit juices), provided that FS containing ATX are not consumed on the same day by children and adolescents.

5.1 | Protection of proprietary data in accordance with Article 26 of Regulation (EU) 2015/2283

The Panel could have reached the conclusion on the safety of the NF under the proposed conditions of use without the data claimed as proprietary by the applicant (Annex 33: a 2D cell culture model with primary hepatocytes from rat, mouse

and human performed in 2019; and Annex 34, transcriptomic analysis of gene expression changes after ATX exposure in 2D cultures of rat and human primary hepatocytes performed in 2020).

ABBREVIATIONS

ADI	acceptable daily intake
ATX	astaxanthin
bw	body weight
CAS	Chemical Abstracts Service
CFU	colony forming units
CoA	Certificate of Analysis
DMDS	dimethyldisuccinate
FAIM	Food additive intake model
FEEDAP	EFSA Panel on Additives and Products or Substances used in Animal Feed
FS	Food supplements
GLP	Good Laboratory Practice
HPLC	High Performance Liquid Chromatography
ISO	International Organization for Standardization
LOAEL	lowest observed adverse effect level
NDA	EFSA Panel on Nutrition, Novel Foods and Food Allergens
NF	Novel food
NMKL	Nordic-Baltic Committee on Food Analysis
OECD	Organisation for Economic Co-Operation and Development
P95	95th percentile
w/w	weight per weight

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REQUESTOR

European Commission

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REFERENCES

- EFSA (European Food Safety Authority). (2004). Scientific Opinion on environmental impact of astaxanthin-rich *Phaffia rhodozyma* (Ecotone®) as feed additive in accordance with Council Directive 70/524/EEC. *EFSA Journal*, 2(4), 43. <https://doi.org/10.2903/j.efsa.2004.43>
- EFSA (European Food Safety Authority). (2006). Scientific Opinion on a request from the European Commission on the safety and efficacy of the product AQUASTA, an Astaxanthin-rich *Phaffia rhodozyma* ATCC SD-5340 for salmon and trout. *EFSA Journal*, 4(2), 320. <https://doi.org/10.2903/j.efsa.2006.320>
- EFSA (European Food Safety Authority). (2007a). Scientific Opinion on the safety and efficacy of CAROPHYLL® Stay-Pink (astaxanthin dimethylsuccinate) as feed additive for salmon and trout. *EFSA Journal*, 5(11), 574. <https://doi.org/10.2903/j.efsa.2007.574>
- EFSA (European Food Safety Authority). (2007b). Scientific Opinion on the safety and efficacy of Panaferd-AX (red carotenoid-rich bacterium *Paracoccus carotinifaciens*) as feed additive for salmon and trout. *EFSA Journal*, 5(10), 546. <https://doi.org/10.2903/j.efsa.2007.546>
- EFSA (European Food Safety Authority). (2011). Use of the EFSA comprehensive European food consumption database in exposure assessment. *EFSA Journal*, 9(3), 2097. <https://doi.org/10.2903/j.efsa.2011.2097>
- EFSA (European Food Safety Authority). (2021). Administrative guidance for the preparation of applications on novel foods pursuant to Article 10 of Regulation (EU) 2015/2283. *EFSA Supporting Publications*, 18(3), EN-6488. <https://doi.org/10.2903/sp.efsa.2021.EN-6488>
- EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). (2010). Scientific Opinion on modification of the terms of authorisation of a red carotenoid-rich bacterium *Paracoccus carotinifaciens* (Panaferd-AX) as feed additive for salmon and trout. *EFSA Journal*, 8(1), 1428. <https://doi.org/10.2903/j.efsa.2010.1428>
- EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). (2014a). Scientific Opinion on the safety and efficacy of astaxanthin (CAROPHYLL® Pink 10% CWS) for salmonids and ornamental fish. *EFSA Journal*, 12(6), 3725. <https://doi.org/10.2903/j.efsa.2014.3725>
- EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). (2014b). Scientific Opinion on the safety and efficacy of synthetic astaxanthin as feed additive for salmon and trout, other fish, ornamental fish, crustaceans and ornamental birds. *EFSA Journal*, 12(6), 3724. <https://doi.org/10.2903/j.efsa.2014.3724>

- EFSA FEEDAP Panel (EFSA Panel on Products or Substances used in Animal Feed). (2017). Guidance on the assessment of the safety of feed additives for the consumer. *EFSA Journal*, 15(10), 5022. <https://doi.org/10.2903/j.efsa.2017.5022>
- EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). (2019). Scientific Opinion on the safety and efficacy of astaxanthin-dimethylsuccinate (Carophyll Stay-Pink 10%CWS) for salmonids, crustaceans and other fish. *EFSA Journal*, 17(12), 5920. <https://doi.org/10.2903/j.efsa.2019.5920>
- EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). (2022). Scientific opinion on the safety and efficacy of a feed additive consisting of astaxanthin-rich *Phaffia rhodozyma* for salmon and trout (Igene Biotechnology, Inc.). *EFSA Journal*, 20(2), 7161. <https://doi.org/10.2903/j.efsa.2022.7161>
- EFSA NDA Panel (EFSA Panel on Nutrition, Novel Foods and Food Allergens). (2023). Safety of a change in specifications of the novel food oleoresin from *Haematococcus pluvialis* containing astaxanthin pursuant to Regulation (EU) 2015/2283. *EFSA Journal*, 21(11), 8338. <https://doi.org/10.2903/j.efsa.2023.8338>
- EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies). (2014). Scientific Opinion on the safety of ATX-rich ingredients (AstaREAL A1010 and AstaREAL L10) as novel food ingredients. European Food Safety Authority (EFSA) panel on dietetic products, nutrition and allergies (NDA). *EFSA Journal*, 12(7), 3757. <https://doi.org/10.2903/j.efsa.2014.3757>
- EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies). (2016). Guidance on the preparation and presentation of an application for authorisation of a novel food in the context of Regulation (EU) 2015/2283. *EFSA Journal*, 2016(11), 4594. <https://doi.org/10.2903/j.efsa.2016.4594>
- EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies). (2020). Scientific opinion on the safety of astaxanthin for its use as a novel food in food supplements. *EFSA Journal*, 18(2), 5993. <https://doi.org/10.2903/j.efsa.2020.5993>
- EFSA Scientific Committee. (2012). Guidance on selected default values to be used by the EFSA Scientific Committee, Scientific Panels and Units in the absence of actual measured data. *EFSA Journal*, 10(3), 2579. <https://doi.org/10.2903/j.efsa.2012.2579>
- European Commission. (2018). Notifications pursuant to article 5 of Regulation (EC) No 258/97 of the European Parliament and of the council. https://food.ec.europa.eu/system/files/2018-06/novel-food_notifications_en.pdf

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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ANNEX A

Estimates of dietary exposure to the Novel Food for each population group from each EU dietary survey

Information provided in this Annex is shown in an Excel file (downloadable at <https://efsa.onlinelibrary.wiley.com/doi/full/10.2903/j.efsa.2025.9636>).