Application for approval of Moringa Oleifera as a food in Australia and New Zealand

Application to Food Standards Australia & New Zealand (FSANZ)

January 2024

Noosa Organica Pty Ltd | January 2024 | Version 1.0

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Executive Summary

The purpose of this application is to amend Schedule 25-2 to clause 3 (a) of the Australia New Zealand Food Standards Code (the Code) Standard 1.5.1 Novel Foods, to permit the introduction of Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil as a food in Australia and New Zealand. Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil are intended to be used a nutritional food source.

The world is moving backwards in its efforts to end hunger, food insecurity and malnutrition. The current global recessionary environment makes it even more challenging for our governments to seek new and innovative ways to positively transform our agrifood systems. In contrast to this however, there are still many opportunities that exist for our governments and our communities alike to rethink how we can reduce the cost of nutritious foods and increase the availability, affordability and sustainability of healthy whole foods.

One such opportunity is the subject of this application. Moringa (species *Moringa Oleifera* Lamarck) belongs to the Moringaceae family and is a fast-growing, deciduous, sub-tropical tree that has wide application as a food. Of particular interest to this application are the high protein light green leaves, immature green pods and seed oil of the Moringa Oleifera tree which are all edible.

Internationally, Moringa Oleifera is considered a 'super food' and is in high demand with the European market recently valued at US$903 million per annum with a forecast market size to reach US$1.9 billion by 2027. Predicted growth in other markets such as the USA offers similar opportunities. In Australia, estimates suggest that the potential size of the Moringa Oleifera industry could reach $2-5 million by 2030.

Although Moringa Oleifera has been recognised as a food in other jurisdictions for many years and is freely available to purchase here in Australia in our major food retail stores, it remains classified under Standard 1.5.1 of the Code as a non-traditional and novel food in Australia and New Zealand. Accordingly, this application seeks to amend the Code to permit the introduction of Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil as a food in Australia and New Zealand. The proposed amendment will bring Australia and New Zealand into line with other jurisdictions that have approved the use of Moringa Oleifera as a food.

The proposed change is to benefit the Australian and New Zealand Moringa Oleifera industry. There is no exclusive capturable commercial benefit claimed in this application. There are several organisations that are already active in this industry and it is anticipated that when the proposed change is approved, many more organisations will look to produce Moringa Oleifera and its product range in Australia and New Zealand.

1.0 General Requirements (s3.1.1)

As per section 3.1.1 of the Application Handbook[1].

A. Form of application

A.1. Language

This application is written in English.

A.2. Format

This application:

- contains a Table of Contents;
- contains an Executive Summary in a separate electronic file;
- clearly identifies the relevant guidelines relating to each section of information; and
- is numbered sequentially on each page.

A.3. Copies

This application has been submitted electronically as an attachment to an email.

This application includes the full electronic copies of all references referred to in the application.

This application is searchable by word and phrase.

B. Applicant details

Applicant details

(a) Applicant name: [redacted]

(a) Organisation name: Noosa Organica Pty Ltd (hereafter Noosa Organica) ABN: 53 648 198 556

(b) Contact name: [redacted]

(c) Street address: 35 Reservoir Road, Stalworth QLD 4613

(c) Postal address PO Box 77, Proston QLD 4613

(d) Telephone (mobile): [redacted]

(e) Email: [redacted]

(f) Nature of business: Noosa Organica is an Australian primary producer.

(g) Details of other parties associated with the application:

[1] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. Section 3.1.1, 49-57. Canberra: FSANZ.

The following scientific and regulatory consultants have been associated with the preparation, submission and stewardship of this application:

[redacted]

Horticulture & Irrigated Agriculture

Primary Industries Development

Department of Primary Industries and Regional Development

444 Albany Highway, Albany WA 6330

[redacted] | w dpird.wa.gov.au

C. Purpose and scope of the application

The purpose of this application is to amend Schedule 25-2 to clause 3 (a) of the Australia New Zealand Food Standards Code (hereafter the Code) Standard 1.5.1 Novel Foods, to permit the introduction of Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil as a food in Australia and New Zealand[2]. Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil are intended to be used a nutritional food source similar to the use of, for example, broccoli.

In scope for this application

The scope of this application is explicitly constrained to:

1. Moringa Oleifera leaf (fresh and dried);
2. Moringa Oleifera immature (green) pods; and
3. Moringa Oleifera seed oil.

In the categories of:

1. plants or animals and their components;
2. dietary macro-components; and
3. as a food ingredient derived from new sources.

Out of scope of this application

This application does not intend to seek amendment of the Code to introduce, market or support Moringa Oleifera for use in the following terms (and these are therefore out of scope of this application):

- use of the flower, bark or root of the Moringa Oleifera plant as a novel food;
- as a plant extract;
- as a herb (both non-culinary and culinary) including extracts;

[2] Food Standards Australia New Zealand (FSANZ). (2016). Australia New Zealand Food Standards Code – Standard 1.5.1-3 Novel Foods - Schedule 25 – Permitted novel foods. Canberra: FSANZ. https://www.legislation.gov.au/Details/F2023C00185 ;accessed 16/02/2023.

- as a microorganism (including probiotics);
- as a food produced by a process not previously applied to food;
- to support medicinal or health claims associated with potential beneficial physiological or health-related effects;
- any other Moringa species, for example Moringa Concanensis or Moringa Stenopetala.

D. Justification for the application

The need for the proposed change

It is an unfortunate and disturbing fact that the world is moving backwards in its efforts to end hunger, food insecurity and malnutrition (Food and Agriculture Organisation (FAO) of the UN et al, 2022:xvi). The current global recessionary environment makes it even more challenging for our governments to seek new and innovative ways to positively transform our agrifood systems. In contrast to this however, there are still many opportunities that exist for our governments and our communities alike to rethink how we can reduce the cost of nutritious foods and increase the availability, affordability and sustainability of healthy whole foods.

One such opportunity is the subject of this application. Moringa (species *Moringa Oleifera* Lamarck) belongs to the Moringaceae family and is a fast-growing, deciduous, sub-tropical tree that has wide application as a food. Of particular interest to this application are the high protein light green leaves, immature (green) pods and seed oil of the Moringa Oleifera tree which are all edible (Reynolds & Robinson, 2022:5; Núñez-Gastélum et al., 2022:2).

Internationally, Moringa Oleifera is considered a 'super food' and is in high demand with the European market recently valued at US$903 million per annum with a forecast market size to reach US$1.9 billion by 2027. Predicted growth in other markets such as the USA offers similar opportunities. In Australia, estimates suggest that the potential size of the Moringa Oleifera industry could reach $2-5 million by 2030 (Reynolds & Robinson, 2022:12).

The nutritional benefits of Moringa Oleifera have been well understood by Australians for many years, however the industry is yet to firmly establish itself commercially (Reynolds & Robinson, 2022:18). One reason for this is the current classification of Moringa Oleifera as a non-traditional and novel food by Food Standards Australia New Zealand (FSANZ). Until Moringa Oleifera is recognised as a bona fide food product by FSANZ, it cannot be sold legally as a food in our domestic market or in lucrative international markets (Reynolds & Robinson, 2022:18)[3]. Yet, even with this restriction in place, our major food retailers have responded to the significant consumer demand for Moringa Oleifera products in Australia. The examples below are all available from retail providers such as Woolworths, Coles and Forest Super Foods, as shown in Figure 1 below[4].

[3] Food Standards Australia New Zealand (FSANZ). (Jun, 2022). Regulation of novel foods. "A novel food cannot be a food for retail sale or an ingredient in a food for retail sale unless it is listed in the table to section S25—2 (sale of novel foods) of the Code.". Canberra: FSANZ. https://www.foodstandards.gov.au/industry/novel/Pages/default.aspx ;accessed 16/02/2023.

[4] Woolworths. (2023). *Nutra nourished organic moringa leaf*. https://www.woolworths.com.au/shop/productdetails/1073909162/nutra-nourished-organic-moringa-leaf-supplement-australian-grown-for-improved-immune-system-60-vegan-caps; accessed 16/02/2023. Woolworths. (2023). *Cornsnax*. https://www.woolworths.com.au/shop/productdetails/803671/moringa-malunggay-cornsnax-hot-spicy; accessed 16/02/23. ; accessed 16/02/2023. Coles.

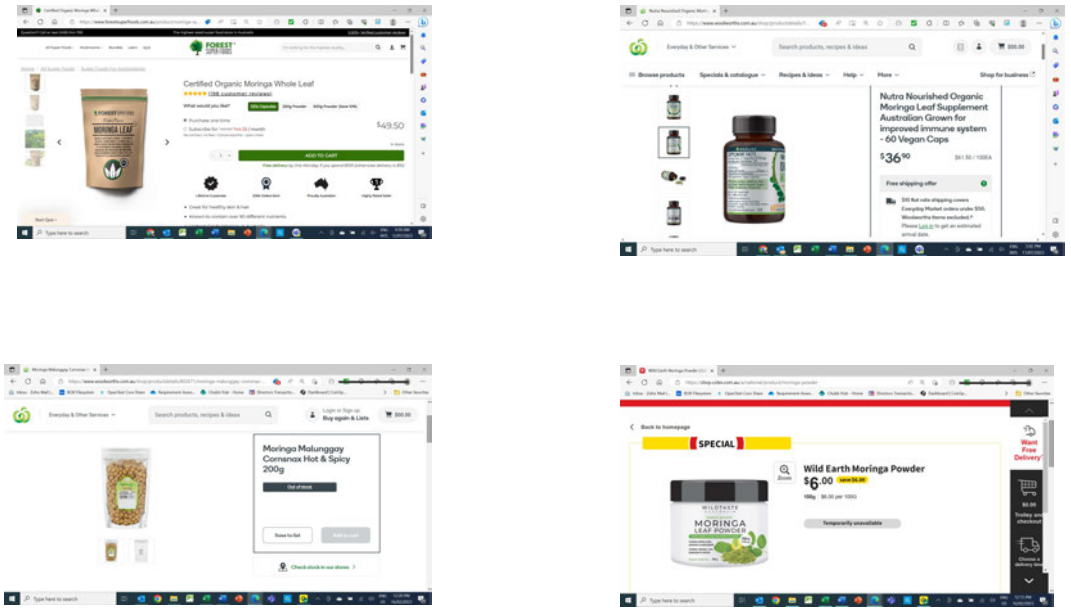


Figure 1 – Examples of Moringa Oleifera availability in Australian retail food stores

The time for change is now

Although Moringa Oleifera has been recognised as a food in other jurisdictions for many years and is freely available to purchase here in Australia in our major food retail stores, it remains classified under Standard 1.5.1 of the Code as a non-traditional and novel food in Australia and New Zealand. This has been confirmed by the Advisory Committee on Novel Foods (ACNF) on multiple occasions for the two Moringa Oleifera food or food ingredient variants (leaf and powdered mix of seed, leaf and fruit (immature/mature pod) in 2009, 2012, 2014, 2015 and 2020[5].

Accordingly, this application seeks to amend Schedule 25-2 to clause 3 (a) of the Code to permit the introduction of Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil as a food in Australia and New Zealand. The proposed amendment will bring Australia and New Zealand into line with other jurisdictions that have approved the use of Moringa Oleifera as a food or novel food.

Advantages of the proposed change

The proposed change brings with it many advantages for the Australian and New Zealand food industries, including (Reynolds & Robinson, 2022:12-20):

(2023). *Moringa Powder*. https://shop.coles.com.au/a/national/product/moringa-powder ; accessed 16/02/2023. Forest Super Foods (2023) Certified Organic Moringa Whole Leaf Certified Organic Moringa Whole Leaf – Forest Super Foods; accessed 12/07/23.

[5] Food Standards Australia New Zealand (FSANZ). (Feb, 2023). 'Record of views formed in response to inquiries. Updated November 2022.', *Food Standards Australia New Zealand*. Online publication. p. 34, https://www.foodstandards.gov.au/industry/novel/novelrecs/Pages/default.aspx.

- Establishing Moringa Oleifera as a legal, safe, nutritious food to be enjoyed as a part of a heathy diet;
- Providing the consumer with a wider range of affordable, sustainable, properly regulated and labelled choices;
- Removing a key barrier to entry and enabling Australian and New Zealand agriculture to build a sustainable and profitable Moringa Oleifera industry to meet the global demand for the product;
- Aligning Australian and New Zealand regulations with those of our international counterparts, reducing the potential for regulatory trade barriers;
- Increasing the value of the Australian and New Zealand Moringa Oleifera industry as a whole, in terms of:
    - Increased market size and revenue, both domestic and international;
    - Increased number of industry participants;
    - Improved opportunities for export;
    - Increased revenue from new product food lines (leaves, fresh green pods and seed oil);
    - Improved education and community awareness;
    - Legal and widespread adoption by mainstream food retailers such as Woolworths and Coles;
    - Mainstream adoption across industry sectors such as food wholesaling/retailing, agriculture and manufacturing;
    - Potential for establishing a Moringa Oleifera growers association, industry body and conferences.

In addition, Moringa benefits our unique ecosystems in the following ways:

- Planting Moringa Oleifera removes carbon dioxide from the air, produces oxygen, holds moisture in the soil, provides erosion control, and reforests the land;
- Moringa Oleifera is considered an excellent source of protein for ruminant and monogastric animals.

Disadvantages of the proposed change

The advantages of the proposed change far outweigh the perceived disadvantages. However, for the sake of completeness, the following disadvantages are noted (Reynolds & Robinson, 2022:20):

- National industry standards (or a certification scheme) for Moringa Oleifera do not exist in Australia at this time;
- Australian and New Zealand producers must remain competitive in the new environment. Consumers will seek the best Moringa Oleifera product/s in terms of clean-and-green product, quality, availability and sustainability.

General Issues with the proposed change

(a) any public health and safety issues related to the proposed change including details of target groups and population groups that may be adversely affected.

This question is addressed below in Section E.2 of this application.

The data indicates that Moringa Oleifera poses no public health and safety issues to consumers at the levels of use proposed. Indeed, with reference to Figure 1 above, there is evidence to suggest that Moringa Oleifera products are already being sold and consumed in Australia, despite the food standard restriction imposed.

The Applicant considers there is a substantial body of evidence to support the safe use of Moringa Oleifera. On the basis of the available toxicology data, nutritional evaluations and appropriate food-grade specifications, it is concluded that Moringa Oleifera does not present a significant risk for human health at the intake which would result from its intended uses as a nutritious novel food.

(b) any consumer choice issues related to the proposed change.

No issues have been identified. With the approval of Moringa Oleifera for consumption as a novel food comes regulation, improved labelling, improved source of origin information and improved availability and quality due to increased competition from Australian and New Zealand producers.

(c) any evidence that the food industry generally or other specific companies have an interest in, or support, the proposed change.

Several projects in Australia have either been completed or are currently underway, covering a range of potential applications and/or production systems for Moringa Oleifera (Reynolds & Robinson, 2022:22-24). There are several Australian organisations that are developing Australian grown Moringa Oleifera, including:

- Ainsley Agroforestry & Aquaponics Pty Ltd, Geraldton, WA
- ALPS EcoScience Pty Ltd, Brisbane, Queensland
- Ella Estates Pty Ltd, Melbourne, Victoria
- Moringa Health & Beauty (moringafarmaustralia.com.au), Cairns, Queensland
- Savannah Sun Foods, Palm Cove, Queensland
- Western Australian Department of Primary Industries and Regional Development
- Noosa Organica Pty Ltd, South Burnett, Queensland

D.1. Regulatory impact information

D.1.1 Cost and benefits of the application

For Consumers, the costs and benefits of the application are:

- Moringa Oleifera leaves have a desirable ‘asparagus-like’ taste and are nutritionally balanced, rich in amino acids, vitamins, minerals and fatty acids (Monteiro, 2022:1);
- Moringa Oleifera leaf is one of the richest sources of natural iron and calcium and is a good source of protein (Trigo et al., 2020:2);
- Known as ‘‘mama’s tree” in South Asia and the ex-patriate community in Australia, the tender, immature pods, when chopped or cooked, can be used in many dishes. When the pod is ripe, it turns brown and may contain 10 to 12 seeds (Núñez-Gastélum et al., 2022:2);
- The oil extracted from the seed (known as ‘ben oil’ due to the behenic acid content) is particularly valuable, high in oleic acid (70%) and can be used as an alternative to olive oil (Leone et al., 2016);

- Moringa Oleifera presents as a sustainable, plant-based nutritional food that will be made in Australia (clean, green and Australian made[6]) to our high standards of quality;
- Moringa Oleifera will be a competitively priced, regulated, nutritional food alternative available in mainstream food retailers such as Woolworths and Coles.

For Industry, the costs and benefits of the application are (Reynolds & Robinson, 2022:12-20):

- New functional, low barrier-to-entry opportunities for Australian and New Zealand Moringa Oleifera food industries including the production of leaf, pods and seed oil;
- Increasing the value of the Australian and New Zealand Moringa Oleifera industries in terms of market size, revenue and number of industry participants;
- Removing a key barrier to entry and enabling Australian and New Zealand producers to build a sustainable and profitable Moringa Oleifera industry to meet the global demand for the product;
- Facilitating improved opportunities for export to large global markets where Moringa Oleifera is already recognised as a food. In these export markets, the strength of Australian and New Zealand produced Moringa Oleifera will be its high-integrity supply chain, and its positioning as a premium segment of the food market as a product with health attributes delivered via its nutritional profile;
- Australian producers can benefit from our 'clean, green' image and differentiate their product as authentic, unique and potent;
- Tapping into a large potential domestic market with an expatriate community that already understands the benefits of Moringa Oleifera;
- Moringa Oleifera is a fast growing, high producing tree species that is very drought tolerant and thus suited to the Australian environment.

In terms of costs, the proposed change imposes no additional costs on the industry or its participants. It is envisaged that the proposed change may in fact benefit industry participants by increasing the options available for production (for example oil extraction) and thus lower the costs of production and the final product.

For Government, the costs and benefits of the application are (Reynolds & Robinson, 2022:12-20):

- Providing regulation and transparency in a growth market;
- Providing supply diversification in the nutritious food sector;
- Aligning Australian and New Zealand regulations with those of our international counterparts, reducing the potential for regulatory trade barriers;
- Creating new, sustainable, taxable revenue streams;
- Providing biodiversity through planting Moringa Oleifera which removes carbon dioxide from the air, produces oxygen, holds moisture in the soil, provides erosion control, and reforests the land;
- Moringa Oleifera is considered an excellent source of protein for ruminant and monogastric animals;

[6] Australian Made Campaign Ltd. (2023). https://australianmade.com.au ; accessed 16/02/2023.

- Moringa is viewed as a distinct opportunity to engage Aboriginal and Torres Strait Islander enterprises, particularly as landowners and managers, due to the multiple products that can be produced from the tree and the associated social benefits, including community building.

In terms of costs, the proposed change is likely to only incur an initial cost to approve Moringa Oleifera as a food and for enforcement agency/s to develop and maintain capability/s to enforce the amended standard.

D.1.2 Impact on international trade

The proposed change will have positive impacts for international trade for Australia and New Zealand, including the following:

- Aligning the applicable Australian and New Zealand regulations with those of international jurisdictions will either reduce or completely remove related regulatory trade barriers;
- Removing a key barrier to entry in Australia and New Zealand will enable domestic producers to meet the demand for the product and facilitate opportunities for export to large global markets where Moringa Oleifera is already recognised as a food including the EU and USA.

Other applications made by the Applicant

The Applicant hereby confirms that no other application/s have been made in any other country regarding the suitability of Moringa Oleifera as a food or novel food.

E. Information to support the application

E.1. Data requirements

To the best of the Applicant's abilities, all information provided in this application has been obtained, described and referenced as prescribed in Section E.1 Data Requirements of the Application Handbook[7]. The application contains sufficient supporting information and data to enable the objectives specified in section 18 of the FSANZ Act to be addressed.

E.1.1 Data related to safety studies

As above in section E1.

E.1.2 Data related to surveys on chemicals or other substances in food

As above in section E1.

E.1.3 Data related to epidemiological/intervention studies in humans

As above in section E1.

[7] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. Section 3.1.1, 53. Canberra: FSANZ.

F. Assessment procedure

In accordance with paragraph 22(2)(e) of the FSANZ Act, the Applicant suggests that this application should be considered according to Subdivision D - General Procedure as described in Part 3, Division 1 of the Act[8].

G. Confidential commercial information (CCI)

Not applicable.

H. Other confidential information

Not applicable.

I. Exclusive Capturable Commercial Benefit (ECCB)

The proposed change made by the Applicant is to benefit the Australian Moringa Oleifera industry. There is no exclusive capturable commercial benefit claimed in this application. There are several organisations that are already active in this industry, as described in Section D above. Further, it is anticipated that when the proposed change is approved, many more organisations will look to produce Moringa Oleifera and its product range in Australia and New Zealand.

J. International and other national standards

J.1. International standards

There is no Codex standard applicable to Moringa Oleifera. However, there is evidence to suggest that the Codex *Standard for Edible Fats and Oils Not Covered By Individual Standards* (CXS 19-1981) may apply to Moringa Oleifera (Ben) oil, derived from the seeds of the Moringa Oleifera tree (Gutiérrez-Luna et al., 2022:1492).

J.2. Other national standards or regulations

J.2.1 United States of America

There is no official approval process or certificate issued by the FDA to approve the sale of any food product or dietary supplement. The ingredients contained in Moringa Oleifera products are Generally Recognized As Safe (GRAS), and obtaining prior approval from the FDA is not required.

The Food and Drug Administration has established stringent regulations, called Good Manufacturing Practices (GMPs) to ensure the safety and manufacturing of foods sold in the United States. Producers of Moringa Oleifera products are required to follow these GMPs to ensure product consistency, purity, and potency.

J.2.2 Canada

Moringa Oleifera (leaf and seed oil) is classified as a standard (non-novel) food in Canada under Division B.28 of the Food and Drug Regulations and is available for use as a food or food ingredient[9]. Moringa Oleifera is also

[8] Food Standards Australia New Zealand Act 1991 (Cth). S25

[9] Government of Canada. (2023) List of non-novel determinations for food and food ingredients. https://www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/requesting-novelty-determination/list-non-novel-determinations.html ;accessed 21/03/2023.

listed in the Natural Health Products Ingredients Database (NHPID) deeming it as an acceptable medicinal and non-medicinal ingredient which may be used in Natural Health Products (NHP)[10].

J.2.3 European Union

The leaves and pods of Moringa Oleifera tree are used as food. Moringa Oleifera was on the market as a standard food or food ingredient and consumed to a significant degree before 15 May 1997. Thus, its access to the EU market is not subject to the Novel Food Regulation (EU) 2015/2283[11]. Moringa Oleifera leaves and pods (which contain the seeds) are the only Moringa Oleifera products that are authorised on the European market[12].

Moringa Oleifera is traded under the HS (Harmonised System) Code 07129090 for other dried vegetables and mixtures of vegetables.

J.2.4 United Kingdom

Any products that contain Moringa Oleifera must comply with the regulations set by the Food Standards Agency (FSA)[13].

J.2.5 China

In 2011, the Ministry of Health of the People's Republic of China issued a notice (Announcement No. 19) to consider Moringa Oleifera leaves as a new food resource[14]. Moringa Oleifera is classified as a new food raw material according to the National Health Commission of China and is consumed as a standard food[15].

J.2.6 Japan

[10] Health Canada. (2023). https://webprod.hc-sc.gc.ca/nhpid-bdipsn/ingredReq.do?id=6295&lang=eng ;accessed 21/03/2023.

[11] Eur-lex.europa.eu. (2015). Regulation (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. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2283&qid=1678843028958 ;accessed 16/02/2023.

[12] CBI Ministry of Foreign Affairs. (Dec, 2022). Entering the European moringa market https://www.cbi.eu/market-information/natural-ingredients-health-products/moringa/market-entry ;accessed 16/02/2023.

[13] Food Standards Agency (FSA) UK (2023). Key regulations. https://www.food.gov.uk/about-us/key-regulations ;accessed 21/03/2023.

[14] Li L, Ma L, Wen Y, Xie J, Yan L, Ji A, Zeng Y, Tian Y and Sheng J. (2022). Crude Polysaccharide Extracted From Moringa oleifera Leaves Prevents Obesity in Association With Modulating Gut Microbiota in High-Fat Diet-Fed Mice. *Front. Nutr*, 9:861588. Page 2. doi: 10.3389/fnut.2022.861588. https://www.frontiersin.org/articles/10.3389/fnut.2022.861588/full ;accessed 24/03/23.

[15] National Health Commission, China (NHC). (2023). http://www.nhc.gov.cn/sps/pztq/201612/712553a5f7554e0e9ec1dfdbcc91e99a.shtml ;accessed 24/03/23.

Moringa Oleifera is known in Japan as Wasabi-no-ki and is consumed as a standard food. An organisation wishing to export Moringa Oleifera to Japan is subject to the regulations of the Plant Protection Act[16] and must provide a valid phytosanitary certificate at the time of customs inspection[17].

J.2.7 Philippines

Locally known as Malunggay, Moringa Oleifera leaves and seed oil are used in the food and nutrition industries in the Philippines. Moringa Oleifera is considered a standard food and in 2007 the Malunggay Development Act was passed to increase productivity and improve the quality of Moringa Oleifera products in the Philippines[18].

K. Statutory Declaration

An original, signed statutory declaration that includes the requisite statements below (as described in the Application Handbook) will be submitted separately to and together with this application[19]:

1. The information provided in this application fully sets out the matters required;
2. The information provided in this application is true to the best of my knowledge and belief; and
3. No information has been withheld that might prejudice this application, to the best of my knowledge and belief.

L. Checklist

The relevant checklists from the Application Handbook are included with this application as follows[20]:

1. Checklist for General Requirements (s3.1.1)
2. Checklist for Novel Foods (s3.5.2)

[16] Plant Protection Act (Act No. 151 of 1950. (2023).https://www.japaneselawtranslation.go.jp/en/laws/view/3916/en ;accessed 24/03/23.

[17] Ministry of Agriculture, Forestry and Fisheries of Japan. (2023). https://www.maff.go.jp/pps/j/introduction/import/ipcfuyou/index.html ;accessed 24/03/23.

[18] Senate of the Philippines. (2007). MALUNGGAY DEVELOPMENT ACT OF 2007. https://legacy.senate.gov.ph/lis/bill_res.aspx?congress=14&q=SBN-1799 ;accessed 24/03/23.

[19] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. SS 3.1.1., 58. Canberra: FSANZ.

[20] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. SS 3.1.1., 58. Canberra: FSANZ.

2.0 Novel Foods (s3.5.2)

As per section 3.5.2 of the Application Handbook[21].

A. Exclusive use

The Applicant does not seek exclusive permission for the novel food in Australia or New Zealand (also refer to Section I. ECCB above).

B. Technical Information on the novel food

The information provided in this application is representative for the Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil products that are to be marketed in Australia and New Zealand. As explicitly stated above in section 3.1.1.C "Purpose and scope of the application" and throughout this application, the substance proposed for registration will be referred to as Moringa, which includes in its scope Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil products. The scope of this application does not extend to any other Moringa species, for example Moringa Concanensis or Moringa Stenopetala.

B.1. Information on the type of novel food

Brief Description of the Novel Food

The subject of this novel food application is the Moringa Oleifera leaf (fresh and dried), immature (green) pod/s and seed oil product. Moringa (species *Moringa Oleifera* Lamarck) belongs to the Brassicales order, Moringaceae family and is also known by other names including the horseradish tree, drumstick tree, miracle tree, benzolive, ben tree, and malunggay (Fahey, 2005:1). Moringa is indigenous to Northern India but is now prevalent and naturalised in tropical and subtropical regions of Africa, Asia, Oceania, Central and South America.

Its multipurpose use as highly nutritional food has led to an increased cultivation and global trade (Grosshagauer et al., 2021:1). Of particular interest to this application are the high protein light green leaves, immature (green) pods and seed oil of the Moringa tree which are all edible (Núñez-Gastélum et al., 2022:2). Moringa Oleifera has seven times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, nine times more protein than yoghurt, 15 times more potassium than bananas, and 25 times more iron than spinach (Rockwood et al., 2013:63).

Moringa leaves show a particularly relevant elemental composition in calcium, potassium and phosphorus plus a protein content that can reach approximately 30% (Monteiro et al., 2022:2). The reported carbohydrate content of Moringa dried leaves has been measured at 41.2 and 38.2 g/100 grams of plant material, while reaching only 8.67 grams in the seeds. Moringa oil is obtained from the seeds, characterized by their high oil content (up to 40%), mainly monounsaturated (oleic acid) (Gutiérrez-Luna, 2022:1490).

No studies have been carried out by the Applicant on the Moringa tree.

[21] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. Section 3.5.2, 103-112. Canberra: FSANZ.

Novel Food Category

The proposed change for the Moringa product falls within the major identified categories of FSANZ[22]:

1. plants or animals and their components;
2. dietary macro-components; and
3. as a food ingredient derived from new sources.

Trade Name of the Novel Food

The name that Moringa will be marketed under by the Applicant is unknown at the time of submitting the Application. However, many trade names exist in the Australian marketplace currently, for example[23]:

- **Moringa Products** organic Moringa leaf;
- **Moringa Health & Beauty** Moringa leaf;
- **Nutra Nourished** organic pure Moringa leaf;
- **Wild Earth** Moringa leaf;
- **Moringa** malunggay cornsnax.

B.2. Information on the purpose of adding a novel food ingredient to food

The purpose of this application is to seek approval for the addition of Moringa to S25-2 of the Code as a food for the following purposes:

1. an alternative to, and at similar levels to, other fresh or dried vegetable sources such as spinach, kale or broccoli;
2. an alternative to, and at similar levels to, other dried food sources such as pea; and
3. an alternative to, and at similar levels to, other food oil sources such as olive oil, sunflower oil or peanut oil.

This Application seeks only the approval of the safety of Moringa as a standard food when used as an alternative nutritious food source and oil. This Application does not seek the use of Moringa to support health claims associated with potential beneficial physiological or health-related effects.

[22] Food Standards Australia New Zealand (FSANZ). (2019). Application Handbook. Section 3.5.2, 104. Canberra: FSANZ.

[23] Moringa Products. (2023). https://moringaproducts.com.au/ ; accessed 24/03/2023. Moringa Shop. (2023). https://moringashop.com.au/ ; accessed 24/03/2023. Moringa Oleifera Australia. (2023). https://www.moringa-oleifera.com.au/ ; accessed 24/03/2023. Nutra Nourished. (2023). https://www.nutranourished.com/ ; accessed 24/03/2023. Woolworths. (2023). *Nutra nourished organic moringa leaf*. https://www.woolworths.com.au/shop/productdetails/1073909162/nutra-nourished-organic-moringa-leaf-supplement-australian-grown-for-improved-immune-system-60-vegan-caps; accessed 16/02/2023. Woolworths. (2023). *Cornsnax*. https://www.woolworths.com.au/shop/productdetails/803671/moringa-malunggay-cornsnax-hot-spicy; accessed 16/02/23. ; accessed 16/02/2023. Coles. (2023). *Moringa*. https://shop.coles.com.au/a/national/product/moringa-powder ; accessed 16/02/2023.

B.3. Information on the physical and chemical properties of the novel food

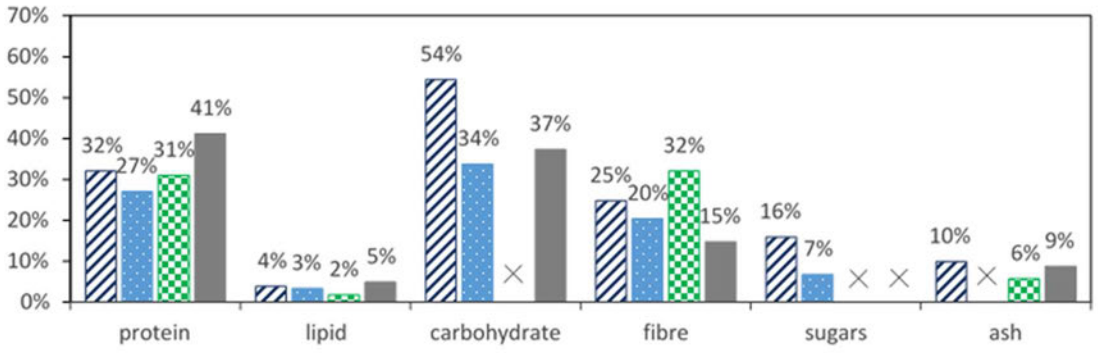
The subject of this application is strictly restricted to the tree species *Moringa Oleifera* Lamarck, family Moringaceae and to the products in scope - leaf (fresh and dried), immature (green) pods and seed oil.

B.3.1 Moringa Oleifera leaf (fresh and dried)

Refer to Tables 1 and 2 below for the nutritional profile and nutritional values of Moringa Oleifera leaves (fresh and dried). Figure 2 illustrates the Nutrient profile analysis undertaken by Stockmann (2018) of dried Moringa Oleifera leaf produced in Western Australia, showing results compared to other dried vegetables.

Sample	Country	Treatment	Protein (%)	Total fat (%)	Fatty acids (% of total FA)	Dietary fiber (%)	Carbo-hydrates (%)
Leaves	Mexico	Oven-dried 60 °C, 8 h	22.4	5.0	SFA 29.9 MUFA 7.2 PUFA 63.2 LA 6.1 ALA 56.9	31.0	27.1

Table 1 - Nutritional profile of Moringa Oleifera dried leaves



*Nutritional composition of broccoli (**dark blue striped pattern**), baby spinach (**light blue with white dotted pattern**), cassava (**green squared pattern**) and moringa (solid grey) leaves. A cross indicates that this data is not reported.*

Figure 2 – Nutrient analysis of Moringa Oleifera leaf compared to broccoli, baby spinach and cassava

NUTRITIONAL VALUE PER 100g fresh, USDA unless specified differently				
CROP	**Moringa leaf fresh**	**Spinach**	**Lettuce iceberg**	**Moringa leaf dry**
Water	78.7	91.4	95.5	
Energy kcal	64	23	17	205
Carbohydrates g	8	3.63	3.37	38
Dietry Fibre g	2	2.2	1.2	11
Sugars g		0.42	1.97	
Fat g	1.4	0.39	0.07	
Protein g	9.4	0.12	0.74	36
Vitamins				
A µg	378	469	500	16.3
B1 mg	0.26	0.078		2.64
B2 mg	0.66	0.189		20.5
B3 mg	2.22	0.724	0.218	8.2
B5 mg	0.16	0.065		
B6 mg	1.2	0.195	0.04	
B9 µg				
C mg	51.7	28.1		17.3
E		2.03	0.18	113
K µg		483		
Minerals				
Ca mg	185	99	14	2003
Cu mg	0.12	0.13	0.033	0.57
Iron mg	16	2.71	0.03	28.2
K µg	337	558	139	1324
Mg mg	42	79	6.3	368
Mn mg	5.8	0.877	0.082	5.8
Na mg	173	79	16	173
P mg	204	49	19	204
S				870
Se µg	0.9	1		0.9
Zn mg	3.06	0.33	0.17	3.06
Amino acids				
Tryptophan g	0.144	39	0.009	0.43
Threonine g	0.411	0.122	0.025	1.19
Isoleucine g	0.451	0.147	0.018	0.83
Leucine g	0.791	0.233	0.025	1.95
Lysine g	0.537	0.174	0.024	1.32
Methionine g	0.123	0.053	0.005	0.35
Cystine g	0.14	0.03	0.005	
Phenylalanine g	0.487	0.129	0.023	1.39
Tyrosine g	0.347	0.108	0.007	
Valine g	0.611	0.761	0.024	1.06
Arginine g	0.532	0.162	0.015	
Histidine g	0.196	0.064	0.009	0.61
Alanine g	0.705	0.142	0.025	
Aspartic acid g	0.92	0.24	0.125	
Glutamic acid g	1.04	0.343	0.194	
Glycine g	0.517	0.134	0.015	
Proline g	0.451	0.112	0.01	0.61
Serine g	0.414	0.104	0.025	

Table 2 – Nutritional values of Moringa Oleifera fresh and dried leaves[24]

[24] USDA Food Data Central (2023) https://fdc.nal.usda.gov/fdc-app.html#/food-details/168416/nutrients ; accessed 12/07/23.

Moringa Oleifera leaves also have relatively high Mg and Se concentrations with average concentrations of 0.5% and 363 mg/kg on a dry weight basis. The elemental composition analysis for Moringa Oleifera leaf is provided in Table 3 below (Monteiro, J et al., 2022).

Plant organ	Ca*	Cu	S*	Fe	P*	Mn	K*	Zn	Mg
Leaf[1]	2.1b ± 0.11	7.4a±0.4	0.8b ± 0.02	137a±13.0	0.2b ± 0.02	64b ± 7.1	1.1b ± 0.04	27a ±4.3	257b ± 15.9
Leaf[2]	2.7a±0.17	7.7a±0.3	1.1a ±0.02	142a ±6.40	0.4a ±0.03	96a ±5.1	1.4a ±0.08	32a ±1.9	522a±10.2

* Mean values are expressed in %//Kg ± standard deviation (Ca, S, P and K) and mg/Kg ± standard deviation (Cu, Fe, Mn e Zn). Leaf[1] = August 2018 sampling; Leaf[2] = November 2019 sampling; Mean values not followed by a common letter are significantly different at the 0.05 significance level.

Table 3 - Elemental composition of Moringa Oleifera leaves

The study by Monteiro, J et al., demonstrated that soluble sugars were found in Moringa Oleifera (refer to Table 4 below - Monteiro, J et al., 2022:5).

	Leaves
Sucrose	3.3 ± 0.6b
Glucose	1.2 ± 0.4b
Frutose	
Arabinose	2.4 ± 1.1
Mannitol	5.0 ± 1.3
Total	12.0 ± 0.7b

Table 4 - Soluble sugar content (mg g-1 DW) of Moringa Oleifera leaves. Total soluble sugars correspond to the sum of individual ones. Results are mean +/- SE (n = 3)

In their vitamin analysis, Borges Teixeira et al. revealed a mean beta-carotene content of 161µg/g and a mean lutein content of 47µg/g lyophilized leaf in Moringa Oleifera (Grosshagauer, S. et al., 2021:4). The results are shown in Table 5 below (Grosshagauer, S. et al., 2021:4).

Sample	Treatment	Vit. A[2]	β-carotene[2]	α-tocopherol	Ascorbic acid
Leaves (powder)	Fresh		183	369	2,710

Table 5 - Vitamin contents in Moringa Oleifera leaves in µg/g

Further data on the composition of Moringa Oleifera leaves may be found in Appendix D1.

B.3.2 Moringa Oleifera immature (green) pods

Refer to Tables 6 and 7 below for the nutritional profile and nutrition values of Moringa immature (green) pods in comparison to green beans.

Sample	Country	Treatment	Protein (%)	Total fat (%)	Fatty acids (% of total FA)	Dietary fiber (%)	Carbo-hydrates (%)
Immature pods	Mexico	Oven-dried 60°C, 8 h	19.3	1.3	SFA 31.6 MUFA 18.4 PUFA 49.9 LA 23.5 ALA 26.2	46.8	25.0

Table 6 – Nutritional profile of Moringa Oleifera immature pods (Values presented as means)

CROP	Moringa green pods	Green bean
Water	88.2	90.3
Energy kcal	37	31
Carbohydrates g	8.53	6.97
Dietry Fibre g	3.2	2.7
Sugars g		3.24
Fat g	0.2	0.22
Protein g	2.1	1.83
Vitamins		
A µg	4	35
B1 mg	0.053	0.082
B2 mg	0.074	0.104
B3 mg	0.62	0.734
B5 mg	0.794	0.225
B6 mg	0.12	0.141
B9 µg		
C mg	141	12.2
E		
K µg		43
Minerals		
Ca mg	30	37
Cu mg	0.084	0.069
Iron mg	0.36	1.03
K µg	461	211
Mg mg	45	25
Mn mg	0.259	0.216
Na mg	50	6
P mg	42	38
Se µg	0.7	0.6
Zn mg	0.45	0.24
Amino acids	**	
Tryptophan g	0.8	0.019
Threonine g	3.9	0.079
Isoleucine g	4.4	0.066
Leucine g	6.5	0.112
Lysine g		0.088
Methionine g	1.4	0.022
Cystine g		0.018
Phenylalanine g	4.3	0.067
Tyrosine g		0.042
Valine g	5.4	0.09
Arginine g	3.6	0.073
Histidine g	1.1	0.034
Alanine g		0.084
Aspartic acid g		0.255
Glutamic acid g		0.187
Glycine g		0.065
Proline g		0.068
Serine g		0.009

Table 7 – Nutritional value of Moringa Oleifera immature (green) pods – per 100g[25]

[25] USDA Food Data Central (2023) https://fdc.nal.usda.gov/fdc-app.html#/food-details/170483/nutrients ; accessed 12/07/23.

From Niranjan et al., 2017, Table 8 shows the phenolic compounds identified in Moringa Oleifera immature (green) pods.

Table 2

Phenolic compounds identified by mass spectrometry in the plant parts of *M. oleifera*.

Compounds	Ion full-scan MS		MS–MS approach Product ion scan	Moringa oleifera		
	$[M-H]^-$	Fragment		Leaves	Flowers	Pods
Chlorogenic acid	353	191	353	√	√	√
Gallic acid	169	125	169	√	√	√
Caffeic acid	179	135	179	√	√	√
Quercetin	301	179, 151, 121	301	√	√	√
p-Coumaric acid	163	119	163	√	√	√
Kaempferol	285	227, 151, 133	285	√	√	√

Table 3

Amount of the total phenolic specific phenolic compounds in *M. oleifera*.

Fruits	Total phenolic content [mg g^{-1} GAE]	Chlorogenic acid [%]	Gallic acid [%]	Caffeic acid [%]	Quercetin [%]	*p*-Coumaric acid [%]	Kaempferol [%]
Young pod	11.98	0.028	0.016	0.014	0.011	0.014	0.020

Table 8 – Phenolic compounds for Moringa Oleifera immature pods

Further data on the composition of Moringa Oleifera immature (green) pods may be found in Appendix D2.

B.3.3 Moringa Oleifera seed oil

Moringa seeds contain a high proportion of lipids that can be extracted as a monounsaturated oil, its main component being oleic acid (a fatty acid). The chemical composition of Moringa seeds was studied by Garsallah, A., et al. and the results are shown below in Table 9.

Chemical composition (dry basis) of *M. oleifera* seeds (% w/w).

Constituents	
Moisture content	7.78 ± 0.62
Crude protein	33.39 ± 3.16
Crude oil	41.7 ± 3.71
Total fiber	4.23 ± 0.32
Total ash	3.1 ± 0.02
Total sugar	17.58 ± 2.32

Values are means ± SD of three determinations.

Table 9 – Chemical composition of Moringa Oleifera seeds

Table 10 below shows the physicochemical characteristics of Moringa Oleifera seed oil (Garsallah, A., et al., 2021:477). Cold-pressed Moringa Oleifera seed oil exhibited an induction period of 30 +/- 0.5 h (refer to Table 10 below).

In a comparative study, Babatunde S. et al., evaluated cold pressed and hexane extracted moringa seed oils (CPMSO and HEMSO) for their physico-chemical and stability characteristics. The results from this study are shown in Table 11 below to contrast with the study described above (Babatunde S. et al., 2014).

Physicochemical characterization of *M. oleifera* seed oil.

Parameter	
Refractive index (40 °C)	1.467 ± 0.03
Specific gravity (25 °C)	0.916
Acid value (mg KOH/g oil)	1.5 ± 0.21
Saponification value (mg KOH/g oil)	168.3 ± 0.45
Iodine value (g I_2/100 g oil)	67.42 ± 0.21
Peroxide value (meq O2/kg oil)	7.5 ± 0.03
Unsaponifiable matter (%)	1.13 ± 0.14
K_{232}	1.17± 0.02
K_{270}	0.043 ± 0.01
Oil stability index (h)	30 ± 0.5
Viscosité à 20 °C (mPa.s)	97.11 ± 0.02
Color parameters	
Red	3.6 ± 0.1
Yellow	70.00 ± 0.0

Values are means ± SD of three determinations.

Table 10 – Physicochemical characterisation of Moringa Oleifera seed oil (Garsallah, A., et al., 2021:477)

Parameters	CPMSO	HEMSO
Color – 1 in. cell (Lovibond units, Y+5R)	$30.0^{a}\pm1.0$ (25 Y & 1 R)	$36.0^{b}\pm1.2$ (30 Y & 1.2 R)
FFA (as oleic acid), %	$3.5^{a}\pm0.12$	$4.0^{b}\pm0.05$
Peroxide value, meq O_2 / kg	$1.0^{a}\pm0.01$	$1.02^{a}\pm0.01$
Iodine value, g I_2 / 100 g oil	$67.8^{a}\pm0.42$	$68.5^{a}\pm0.36$
Saponification value, mg KOH / g oil	$190.4^{a}\pm0.57$	$191.2^{a}\pm0.52$
Unsaponifiable matter, %	$0.59^{a}\pm0.05$	$0.65^{a}\pm0.03$
Total tocopherols, mg/kg	$95.5^{a}\pm1.0$	$90.2^{a}\pm1.7$
Total polar materials, %	$3.1^{a}\pm0.05$	0.0^{b}
Refractive index	$1.47^{a}\pm0.001$	$1.47^{a}\pm0.001$
Density at 25 °C, g/mL	$0.90^{a}\pm0.01$	$0.92^{a}\pm0.01$
Specific gravity	$0.93^{a}\pm0.01$	$0.90^{a}\pm0.01$
Viscosity, mPa.s	$43.8^{a}\pm0.14$	$43.6^{a}\pm0.25$

NR not reported

Table 11 – Physicochemical characteristics of cold pressed Moringa Oleifera seed oil (CPMSO) and hexane extracted Moringa Oleifera seed oil (HEMSO) (Babatunde S. et al., 2014:506)

The fatty acid composition of Moringa Oleifera seed oil is illustrated in Table 12 (Garsallah, A., et al., 2021:477) below and a comparison to olive oil may be found in Table 13 (USDA) below.

Fatty acid (%) composition of *M. oleifera* seed oil.

Fatty acids	Composition
Palmitic (C16:0)	6.11 ± 0.84
Palmitoleic (C16:1)	1.4 ± 0.09
Stearic (C18:0)	5.37 ± 0.45
Oleic (C18:1)	73.36 ± 0.22
Linoleic (C18:2)	1.01 ± 0.06
Linolenic (C18:3)	0.44 ± 0.22
Arachidic (C20:0)	3.26 ± 0.04
Gadoleic (C20:1)	2.21 ± 0.25
Behenic(C22:0)	5.71 ± 0.2
Lignoceric (C24:0)	0.66 ± 0.27
SAFA	21.11 ± 0.65
MUFA	76.97 ± 0.19
PUFA	1.45 ± 0.16

SAFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids;.
Values are means ± SD of three determinations.

Table 12 – Fatty acid (%) composition of Moringa Oleifera seed oil (Garsallah, A., et al., 2021:477)

OIL	Olive oil	MO
Fatty acids, total saturated	13.8	21.11
SFA 16:0	11.3	6.11
SFA 17:0	0.022	0
SFA 18:0	1.95	5.37
SFA 20:0	0.414	3.26
SFA 22:0	0.129	5.71
SFA 24:0	0	0.66
Fatty acids, total monounsaturated	73	74.76
MUFA 16:1	1.26	1.4
MUFA 17:1	0.125	0
MUFA 18:1	71.3	73.36
MUFA 20:1	0.311	0
Fatty acids, total polyunsaturated	10.5	1.45
PUFA 18:2	9.76	1.01
PUFA 18:3	0.761	0.44

Table 13 – Fatty acid analysis of Moringa Oleifera seed oil compared to olive oil[26]

Nadeem & Imran 2016, compare the chemical characteristics of Moringa Oleifera seed oil with other common vegetable oils such as sunflower and soybean oil – refer to Table 14 below.

Table 1 Oil content of *Moringa oleifera* oil and some vegetable oils

Oil type	Oil content (%)	Reference
MOO	38–42	[22]
SFO	37–40	[52]
MKO	13–15	[53]
CSO	18–20	[54]
PKO	46–50	[15]
CHO	35–40	[55]
SBO	18–20	[56]
WSO	35–40	[54]
LSO	40–42	[55]

MOO Moringa oleifera Oil, *SFO* Sunflower Oil, *MKO* Mango Kernel Oil, *CSO* Cottonseed Oil, *PKO* Palm Kernel Oil, *CHO* Chia Seed Oil, *SBO* Soybean Oil, *WSO* Watermelon Seed Oil, *LSO* Lemon Seed Oil

Table 3 Comparison of chemical characteristics of *Moringa oleifera* oil with some vegetable oils

Parameter	MOO	SBO	CO	SFO	P. Olein	PO
FFA %	0.16	0.88	0.35	0.31	0.08	0.08
Moisture	0.17	0.18	0.15	0.19	0.11	0.14
*Colour	1.0 + 10	3.5 + 35	3.2 + 33	1.3 + 13	1.2 + 12	1.0 + 10
RI@40 °C	1.452	1.467	1.462	1.473	1.457	1.452
Sap. Value	192	189	195	192	191	194
USM	1.28	1.21	1.24	1.31	0.67	0.62
IV	65.7	133.7	114.5	121.8	56.2	53.1
PV	0.24	1.8	1.5	2.34	0.27	0.21
Reference	[4]	[56]	[52]	[60]	[15]	[15]

MOO Moringa oleifera Oil, *FFA* Free Fatty Acids, *Sap. Value* Saponification Value, *USM* Unsaponifiable Matter, *IV* Iodine Value, *PV* Peroxide Value, *SBO* Soybean Oil CO: Canola Oil, *SFO* Sunflower Oil, *P. Olein* Palm Olein, *PO* Palm Oil
*Lovibond Tintometer Scale (Red + Yellow) 1" Quartz Cell

Table 14 – Comparison of Moringa Oleifera seed oil (MOO) with other vegetable oils

Further data on the composition of Moringa Oleifera seed oil may be found in Appendix E.

[26] USDA Food Data Central (2023) https://fdc.nal.usda.gov/fdc-app.html#/food-details/168416/nutrients; accessed 12/07/23.

B.4. Information on the impurity profile for a typical preparation

B.4.1 Anti-nutrient analysis - Moringa Oleifera leaf (fresh and dried)

Current studies have demonstrated that Moringa Oleifera may serve as a convenient, affordable, relatively safe and readily available source of proteins and minerals (Rong, L. et al. 2022). Moringa Oleifera leaves are highly recommended as natural dietary supplements because of their high nutritional value and low anti-nutritional factors. No adverse effects of moringa leaves have been observed in human studies so far. The daily consumption of 70 grams Moringa Oleifera leaf was considered safe with no toxicity (Kashyap, P., et al., 2022).

Popoola JO., et al. note that studies on the toxic effects and safety have reported Moringa Oleifera to be safe in various models on mice, rats, rabbits, in vitro assays and some clinical trials. In retrospect, very few toxicity and safety evaluations were encountered in investigations involving humans or clinical trials (Popoola JO., et al., 2020:177).

Grosshagauer, S. et al. 2021, summarise the research findings of previous studies into the anti-nutrient contents of Moringa Oleifera leaf refer to Table 15 below.

Refer to Appendix J for further information.

Sample	Treatment	Phytate	Tannins	Saponins	Oxalate	Trypsin inhibitor
Leaves	Raw	0.3[a]	0.22[a]	–	na	nd[3]
	Cooked	0.2[a]	0.16[bc]			nd[3]
Immature pods	Raw	0.2[a]	0.2[ab]	–	na	0.3[a]
	Cooked	0.2[a]	0.1[c]			0.3[a]

Table 15 – Anti-nutrient contents in Moringa Oleifera mg/100 g[1] (Grosshagauer, S. et al., 2021:6)

Moringa does not intrinsically contain heavy metals – it is a function of the environment. Areas where it will be grown in Australia are not known for high levels of heavy metals.

B.4.2 Anti-nutrient analysis – Moringa Oleifera immature (green) pods

Grosshagauer, S. et al. 2021, summarise the research findings of previous studies into the anti-nutrient contents of Moringa Oleifera immature (green) pods. Refer to Table 15 above and appendices D2 and J for further information.

B.4.3 Anti-nutrient analysis – Moringa Oleifera seed oil

Not applicable.

B.5. Manufacturing process for a novel food ingredient

Moringa Oleifera leaves and immature (green) pods may be consumed as a whole, unprocessed food and prepared in a similar manner to other vegetables such as okra or beans. The vegetable matter is washed in clean water and then cut to desired size and cooked on its own or as a part of a meal. The outer layer of the pods is peeled with a standard potato-peeler.

It is noted that none of the following processes are mandatory for any of the Moringa Oleifera products (leaf, immature pod or oil) to reduce or remove antinutrients and/or to improve palatability.

B.5.1 Manufacturing process for leaf (fresh and dried)

Fresh: hand-picked, washed.

Dried: Machine or hand-picked, washed, dried in food-grade commercial dryer, packed in air-tight, darkened food-grade container.

B.5.2 Manufacturing process for immature (green) pods)

Fresh: hand-picked, washed.

Dried: Machine or hand-picked, washed, dried in food-grade commercial dryer, packed in air-tight, darkened food-grade container.

B.5.3 Manufacturing process for seed oil

Globally, there are three common methods used to produce nut (for example almond, cashew, hazelnut, peanut, pecan, pistachio and walnut) oils – cold-pressing, solvent extraction and a combination of pre-pressing and solvent extraction. Cold-pressing is the preferred method for Moringa seed oil extraction as it neither uses heat nor chemical treatments to obtain natural and safe edible oil products (Özcan, M.M. et al., 2019). It is noted that none of the abovementioned methods are mandatory. This specification for classification of Moringa seed oil as a food is not linked to the way it is processed.

B.6. Specification for identity and purity for a novel food ingredient

There is no existing standard or monograph for Moringa Oleifera in the primary or secondary sources referenced in Schedule 3-2 of the Code.

In the EU, the European Commission has implemented specifications governing dried Moringa Oleifera leaves and pods (which contain the seeds) (also refer to section J.2.3). These are:

1. European General Food Law Regulation[27] **(EC) No 178/2002** which requires all foods marketed in the EU to be safe and traceable;

[27] Eur-lex.europa.eu. (2023). https://food.ec.europa.eu/horizontal-topics/general-food-law_en ;accessed 26/03/23.

2. Food safety requirements, including those on maximum residue levels (MRLs) [28] **(EC) 629/2008, (EC) 1881/2006, (EC) 1169/2011**;
3. Food safety requirements - contaminants in food[29] **(EC) 315/93/EEC: Food**;
4. Food safety requirements - microbiological contamination of food[30] **(EC) No 2073/2005.**

B.6.1 Moringa Oleifera leaf (fresh and dried)

It is proposed that the product specifications for Moringa Oleifera leaf (fresh and dried) be as described below. The format of the specification in Table 16 is in accordance with Schedule 3 of the code. Individual specification examples are provided in Appendix F.

General Information

Product: Moringa leaf (fresh and dried)

Botanical source: Moringa Oleifera

Ingredients: 100% Moringa leaf

Carrier: Absent (100% pure)

Irradiation: Free

Parameter	Unit	Value	Method
Appearance	-	Fine leaf	Visual
Colour	-	Light green	Visual
Flavour / Odour	-	Characteristic	Sensorial
Composition			
Energy	Kcal per 100g	64	Accredited lab standard
Total lipid (fat)	g per 100g	1.4	Accredited lab standard
Carbohydrates, by difference	g per 100g	8.28	Accredited lab standard
Fibre	g per 100g	2	Accredited lab standard

[28] Eur-lex.europa.eu. (2023). https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en ;accessed 26/03/23.

[29] Eur-lex.europa.eu. (2023). https://food.ec.europa.eu/safety/chemical-safety/contaminants_en ;accessed 26/03/23.

[30] Eur-lex.europa.eu. (2023). https://food.ec.europa.eu/safety/biological-safety/food-hygiene/microbiological-criteria_en ;accessed 26/03/23.

Protein	g per 100g	9.4	Accredited lab standard
Ash	g per 100g	2.26	Accredited lab standard
Moisture content	%w/w	<= 8	Accredited lab standard
Calcium	mg per 100g	185	Accredited lab standard
Purity			
Total Heavy Metals	mg/kg	< 10.0	Accredited lab standard
Pb (lead)	mg/kg	< 3.0	Accredited lab standard
Cd (cadmium)	mg/kg	< 1.0	Accredited lab standard
Hg (mercury)	mg/kg	< 0.1	Accredited lab standard
As (Arsenic)	mg/kg	< 1.0	Accredited lab standard
Pesticides	mg/kg	0.01	Accredited lab standard
Microbiological criteria			
Total plate count	CFU/g	< 500.000	Accredited lab standard
Yeast and Mould	CFU/g	< 100.000	Accredited lab standard
Escherichia coli	CFU in 25g	Absent in 25g	Accredited lab standard
Bacillus cereus	CFU/g	< 1.000	Accredited lab standard
Salmonella	CFU in 25g	Absent in 25g	Accredited lab standard

Table 16 – Moringa Oleifera leaf specification

B.6.2 Moringa Oleifera immature (green) pods

It is proposed that the product specifications for Moringa Oleifera immature (green) pods be as described below. The format of the specification in Table 17 is in accordance with Schedule 3 of the code. Individual specification examples are provided in Appendix F.

General Information

Product: Moringa immature (green) pods

Botanical source: Moringa Oleifera

Ingredients: 100% Moringa pods

Carrier: Absent (100% pure)

Irradiation: Free

Parameter	Unit	Value	Method
Appearance	-	Green pod	Visual
Colour	-	Light green	Visual
Flavour / Odour	-	Characteristic	Sensorial
Composition			
Energy	Kcal per 100g	37	Accredited lab standard
Total lipid (fat)	g per 100g	0.2	Accredited lab standard
Carbohydrates, by difference	g per 100g	8.53	Accredited lab standard
Fibre	g per 100g	3.2	Accredited lab standard
Protein	g per 100g	2.1	Accredited lab standard
Ash	g per 100g	0.97	Accredited lab standard
Moisture content	%w/w	<= 8	Accredited lab standard
Calcium	mg per 100g	30	Accredited lab standard
Purity			
Total Heavy Metals	mg/kg	< 10.0	Accredited lab standard
Pb (lead)	mg/kg	< 3.0	Accredited lab standard
Cd (cadmium)	mg/kg	< 1.0	Accredited lab standard
Hg (mercury)	mg/kg	< 0.1	Accredited lab standard

As (Arsenic)	mg/kg	< 1.0	Accredited lab standard
Pesticides	mg/kg	0.01	Accredited lab standard
Microbiological criteria			
Total plate count	CFU/g	< 500.000	Accredited lab standard
Yeast and Mould	CFU/g	< 100.000	Accredited lab standard
Escherichia coli	CFU in 25g	Absent in 25g	Accredited lab standard
Bacillus cereus	CFU/g	< 1.000	Accredited lab standard
Salmonella	CFU in 25g	Absent in 25g	Accredited lab standard

Table 17 – Moringa Oleifera Immature (green) pod specification

B.6.3 Moringa Oleifera seed oil

It is proposed that the product specifications for Moringa Oleifera seed oil be as described below. The format of the specification in Table 18 is in accordance with Schedule 3 of the code. Individual specification examples are provided in Appendix F.

General Information

Product: Moringa oil

Botanical source: Moringa Oleifera

Ingredients: 100% Moringa seeds

Extraction Method: Cold Pressed

Carrier: Absent (100% pure)

Parameter	Unit	Value	Method
Appearance	-	Pale yellow to golden green	Visual
Flavour / Odour	-	Characteristic mild, pleasant odour	Sensorial
Refractive index		1.460 – 1.474 @ 20°C	Accredited lab standard

Specific gravity	g/ml	0.900 – 0.922 @ 20°C	Accredited lab standard
Saponification	mgKOH/g	176 - 196	Accredited lab standard
Peroxide	meq O2/kg	< 5.0	Accredited lab standard
Iodine	g I2/100g	57 - 77	Accredited lab standard
Acid	mgKOH/g	< 1.0	Accredited lab standard
Fatty Acid			
Palmitic Acid C16:0	%	2.00 – 10.00	Accredited lab standard
Palmitoleic Acid C16:1 (n-7)	%	1.00 – 5.00	Accredited lab standard
Stearic Acid C18:0	%	2.00 – 8.00	Accredited lab standard
Oleic Acid C18:1 (n-9)	%	65.00 – 85.00	Accredited lab standard
Linoleic Acid C18:2 (n-6)	%	Maximum 2.0	Accredited lab standard
Alpha-Linolenic Acid C18:3 (n-3)	%	Maximum 0.5	Accredited lab standard
Arachidic Acid C20:0	%	2.00 – 5.00	Accredited lab standard
11-Eicosenoic acid C20:1 (n-9)	%	0.50 – 4.00	Accredited lab standard
Behenic Acid C22:0	%	3.00 – 10.00	Accredited lab standard
Purity			
Total Heavy Metals	mg/kg	< 10.0	Accredited lab standard
Pb (lead)	mg/kg	< 3.0	Accredited lab standard
Cd (cadmium)	mg/kg	< 1.0	Accredited lab standard

Hg (mercury)	mg/kg	< 0.1	Accredited lab standard
As (Arsenic)	mg/kg	< 1.0	Accredited lab standard
Microbiological criteria			
Aerobic Mesophilic Bacterial Count	CFU/g	< 100	Accredited lab standard
Yeast and Mould	CFU/g	< 10	Accredited lab standard
Candida albicans	CFU in 1g	ABSENT / 1g	Accredited lab standard
Escherichia coli	CFU in 1g	ABSENT / 1g	Accredited lab standard
Pseudomonas aeruginosa	CFU in 1g	ABSENT / 1g	Accredited lab standard
Staphylococcus aureus	CFU in 1g	ABSENT / 1g	Accredited lab standard

Table 18 – Moringa Oleifera seed oil specification

B.7. Analytical method for detection of a novel food ingredient

It is noted that the application seeks to amend the Code for Moringa Oleifera to be consumed as a food whether in an unprocessed form as vegetable matter, or processed form as an oil. However, Moringa Oleifera may be detected as a food ingredient using common analytical methods, including the following:

1. Accredited laboratories (e.g. National Measurement Institute, CSIRO) for **Nutrition panel** (proteins, water, ash, energy, FAME, fat, carbohydrate and fibre); and
2. Accredited laboratories (e.g. National Measurement Institute, CSIRO) for **Batch-test** (including minerals, metals, PAH, allergens).

C. Information on the safety of the novel food

C.1. Plant or animals (or their components)

C.1.1 Information on the composition of the novel food

Each of the three forms of Moringa Oleifera products (leaves, immature (green) pods and seed oil) are considered separately in this section.

C.1.1.1 Moringa Oleifera Leaf (fresh and dried)

Please refer to section 2.0 B.3.1 and Appendix D1 for the following analysis on Moringa Oleifera leaf (fresh and dried):

1. Nutrient analysis and nutritional values;
2. Elemental composition;
3. Sugar content;
4. Vitamins;
5. Amino acids;
6. Fatty acids;
7. Polyphenolic compounds analysis, and
8. Anti-nutrient analysis.

To complement the analysis provided above in sections 2.0 B.3, 2.0 B.4, Appendix D1, Appendix D2 and Appendix E, outcomes of the review by Azlan, U.K., et al., in September 2022 are provided. Among the findings, they reviewed the absorption, metabolism and excretion properties of Moringa Oleifera and highlighted the safety and non-toxicity effects of Moringa Oleifera treatment at various doses, including in vitro, in vivo and clinical trials from human studies.

The high polyphenolic contents of Moringa Oleifera plants may exhibit a conflicting inhibitory effect on iron absorption via the formation of non-bioavailable polyphenol–iron complexes. However, the formation of inhibitory complexes that lead to poor iron absorption into the body relies specifically on the structures of polyphenol compounds. In addition, a study has suggested that the low iron bioavailability is caused by the presence of high phytic acid content in the Moringa Oleifera sample, and the removal of phytic acid during its processing may improve the bioavailability (Azlan, U.K., et al., 2022:9).

Vitamins A and B are among the significant reported nutrients of Moringa Oleifera leaves and one of the most abundant natural sources for β-carotene and provitamin A carotenoid. In vivo and in vitro studies found that the natural vitamin sources of Moringa Oleifera are highly bioavailable.

Further, Moringa Oleifera includes all essential amino acids that act as the building blocks for proteins necessary for body nourishment. Other studies have also found that most of the amino acids or proteins in Moringa Oleifera are highly digestible which equates to its bioavailability (Azlan, U.K., et al., 2022:9).

Azlan, U.K., et al., state that, to the best of their knowledge, there are no adverse effects of Moringa Oleifera consumption based on human studies that have ever been reported. Likewise, the potential toxicity of the plant has been assessed in both in vitro and in vivo studies - refer to Table 19 below (Azlan, U.K., et al., 2022:3).

Dried leaf powder	5, 50, 300 and 2000 mg/kg	Rats (Male and female, Sprague Dawley nulliparous and non-pregnant)	No adverse effect observed in clinical signs or gross pathology.	[19]

Table 19 – Summary of findings of safety and toxicity of Moringa Oleifera in in vitro and in vivo studies

Pareek, A., et al., conclude that the pharmacological potential of Moringa Oleifera, as well as its safety and toxicity, has been critically studied in both in vitro and in vivo studies, and many studies have found compelling activities of Moringa Oleifera as a potent agent with minimal toxicity.

C.1.1.2 Moringa Oleifera Immature (green) pods

Please refer to section 2.0 B.3.2 and Appendix D2 for the following analysis on Moringa Oleifera immature (green) pods:

1. Nutrient analysis and nutritional values;
2. Elemental composition;
3. Vitamins;
4. Amino acids;
5. Fatty acids;
6. Polyphenolic compounds analysis; and
7. Anti-nutrient analysis.

C.1.1.3 Moringa Oleifera seed oil

Please refer to section 2.0 B.3.3 and Appendix E for the following analysis on Moringa Oleifera seed oil:

1. Nutrient analysis and nutritional values;
2. Elemental composition;
3. Vitamins;
4. Amino acids;
5. Fatty acids;
6. Physicochemical analysis; and
7. Polyphenolic compounds analysis.

C.1.2 Information on the effects of food processing or preparation

The effect of food plant processing technology on anti-nutrition has been studied by several researchers. Muslimin, L., et al., affirm that the level of anti-nutrients in Moringa Oleifera leaves depends on the processing method employed (Muslimin, L., et al.,2023:29).

The Moringa Oleifera leaf heating technique by boiling is known to be the most significant technique in reducing anti-nutrient levels (Muslimin, L., et al.,2023:30). With the penetration of heat, the enzyme structure in the leaf tissue will be damaged and the bitter and sour taste will disappear. This concurs with the analysis of Grosshagauer, S. et al., 2021:5. Furthermore, by the process of roasting (overexposing the leaves, pods and seeds to heat for a long period of time) it can be shown that the levels of oxalate, and phytate in the end product are reduced (Muslimin, L., et al.,2023:30).

Another processing technique is Fermentation which causes chemical and biochemical changes in the macro and micro components of Moringa Oleifera, resulting in increases in bioavailability and digestibility. The microbes in Moringa Oleifera leaves decompose into other substances - citric acid is converted to lactic acid and acetic acid and several other organic acids are also produced (Muslimin, L., et al.,2023:30). During fermentation, tannins, phytic acid, and glucosinolates are also reduced due to the secretion of tannase enzymes and phytase enzymes which can break down tannins, phytic acid, and glucosinolates (Muslimin, L., et al.,2023:30).

The presence of phytate and other anti-nutrients can reduce the bioavailability of certain nutrients, but fermentation can be used to neutralize this effect and potentiate maximum utilisation of the required nutrients from the seeds (Gautier, A., et al., 2022:2). It obviously also depends on the maturity (ripeness) of the seed. The concentration of glucosinolades is at its highest in mature seed (the plant's mechanism to ensure reproduction), thus mature seed is not normally consumed.

Devisetti R, et al., state that the dark colour, astringent taste and distinct flavour present limitations for the incorporation of Moringa Oleifera leaf in food products to be used as a food (Devisetti R, et al., 2016:656). These results provided useful information for effective utilization of moringa leaf as a functional food ingredient (Devisetti R, et al., 2016).

Refer to Appendix D1 for further information.

C.1.3 Information on the current use of this food or food component in population sub-groups or in other countries

Moringa Oleifera is widely cultivated in Asian, African and Oceanic countries and has been consumed by population sub-groups in those countries for millennia. As most parts of the tree (leaves, flowers, fruit (immature pods)) are used in various traditional food formulations and for industrial purposes, it is now considered to be one of the most useful trees. The leaves may be consumed, for example, as fresh/cooked in soups, risotto, muffins,

salads and porridges, frittata, hummus[31] and ready-to-eat chutney (Devisetti R, et al., 2016). In recent years, the various food applications of the dried leaf (e.g., bread, yoghurt, biscuits) have led to an uptrend in use in developed countries (Gautier, A., et al., 2022).

Most of the production and international trade of Moringa Oleifera comes from India, in canned produce, frozen pods, oil, and leaf. India has an annual production of 1.1 - 1.3 million tonnes of tender pods. Despite relatively low consumer awareness of Moringa Oleifera, market researchers predict that demand will grow – refer to Figure 3 below (Islam, Z., et al., 2021). Global demand for Moringa Oleifera ingredients was estimated at US$5.8 billion in 2018 and predicted to grow by 8.9% between 2019-2025. Of the total global market of up to US$10 billion in 2025, the European market is predicted to be US$2 billion[32]. It is estimated that approximately 50-60 tonnes and 20-30 tonnes of Moringa Oleifera leaf are imported to Germany and the UK respectively, each year[33].

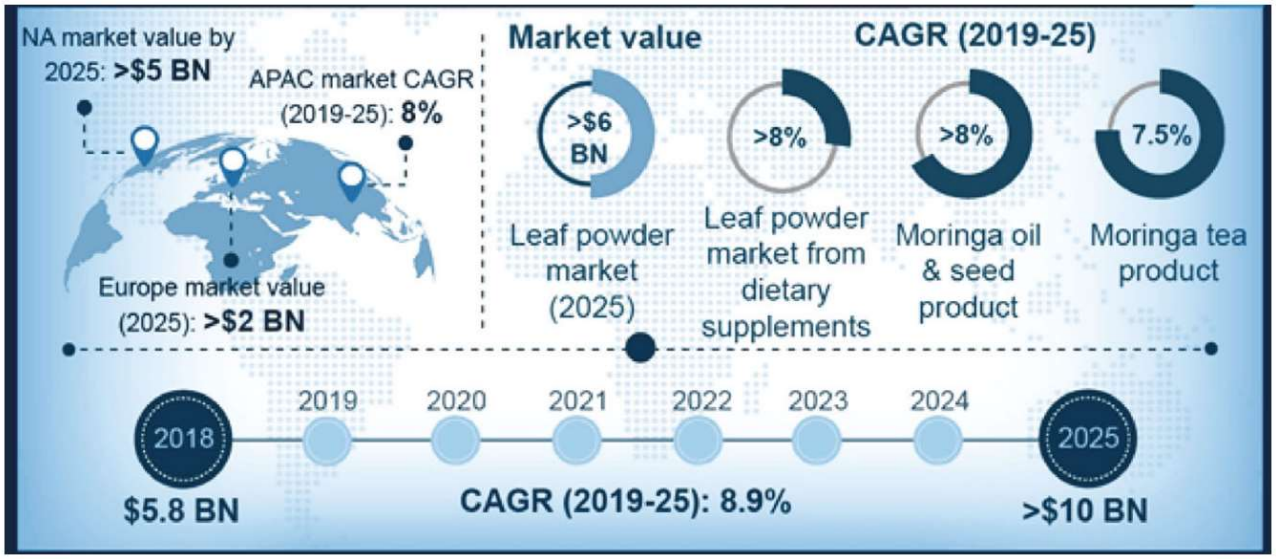


Figure 3 – Moringa Oleifera global market outlook 2025

C.1.4 Information regarding the potential adverse effects associated with the food or its ingredients

Sections C.1.1 and C.6.3 provide analysis on the toxicity and safety assessment of Moringa Oleifera.

C.2. Plant and animal extracts

Not applicable. The scope of this application is concerned with whole foods only. No use of Moringa Oleifera extract/s is to be considered.

[31] The Moringa initiative. (2023). https://moringainitiative.com/recipes/ ;accessed 29/03/23.

[32] CBI Ministry of Foreign Affairs. (Dec, 2022). *The European market potential for moringa.* https://www.cbi.eu/market-information/natural-ingredients-health-products/moringa/market-potential#which-european-countries-offer-most-opportunities-for-moringa ;accessed 16/02/2023.

[33] CBI Ministry of Foreign Affairs. (Dec, 2022). *The European market potential for moringa.* https://www.cbi.eu/market-information/natural-ingredients-health-products/moringa/market-potential#which-european-countries-offer-most-opportunities-for-moringa ;accessed 16/02/2023.

C.2.1 Information on the method of extraction and the composition of the concentrated extract

C.2.2 Information on the use of this plant or animal extract as a food in other countries

C.2.3 Information on the toxicity of the extract obtained from studies conducted in animals or humans

C.2.4 Safety assessment reports prepared by international agencies or other national government agencies

C.3. Herbs (both non-culinary and culinary) including extracts

Not applicable.

C.3.1 Information on the history of use of the herb

C.3.2 Information on the composition of the herb

C.3.3 For a herbal extract, information on the method of extraction and the composition of the concentrated extract

C.3.4 Information on the use of this herbal extract as a food in other countries

C.3.5 Information regarding the potential allergenicity of the herb or herbal extract

C.3.6 Information on the toxicity of the herb, or herbal extract, or any key constituents obtained from studies conducted in animals or humans

C.3.7 Safety assessment reports prepared by international agencies or other national government agencies

C.4. Single chemical entities & Dietary macro-components

Please refer to section 2.0 B.3.3 and Appendix E for the following analysis on Moringa Oleifera seed oil:

1. Nutrient analysis and nutritional values;
2. Elemental composition;
3. Vitamins;
4. Amino acids;
5. Fatty acids;
6. Physicochemical analysis; and
7. Polyphenolic compounds analysis.

C.4.1 Information on the toxicokinetics and metabolism of the single chemical entity and, where appropriate, its degradation products and major metabolites

Nadeem & Imran, 2016, demonstrated in their study that the use of Moringa Oleifera seed oil is safe for human consumption. After long term storage, Moringa Oleifera seed oil (MOO) showed superior oxidative stability with lower levels of peroxides and specific extinctions measured at 232 nm. MOO oil contains zeatin, a potentially

bioactive substance which is believed to have antioxidant and anti-inflammatory properties. It also contains beta-sitosterol, which blocks the biochemical events of cholesterol formation and possesses anti-inflammatory perspective. MOO is also a rich source of kaempferol, which improves the metabolism and cell function. The data regarding the presence of sterols (Table 20), tocopherols (Table 21), total phenolic contents (Table 22) and induction point (Table 23) are shown below, respectively. MOO is compared with common vegetable oils.

Sterol	MOO	SBO	CO	SFO
Campesterol	15.81	68	10.29	9.28
Stigma sterol	23.10	64	7.51	0.18
β-Sitosterol	45.58	183	58.01	50.28
Δ^5 - Avenasterol	8.46	5	1.26	1.11
Δ^7 – stigmasterol	Not Reported	5	9.72	0.11
Δ^7- Avenasterol	0.53	2	5.54	0.06
Reference	[23]	[62]	[63]	[63]

***MOO Moringa oleifera* Oil SBO: Soybean Oil CO: Canola Oil, *SFO* Sunflower Oil**

Table 20 – Sterols - Moringa seed oil vs other vegetable oils

Oil type	Tocopherol	Concentration mg/kg	Reference
Moringa oleifera oil	α-Tocopherol	134.42	[3]
	γ-Tocopherol	93.7	
	δ-Tocopherol	48.0	
Virgin Olive Oil	α-Tocopherol	88.50	[23]
	γ-Tocopherol	9.90	
	δ-Tocopherol	1.60	
Watermelon Seed Oil	α-Tocopherol	127.49	[54]
	γ-Tocopherol	——	
	δ-Tocopherol	55.36	
Mango Kernel Oil	α-Tocopherol	205.44	[64]
	γ-Tocopherol	——	
	δ-Tocopherol	34.81	
Soybean Oil	α-Tocopherol	9.3	[65]
	γ-Tocopherol	62.8	
	δ-Tocopherol	26.7	
Sunflower Oil	α-Tocopherol	613	[66]
	γ-Tocopherol	19	
	δ-Tocopherol	——	
Canola Oil	α-Tocopherol	226	[67]
	γ-Tocopherol	202	
	δ-Tocopherol	3	
Corn Oil	α-Tocopherol	134	[54]
	γ-Tocopherol	412	
	δ-Tocopherol	39	

Table 21 – Tocopherols - Moringa seed oil vs other vegetable oils

Oil type	TPC % (GAE)	Reference
Moringa oleifera oil	7.1	[21]
Chia Oil (Olein	4.25	[68]
Chia Oil (Stearin)	2.57	[68]
Almond Peel	3.82	[22]
Sesame Cake	1.84	[22]
Chia Seed Extract	5.6	[54]
Sugarcane Juice	6.19	[55]
Date Fruit Extract	5.19	[69]
Tamarind seed	6.45	[70]

TPC Total Phenolic Contents, *GAE* Gallic Acid Equivalent

Table 22 – Total phenolic contents - Moringa seed oil vs other substances

Oil Type	Induction period (Hours)	Reference
MOO	42.56 after degumming	[23]
MOO	72.56 crude oil	[23]
PO	10.4	[52]
SBO	4.27	[56]
CO	5.84	[19]
SFO	3.51	[19]
WSO	3.82	[54]
CHO	1.32	[71]
WSO	4.1	[54]

MOO Moringa oleifera Oil SFO: Sunflower Oil MKO: Mango Kernel Oil, *CSO* Cottonseed Oil, *CHO* Chia Seed Oil, *SBO* Soybean Oil, *WSO* Watermelon Seed Oil, *LSO* Lemon Seed Oil

Table 23 – Induction period - Moringa seed oil vs other vegetable oils

Fu, X. et al., 2021, found that most crystals of Moringa oleifera seed oil are melted at − 0.9 °C. Moringa oleifera seed oil remained stable up to 305 °C, and its degradation was negligible up to this temperature. Due to these excellent physical and chemical properties, Moringa seed oil can be used as frying oil.

C.4.2 Information from studies in animals or humans that is relevant to the toxicity of the single chemical entity and, where appropriate, its degradation and major metabolites

Nadeem & Imran, 2016, studied the impact of Moringa Oleifera seed oil (MOO) centred feed on growth performance, packed cell volume, haemoglobin, white blood cells, monocytes, lipid profile, urea, creatine in albino rats. The group of rats fed on soybean oil was used as control, while, the second group was fed on MOO, the experiment lasted for six weeks. Blood samples of both the groups were tested for total cholesterol, high density lipoprotein, low density lipoprotein, triglyceride. Body weight, creatine, urea concentration and haematological parameters of both the groups were not significantly different. These results evidenced that MOO improved the growth performance and had a positive immune stimulatory impact on the growth of albino rats, with neutraceutical effect and no risk of cardiovascular disease.

C.4.3 Safety assessment reports prepared by international agencies or other national government agencies

1. Government of Canada. List of non-novel determinations for food and food ingredients: https://www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/requesting-novelty-determination/list-non-novel-determinations.html
2. European Commission for Food Safety: https://webgate.ec.europa.eu/fip/novel_food_catalogue/
3. National Health Commission, China (NHC) Announcement No. 19 - to consider Moringa Oleifera leaves as a new food resource: http://www.nhc.gov.cn/sps/pztg/201612/712553a5f7554e0e9ec1dfdbcc91e99a.shtml
4. Senate of the Philippines. Malunggay development act of 2007: https://legacy.senate.gov.ph/lis/bill_res.aspx?congress=14&q=SBN-1799

C.5. Microorganisms (including probiotics)

Not applicable.

C.5.1 Information on potential pathogenicity

C.5.2 Information on the effects of the microorganism on gut microflora

C.5.3 Information on the use of this microorganism in food or as a food in other countries

C.5.4 Information on human toleration studies

C.6. Food ingredients derived from a new source

C.6.1 Information on the safety of the source organism

Refer to Section 2.0 C.1.1 above.

C.6.2 Information on the composition of the novel food ingredient derived from a new source

Refer to Section 2.0 C.1.1 above.

C.6.3 Information on the toxicity of the novel food ingredient derived from the new source

A comprehensive review of the potential toxicity of the leaves, immature (green) pods and seed oil is included in this application. The analysis has been divided into the following areas:

1. Genotoxicity
2. Developmental and Reproductive Toxicity (DART)
3. Abortifacient effects

C.6.3.1 Genotoxicity

Stohs SJ. & Hartman MJ., 2015 examined the potential toxicological effects of a single oral dose of 5000 mg/kg of an aqueous Moringa Oleifera extract as well as oral doses of up to 1000 mg/kg of the same extract for 14 days on rats. The authors noted that no overt adverse reactions were observed at these doses, and no histopathological findings were found. A dose of 1000 mg/kg was deemed safe and did not produce genotoxicity when given to rats. A dose of 400 mg/kg would be equivalent to 12 g of leaves per kilogram, which is a very unrealistic dose. A dose of 1000 mg/kg in a rat is equivalent to over 30 times a typical 400 mg dose of an aqueous extract in an 80-kg human. In summary, the previous human studies indicate that whole leaf powders of Moringa Oleifera given orally exhibit significant anti-hyperglycemic, anti-dyslipidemic, and antioxidant effects in human subjects without production of adverse effects.

De Barros et al., 2022 used female mice and oral administration in a single dose at 2000 and 5000 mg/kg of Moringa Oleifera infusion or powder. The 28-day repeated dose toxicity assay employed mice with oral administration of infusion or powder at the doses 250, 500 and 1000 mg/kg. In vivo genotoxicity and mutagenicity (2000 mg/kg) were evaluated by the comet assay and the micronucleus test, respectively. The authors concluded that genotoxicity and mutagenicity were not detected at 2000 mg/kg of Moringa Oleifera leaf. However, indiscriminate use of both infusion and crude leaf powder above 2000 mg/kg and powder at 500 and 1000 mg/kg are not recommended. Furthermore, the amounts given and results achieved from rodent studies are not transferable one-to-one to humans and need to be extrapolated. An amount of 12 g leaves/kg body weight for a rat would mean ~156 g Moringa leaves for an 80-kg adult, which is higher than the commonly recommended doses of ~40 g/day.

Albrahim & Binobead, 2018 noted in their study that modifications in liver functions, oxidative stress, DNA damage, liver injury, and PCNA expression were alleviated when vetsin (Monosodium Glutamate) was administered alongside MLE (Moringa Oleifera extract). The authors conclude that vetsin may have many side effects and that MLE can ameliorate biochemical changes, oxidative stress, hepatic injury, PCNA, and P53 alterations induced by vetsin administration. The control and MLE groups did not differ significantly in terms of DNA damage (tail length) in hepatic tissues.

Grosshagauer et al., 2021 concluded that genotoxicity was only observed when rats were administered with an aqueous Moringa Oleifera leaf extract at a supra-supplementation level of 3,000 mg/kg body weight. However, an amount of 1,000 mg/kg body weight, which is still higher than commonly consumed doses, did not exhibit genotoxic effects. Similarly, Asare, et al., 2012, state that "*Moringa Oleifera is genotoxic at supra-supplementation levels of 3,000 mg/kg b.wt. However, intake is safe at levels ≤ 1,000 mg/kg b.wt. (aqueous extract)"*.

To summarise the above research, it is reasonable to conclude that a daily intake of up to 40 grams of Moringa Oleifera leaf is acceptable for human consumption.

C.6.3.2 Developmental and Reproductive Toxicity (DART)

In Bhattacharya at al., 2018, Moringa Oleifera leaf extract showed a significant increase in the weight of testis, seminal vesicle, epididymis, and a higher score for epididymal maturity and lumen formation along with an increase in seminiferous tubule diameter. The abortive effect of leaf extract on rats after treatment for 10 days after insemination is noted. The extract showed a synergistic effect with estradiol and an inhibitory effect with progesterone. Fresh leaves of Moringa Oleifera contain approximately 11,300–23,000 IU of vitamin A, which has a major role in various anatomical processes, such as reproduction, embryonic growth and development, immunity development, and cell differentiation.

Laoung-On et al., 2021 demonstrated that Moring Oleifera leaf tea contained rich total phenols and flavonoids. The courtship behaviour, seminiferous tubule diameter, epithelium height, epithelium area, type A spermatogonia, and spermatogonia efficiency were significantly increased in all treatment groups. Phenols and flavonoids act as antioxidants and might activate dopamine secretion as they operate in the hypothalamic region and medial amygdala leading to successful sexual behaviour

Awodele et al., 2012 concluded that the aqueous leaf extract of Moringa Oleifera did not produce any mortality when administered orally at various doses of 400 mg/kg to 6.4 g/kg. It can be concluded that Moringa Oleifera is relatively safe for human consumption.

Olayemi et al., 2016 demonstrated that Moringa Oleifera dried leaf extract maybe reasonably safe for consumption but with the recommendation that the consumption of the leaves should not exceed a maximum of 70 gram per day. Similarly, Asiedu-Gyekye et al., 2014 found that there were no observed overt adverse reactions in the acute and subacute studies. However, the consumption of Moringa oleifera leaves should not exceed a maximum of 70 grams per day to prevent cumulative toxicity of these essential elements over long periods.

Zvinorova, et al., 2014 demonstrate that Moringa Oleifera supplementation did not affect blood metabolite concentrations, liver glycogen, or lipid storage.

It is noted in Balamurugan et al., 2017 that the burning of leaves and inhaling the fumes has been used as a contraceptive and dried bark used for irregular menstruation.

To summarise the above research, based on human, animal, and in vitro studies, and the extrapolation of results from animal studies to humans, various preparations of Moringa Oleifera leaves including aqueous extracts appear to be exceedingly safe at the doses and in the amounts commonly utilised.

C.6.3.3 Abortifacient effects

The study by Zade et al., 2010, was carried out to validate scientifically the claimed abortifacient properties of Moringa Oleifera in female albino rats. It is noted that the study used *"aqueous extracts of the **roots** of both plants Moringa oleifera and Moringa concanensis and of the **bark** of Moringa oleifera".*

Similarly, in Shukla et al., 1988, "*80% of women use Moringa oleifera **root** (also known as "Sahijan") to abort pregnancy in its early stages.*". In Pandey et al., 2012, "*M. Oleifera **root** is shown to have unique anti-pregestational activities. It is reported to induce alterations in the normal uterine histoarchitecture which might be the reason for anti-implantational characteristics*".

In Njan et al., 2023, "*aqueous extracts of the **root** and **bark** showed post-coital antifertility effect in rats and have been demonstrated to induce foetal resorption in pregnant rats. Aqueous and alcohol extracts of the **root** have been reported to be teratogenic and to cause abortion in rats. They are also reported to possess anti-oestrogenic as well as anti-progrestational effects*.". Similarly, Pankaj, Chaudhary et al., 2022 used Moringa Oleifera **bark** in their study.

In Sethi et al., 1988, the description of the tree characteristics is not consistent with Moringa Oleifera and the authors actually refer to it as Moringa Concanensis in the article. Sethi et al quote Sukla et al., 1988 and Zade et al., 2010 who clearly stated: "*aqueous extracts of the **roots** of both plants Moringa Oleifera and Moringa Concanensis and of the **bark** of Moringa oleifera have been reported to be effective in preventing implantation in rats*".

Other studies investigating the potential abortifacient properties of Moringa Oleifera:

- Nath et al.,1992 demonstrated that Moringa Oleifera leaf extract at 175mg/kg showed 100% abortifacient activity in rats;
- Ekhator, C. N. and U. C. Osifo. (2015) show that Moringa Oleifera leaves may be abortifacient, potentially occurring in the 1st trimester of pregnancy in rats;
- Agrawal et al., 2018 demonstrated that Moringa Oleifera ethanol leaf extract of 100 mg/kg did not show any significant difference in antifertility post-implantation compared to control but at dose 500 mg/kg produced antifertility activity by inhibiting the implantation in female rats; and
- Attah et al., 2020 found that aqueous extract of Moringa Oleifera leaf in Nigerian ethnomedicine alters conception and some pregnancy outcomes in Wistar rats. "*The abundance of these phenolic antioxidant metabolites in M. Oleifera leaves could result in significant disruption of endocrine physiology manifesting in the observed inhibition of conception and abortifacient activity*.".

In a recent study, Onyeaghala, et al., (2024) conclude that "*Supplementation with Moringa Oleifera in infertile women could help reduce the effects of Oxidative Stress (OS) and may likely improve pregnancy outcomes*."

To summarise the above research:

All the studies involved extracts from different parts of the plant and using different solvents. The conclusions on all reviews of these experiments indicate that using Moringa leaf, immature (green) pods and seed oil are safe as quantities of intake to match extraction concentrations would be near impossible to consume.

The Applicant acknowledges that this application is strictly constrained to use of Moringa Oleifera leaf (fresh and dried), immature (green) pods and seed oil as a food. The bark, root and extracts from the Moringa Oleifera tree are not in scope for the application. Nevertheless, it is important to underscore that Moringa Oleifera, especially at high doses such as 600 mg/kg+, must be used with caution, particularly for women who are pregnant or are attempting to get pregnant.

C.6.4 Safety assessment reports prepared by international agencies or other national government agencies

Refer to the following information sources:

1. Government of Canada. List of non-novel determinations for food and food ingredients: https://www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/requesting-novelty-determination/list-non-novel-determinations.html
2. European Commission for Food Safety: https://webgate.ec.europa.eu/fip/novel_food_catalogue/
3. National Health Commission, China (NHC) Announcement No. 19 - to consider Moringa Oleifera leaves as a new food resource: http://www.nhc.gov.cn/sps/pztg/201612/712553a5f7554e0e9ec1dfdbcc91e99a.shtml
4. Senate of the Philippines. Malunggay development act of 2007: https://legacy.senate.gov.ph/lis/bill_res.aspx?congress=14&q=SBN-1799

C.7. Foods produced by a process not previously applied to food

Not applicable.

C.7.1 Details of the process not previously applied to food

C.7.2 Information on the toxicity of the novel food produced by a process not previously applied to food

C.7.3 Safety assessment reports prepared by international agencies or other national government agencies

D. Information on dietary exposure to the novel food

D.1. A list of the foods or food groups proposed to or which might contain the novel food ingredient or substance

It is proposed that Moringa Oleifera may be used as a food or food ingredient, as follows:

1. Fresh leaf – consumed as a vegetable, similar to kale or broccoli;
2. Dried leaf – typically powdered and consumed as a food ingredient in non-alcoholic beverages or consumed as a capsule;
3. Immature (green) pods – consumed as a vegetable, similar to asparagus or broccoli;
4. Seed oil – used for frying.

D.2. The proposed level of the novel food ingredient or substance for each food or food group

1. Fresh leaf – 40 grams per person daily (with an absolute maximum of 70 grams per person daily);
2. Dried leaf (powdered) – 5 grams per person daily:
    a. Water beverage – 2 grams/300ml water;
    b. Blended juice - 5 - 20% in blended juice;
    c. Smoothie – 1.5% - 4.5% w/w;
    d. Capsule – 5 grams (1 teaspoon) in capsule form;
3. Immature (green) pods – 40 grams per person daily (with an absolute maximum of 70 grams per person daily);
4. Seed oil – maximum of 5 ml (1 teaspoon) per person daily used in combination with other common oils such as canola, sunflower or olive oil for frying.

Refer to Appendix H for examples of products that are readily available in the USA[34].

Refer to Appendix K for more information on food product analysis.

D.3. For foods or food groups not currently listed in the most recent Australian or New Zealand (NNSs), information on the likely level of consumption

Information concerning Moringa Oleifera was not available in the 2011–12 National Nutrition and Physical Activity Survey (NNPAS) component of the 2011–13 Australian Health Survey (2 years and above), the 2008–09 New Zealand NNS (15 years and above) and the 2002 New Zealand Children's NNS (5–14 years).

1. Fresh leaf - 40 grams per person daily (with an absolute maximum of 70 grams per person daily);
2. Dried leaf (powdered) - 5 grams (1 teaspoon) per person daily:
    a. Water beverage – 2 grams/300ml water;
    b. Blended juice - 5 - 20% in blended juice;
    c. Smoothie – 1.5% - 4.5% w/w;

[34] US Department of Agriculture (USDA). (2023). https://fdc.nal.usda.gov/fdc-app.html#/ ;accessed 16/02/23.

d. Capsule – 5 grams (1 teaspoon) in capsule form;

3. Immature (green) pods – 40 grams per person daily (with an absolute maximum of 70 grams per person daily);
4. Seed oil – 5 ml (1 teaspoon) per person daily.

D.4. The percentage of the food group in which the novel food ingredient is proposed to be used or the percentage of the market likely to use the novel food ingredient

According to Reynolds, O., & Robertson, M., in Australia, Moringa Oleifera had an industry value of $0.1m in 2019, with estimates suggesting the potential size of the Moringa industry could reach $2-5m by 2030.

D.5. For foods where consumption has changed in recent years, information on likely current food consumption

Refer to section D.2 above for the proposed levels of consumption.

D.6. Data to show whether the food, or the food in which the novel food ingredient is used, is likely to replace another food from the diet, if applicable

The novel food Moringa Oleifera is to be used as an alternative nutritious food source in a balanced diet and not as a substitute or replacement of one food group for another, e.g., not to replace fats or carbohydrates. Therefore, the nutritional intake in a total, balanced diet is expected to remain constant.

D.7. Information relating to the use of the novel food or novel food ingredient in other countries, if applicable

As described in section C.1.3 above, Moringa Oleifera leaves, pods and oil are available as standard foods in many countries, including (but not limited to) the USA, Canada, European Union, UK, China, Japan and the Philippines. Here in Australia, Moringa Oleifera food products are freely available in our major retail food stores, despite its current classification as a non-traditional and novel food (refer to section D).

Most of the production and international trade of Moringa Oleifera comes from India, in canned produce, fresh fruits, oil, seeds, and leaf. India has an annual production of 1.1 - 1.3 million tonnes of tender pods. It is estimated that approximately 50-60 tonnes and 20-30 tonnes of Moringa Oleifera leaf are imported to Germany and the UK respectively, each year[35]. Refer to Appendix H for an additional set of data from the US Department of Agriculture (USDA) Food Data Central website demonstrating the range of products that are readily available in the USA[36].

[35] CBI Ministry of Foreign Affairs. (Dec, 2022). *The European market potential for moringa*. https://www.cbi.eu/market-information/natural-ingredients-health-products/moringa/market-potential#which-european-countries-offer-most-opportunities-for-moringa ;accessed 16/02/2023.

[36] US Department of Agriculture (USDA). (2023). https://fdc.nal.usda.gov/fdc-app.html#/ ;accessed 16/02/23.

E. Information on the nutritional and health impact of the novel food

E.1. Information to demonstrate that the use of the novel food or novel food ingredient will not cause a nutritional imbalance in the diet

The novel food Moringa Oleifera is to be used as an alternative nutritious food source in a balanced diet and not as a substitute or replacement of one food group for another, e.g., not to replace fats or carbohydrates. Therefore, the nutritional intake in a total, balanced diet is expected to remain constant and not cause a nutritional imbalance.

E.2. Information to demonstrate that the addition of the novel food ingredient will not create a significant negative public health impact

The proposed change and inclusion of Moringa as a food is not intended to effectuate a potential beneficial physiological or health-related effect. Therefore, this sub-section is not applicable.

F. Information related to potential impact on consumer understanding and behaviour

F.1. Information to demonstrate the level of consumer awareness and understanding of the novel food or novel food ingredient

The proposed change and inclusion of Moringa as a novel food is not intended to effectuate a potential beneficial physiological or health-related effect. Therefore, this sub-section is not applicable.

F.2. Information on the actual or potential behaviour of consumers in response to the novel food or novel food ingredient

The proposed change and inclusion of Moringa as a food is not intended to effectuate a potential beneficial physiological or health-related effect. Therefore, this sub-section is not applicable.

F.3. Information to demonstrate that the food(s) containing the novel food ingredient will not adversely affect any population groups (e.g., particular age or cultural group)

The novel food Moringa Oleifera is to be used as an alternative nutritious food source in a balanced diet and not as a substitute or replacement of one food group for another, e.g., not to replace fats or carbohydrates. Therefore, the nutritional intake in a total, balanced diet is expected to remain constant.

The novel food Moringa will provide an alternative, plant-based nutritious food source to those sub-populations who may be seeking alternatives to animal products due to their religious beliefs or personal choices (e.g., vegetarians, vegans).

3.0 Bibliography

Abd Rani, Z., Husain, K., Kumolosasi, E. (2018) Moringa Genus: A Review of Phytochemistry and Pharmacology. Frontiers in Pharmacology.,9 (2018), p.108. https://www.frontiersin.org/articles/10.3389/fphar.2018.00108.

Agrawal SS., Vishal Dm Sumeet G., Shekhar C., Ashish N., Parul D., Ankita S., Prakash A., Prakash T., Kumar P., Varun C. (2018). Antifertility Activity of Ethanol Leaf Extract of Moringa oleifera Lam. In female Wistar rats. Indian Journal of Pharmaceutical Sciences May-June 2018.

Al Juhaimi F., Özcan MM., Ghafoor K., Babiker EE., Hussain S. (2018). Comparison of cold-pressing and soxhlet extraction systems for bioactive compounds, antioxidant properties, polyphenols, fatty acids and tocopherols in eight nut oils. *Food Science Technology*, Aug;55(8):3163-3173. doi: 10.1007/s13197-018-3244-5. Epub 2018 Jun 7. PMID: 30065427; PMCID: PMC6045996.

Albrahim T, Binobead MA. (2018). Roles of Moringa oleifera Leaf Extract in Improving the Impact of High Dietary Intake of Monosodium Glutamate-Induced Liver Toxicity, Oxidative Stress, Genotoxicity, DNA Damage, and PCNA Alterations in Male Rats. Oxid Med Cell Longev. 2018 Dec 17;2018:4501097. doi: 10.1155/2018/4501097. PMID: 30647808; PMCID: PMC6311796.

Asare GA., Gyan B., Bugyei K., Adjei S., Mahama R., Addo P., Otu-Nyarko L., Wiredu EK., Nyarko A. (2012). Toxicity potentials of the nutraceutical Moringa oleifera at supra-supplementation levels. J Ethnopharmacol. 2012 Jan 6;139(1):265-72. doi: 10.1016/j.jep.2011.11.009. Epub 2011 Nov 11. PMID: 22101359.

Asiedu-Gyekye IJ., Frimpong-Manso S., Awotwe C., Antwi DA., Nyarko AK. (2014). Micro- and Macro-elemental Composition and Safety Evaluation of the Nutraceutical Moringa oleifera Leaves. J Toxicol. 2014;2014:786979. doi: 10.1155/2014/786979. Epub 2014 Jul 22. PMID: 25136361; PMCID: PMC4129914.

Attah AF., Moody JO., Sonibare MA., Salahdeen HH., Akindele OO., Nnamani PO., Diyaolu OA., Raji Y. (2020). Aqueous extract of Moringa oleifera leaf used in Nigerian ethnomedicine alters conception and some pregnancy outcomes in Wistar rat. African Journal of Botany 129:255-262.

Awodele O., Oreagba IA., Odoma S., Teixeira da Silva JA., Osunkalu VO. (2012). Toxicological evaluation of the aqueous leaf extract of Moringa oleifera Lam. (Moringaceae) J. Ethnopharmacol. 139(2):330-6.

Azlan, U.K.; Mediani, A.; Rohani, E.R.; Tong, X.; Han, R.; Misnan, N.M.; Jam, F.A.; Bunawan, H.; Sarian, M.N.; Hamezah, H.S. (2022). A Comprehensive Review with Updated Future Perspectives on the Ethnomedicinal and Pharmacological Aspects of Moringa oleifera. *Molecules*, 27, 5765. https://doi.org/ 10.3390/molecules27185765.

Babatunde S. Ogunsina & T. N. Indira, A. S. Bhatnagar, C. Radha, S. Debnath & A. G. Gopala Krishna. (2014). Quality characteristics and stability of Moringa oleifera seed oil of Indian origin. *Food Science Technology,* 51(3):503–510. DOI 10.1007/s13197-011-0519-5: https://www.researchgate.net/publication/267336234.

Balamurugan S., Vijayakumar S., Prabhu S., Morvin Yabesh JE. (2018). Traditional plants used for the treatment of gynaecological disorders in Vedaranyam taluk, South India - An ethnomedicinal survey J Tradit Complement Med. 8(2):308-323.

Bhattacharya, A., Tiwari P., Sahu PK., Kumar S. (2018). A review of the phytochemical and pharmacological characteristics of Moringa oleifera. J. Pharm. Bioallied Sci. 10, 181–191.

Borges Teixeira EM., Barbieri Carvalho MR., Neves VA., Apareci Silva M., Arantes-Pereira L. (2014). Chemical characteristics and fractionation of proteins from Moringa oleifera Lam. *Leaves Food Chem*, 147:51– 4. doi: 10.1016/j.foodchem.2013.09.135.

Coriolis. (2020a). New Opportunities 2020: The next wave in new and emerging agricultural industries in Australia (Stage I). AgriFutures Australia, Wagga Wagga, NSW, Australia. https://www.agrifutures.com.au/wp-content/ uploads/2021/05/21-052a.pdf.

De Barros MC., Silva AGB., Souza TGDS., Chagas CA., Machado JCB., Ferreira MRA., Soares LAL., Xavier VL., de Araújo LCC., Borba EFO., da Silva TG., Alves RRV., Coelho LCBB., de Oliveira AM., Napoleão TH., Paiva PMG. (2022). Evaluation of acute toxicity, 28-day repeated dose toxicity, and genotoxicity of Moringa oleifera leaves infusion and powder. J Ethnopharmacol. 2022 Oct 5;296:115504. doi: 10.1016/j.jep.2022.115504. Epub 2022 Jun 26. PMID: 35760258.

Devisetti R., Sreerama YN., Bhattacharya S. (2016). Processing effects on bioactive components and functional properties of moringa leaves: development of a snack and quality evaluation. *Food Science Technology*, Jan;53(1):649-57. doi: 10.1007/s13197-015-1962-5. Epub 2015 Aug 14. PMID: 26787984; PMCID: PMC4711410.

Ekhator, C. N. and U. C. Osifo. (2015). Abortifacient Efficacy of Moringa oleifera Leave: An Experimental Study on Adult Female Wistar Rats. American Journal of Biology and Life Sciences 2015; 3(6): 269-272.

Fahey, Jed. (2005). Moringa oleifera: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part 1. *Trees Life*, 1. 10.1201/9781420039078.ch12.

FAO., IFAD., UNICEF., WFP. and WHO. (2022). The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable., Rome, FAO, p. 25 (Executive Summary), https://doi.org/10.4060/cc0639en (accessed 11/03/2023).

Fu, X., Su, J., Hou, L. et al. (2021). Physicochemical and thermal characteristics of Moringa oleifera seed oil. Adv Compos Hybrid Mater 4, 685–695 (2021). https://doi.org/10.1007/s42114-021-00302-4

Gautier, A., Duarte, C.M., Sousa, I. (2022). Moringa oleifera Seeds Characterization and Potential Uses as Food. *Foods*, 11, 1629. https://doi.org/10.3390/ foods11111629.

Gharsallaha, K., Rezigb, L., Msaadad, K., Chalhe, A., Soltani, T., (2021). Chemical Composition and Profile Characterisation of Moringa oleifera Seed Oil. *South African Journal of Botany*, 137. 475-482. 10.1016/j.sajb.2020.11.014.

Grosshagauer S., Pirkwieser P., Kraemer K. and Somoza V. (2021). The Future of Moringa Foods: A Food Chemistry Perspective. *Front. Nutr,* 8:751076. doi: 10.3389/fnut.2021.751076. https://www.frontiersin.org/articles/10.3389/fnut.2021.751076/full

Gutiérrez-Luna, K., Ansorena, D., & Astiasarán, I. (2022). Fatty acid profile, sterols and squalene content comparison between two conventional (olive oil and linseed oil) and three non-conventional vegetable oils (echium oil, hempseed oil, and moringa oil). *Journal of Food Science*, 87,1489–1499. https://doi.org/10.1111/1750-3841.16111.

Hamid, Hamid. & Attri, Surekha. & Thakur, N. (2014). ANTINUTRITIONAL FACTORS IN FOODS. 10.13140/RG.2.2.23561.75368. https://www.researchgate.net/publication/325651452_ANTINUTRITIONAL_FACTORS_IN_FOODS

Harvard T.H. Chan School of Public Health. (2022). Are Anti-Nutrients Harmful?

https://www.hsph.harvard.edu/nutritionsource/anti-nutrients/

Islam, Zahidul & Islam, s. M. & Hossen, Faruk & Hasan, Mohammad & Karim, Rezaul & Mahtab-ul-Islam, Kazi. (2021). Moringa oleifera is a Prominent Source of Nutrients with Potential Health Benefits. *International Journal of Food Science*, 11. 10.1155/2021/6627265.

Kartik Sharma, Ramandeep Kaur, Satish Kumar, Ramesh Kumar Saini, Surabhi Sharma, Subhash V Pawde, Vikas Kumar. (2023). Saponins: A concise review on food related aspects, applications and health implications. Food Chemistry Advances, Volume 2, 2023, 100191, https://doi.org/10.1016/j.focha.2023.100191.

(https://www.sciencedirect.com/science/article/pii/S2772753X23000114)

Kashyap, P., Kumar, S., Riar, C.S., Jindal, N., Baniwal, P., Guiné, R.P.F., Correia, P.M.R., Mehra, R., Kumar, H. (2022). Recent Advances in Drumstick (Moringa oleifera) Leaves Bioactive Compounds: Composition, Health Benefits, Bioaccessibility, and Dietary Applications. *Antioxidants,* 11, 402. https://doi.org/ 10.3390/antiox11020402.

Khan, Muhammad & Shakoor, Sadaf & Ameer, Kashif & Farooqi, Muhammad & Rohi, Madiha & Saeed, Muhammad & Asghar, Muhammad & Irshad, Muhammad & Waseem, Muhammad & Tanweer, Saira & Ali, Umair & Mohamed Ahmed, Isam & Ramzan, Yasra. (2023). Effects of Dehydrated Moringa (Moringa oleifera) Leaf Powder Supplementation on Physicochemical, Antioxidant, Mineral, and Sensory Properties of Whole Wheat Flour Leavened Bread. *Journal of Food Quality*, 1-13. 10.1155/2023/4473000.

Laode Muslimin, Ramdan Panigoro, Gaga Irawan Nugraha, Susi Susanah, Gemilang Lara Utama, Mas Rizki A.Asyamsumarno, and Tasnim. (2023). The Effect of Anti-nutrition and Bioavailability of Iron of Moringa Oleifera on Rat Hematology Model Iron Deficiency Anemia. Review Article. *Journal of Food and Nutrition Research*, vol. 11, no. 1 : 25-36. doi: 10.12691/jfnr-11-1-3.

Laoung-On J., Saenphet K., Jaikang C., Sudwan P. (2021). Effect of Moringa oleifera Lam. Leaf Tea on Sexual Behavior and Reproductive Function in Male Rats. Plants (Basel). 2021 Sep 26;10(10):2019.

Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J., & Bertoli, S. (2016). Moringa oleifera Seeds and Oil: Characteristics and Uses for Human Health. *International Journal of Molecular Sciences*, 17(12).

Li L, Ma L, Wen Y, Xie J, Yan L, Ji A, Zeng Y, Tian Y and Sheng J. (2022). Crude Polysaccharide Extracted From Moringa oleifera Leaves Prevents Obesity in Association With Modulating Gut Microbiota in High-Fat Diet-Fed Mice. *Front. Nutr*, 9:861588. Page 2. doi: 10.3389/fnut.2022.861588. https://www.frontiersin.org/articles/10.3389/fnut.2022.861588/full (accessed 24/03/23).

Lo, Diana & Wang, Hsin-I & Wu, Jane & Yang, Ray-Yu. (2018). Anti-nutrient components and their concentrations in edible parts in vegetable families. https://www.researchgate.net/publication/329880400_Anti-nutrient_components_and_their_concentrations_in_edible_parts_in_vegetable_families

Mbah BO., Eme PE., Ogbusu OF. (2012). Effect of cooking methods (boiling and roasting) on nutrients and anti-nutrients content of Moringa oleifera seeds. *Pakistan J Nutr*, 11:211–5. doi: 10.3923/pjn.2012.211.215

Monteiro, Josélia and Scotti-Campos, Paula and Pais, Isabel and Figueiredo, A. Cristina and Viegas, Dulce and Reboredo, Fernando Henrique. (2022). Elemental Composition, Total Fatty Acids, Soluble Sugar Content and Essential Oils of Flowers and Leaves of Moringa Oleifera Cultivated in Southern Portugal. Available at SSRN: https://ssrn.com/abstract=4128781 or http://dx.doi.org/10.2139/ssrn.4128781.

Muhammad Azhar Ali, Yus Aniza Yusof, Nyuk Ling Chin, M. N. Ibrahim & Sadaf Muneer. (2019). Development and Standardization of Moringa oleifera Leaves as a Natural Dietary Supplement, Journal of Dietary Supplements, 16:1, 66-85, DOI: 10.1080/19390211.2018.1429517.

Nadeem M., Imran M. (2016). Promising features of Moringa oleifera oil: recent updates and perspectives. Lipids Health Dis. 2016 Dec 8;15(1):212. doi: 10.1186/s12944-016-0379-0. PMID: 27931216; PMCID: PMC5146848.

Nath D., Sethi N., Singh RK., Jain AK. (1992). Commonly used Indian abortifacient plants with special reference to their teratologic effects in rats J. Ethnopharmacol. 1992 Apr;36(2):147-54.

Niranjan, A., Ngpoore, N. K., Anis, N., Kumar, A., Lehri, A., Shirke, P. A., & Tewari, S. K. (2017). Simultaneous quantification of six phenolic compounds in various parts of Moringa oleifera Lam. using high-performance thin-layer chromatography. JPC - Journal of Planar Chromatography - Modern TLC, 30(6), 502–509. https://doi.org/10.1556/1006.2017.30.6.7

Njan A.A., Amali M.O., Olatunji L.O. and Olorundare O.E. (2023). An Overview of the Ethno-Pharmacological Potentials of Moringa Oleifera Lam, "The Miracle Tree". https://www.researchgate.net/publication/284183087_An_Overview_of_the_Ethno-Pharmacological_Potentials_of_Moringa_Oleifera_Lam_The_Miracle_Tree

Núñez-Gastélum JA., A.A. Arguijo-Sustaita, José A. López-Díaz et al. (2022). Seed germination and sprouts production of Moringa oleifera: A potential functional food?, *Journal of the Saudi Society of Agricultural Sciences*, https://doi.org/10.1016/j.jssas.2022.12.002 (accessed 11/03/2023).

Olayemi AT., Olanrewaju MJ., Oloruntoba AC. (2016). Toxicological evaluation of Moringa oleifera Lam seeds and leaves in Wistar rats Pharmacogn.Commn. 6(2) 100-111.

Onyeaghala, Augustine, Agwu, Megdaleine Chika and Ogungbemile, Babalola Dokun. (2024). Effect of Supplementation with Moringa Oleifera on Antioxidant and Oxidative Stress Biomarkers of Infertile Women: A Pilot Open-Label Case-Control Randomized Clinical Study. Qeios. doi:10.32388/KMR4OD.

Ozaifa Kareem, Tabasum Ali, Lateef Ahmad Dar, Suhail Ahmad Mir, Rumaisa Rashid, Naqshab Nazli, Tawseef Gulzar & G. N. Bader. (2022). Positive Health Benefits of Saponins from Edible Legumes: Phytochemistry and Pharmacology. First Online: 15 March 2022. https://link.springer.com/chapter/10.1007/978-981-16-4959-2_8

Özcan, M.M., & Ghafoor, Kashif & Juhaimi, F., & Mohamed Ahmed, Isam & Babiker, Elfadil. (2019). Effect of cold-press and soxhlet extraction on fatty acids, tocopherols and sterol contents of the Moringa seed oils. *South African Journal of Botany*, 124. 333-337. 10.1016/j.sajb.2019.05.010.

Pandey A., Pandey RD., Tripathi P., Gupta PP., Haider J., et al. (2012). Moringa Oleifera Lam. (Sahijan) - A Plant with a Plethora of Diverse Therapeutic Benefits: An Updated Retrospection. Medicinal Aromatic Plants 1:101.

Pankaj H., Chaudhary et al. (2022). A Pharmacognosy, Ethanobotany and Phytopharmacology of Moringa oleifera Lam. Journal of PharmTech Research, 2022,15(2):73-82.

Pareek, A., Pant, M., Gupta, M.M., Kashania, P., Ratan, Y., Jain, V., Pareek, A., Chuturgoon, A.A. (2023). Moringa oleifera: An Updated Comprehensive Review of Its Pharmacological Activities, Ethnomedicinal, Phytopharmaceutical Formulation, Clinical, Phytochemical, and Toxicological Aspects. *Int. J. Mol. Sci.*, 24, 2098. https://doi.org/ 10.3390/ijms24032098.

Peñalver, R., Martínez-Zamora, L., Lorenzo, J.M., Ros, G.; Nieto, G. (2022). Nutritional and Antioxidant Properties of Moringa oleifera Leaves in Functional Foods. *Foods,* 11, 1107. https:// doi.org/10.3390/foods11081107.

Pop, O.L., Kerezsi, A.D., Ciont (Nagy), C. (2022). A Comprehensive Review of Moringa oleifera Bioactive Compounds—Cytotoxicity Evaluation and Their Encapsulation. *Foods*, 11, 3787. https://doi.org/10.3390/ foods11233787.

Popoola JO., Aworunse OS., Oyesola LO., Akinnola OO., Obembe OO. (2020). A systematic review of pharmacological activities and safety of Moringa oleifera. *J Herbmed Pharmacol*, 9(3):174-190. doi: 10.34172/jhp.2020.24.

Reynolds O., and Robertson. M. (2022). Australian Moringa Strategic RD&E Plan (2022-2027), *Agrifutures Australia,* p. 5, https://agrifutures.com.au/wp-content/uploads/2022/02/22-002.pdf (accessed 22/08/2022).

Rockwood J. L., Anderson B. G., Casamatta D. A. (2013). Potential uses of Moringa oleifera and an examination of antibiotic efficacy conferred by Moringa Oleifera seed and leaf extracts using crude extraction techniques available to under-served indigenous populations. *International Journal of Phytotherapy Research*, 3(2):61–71. [Google Scholar].

Rong Liu, Jing Liu, Qi Huang, Shao Liu, Yueping Jiang, (2022). Moringa oleifera: a systematic review of its botany, traditional uses, phytochemistry, pharmacology and toxicity. Journal of Pharmacy and Pharmacology, Volume 74, Issue 3, March 2022, Pages 296–320, https://doi.org/10.1093/jpp/rgab131

Sánchez-Machado DI., Núñez-Gastélum JA., Reyes-Moreno C., Ramírez-Wong B., López-Cervantes J. (2010). Nutritional quality of edible parts of Moringa oleifera. *Food Anal Methods*, 3:175–80. Doi: 10.1007/s12161-009-9106-z.

Sethi, N. & Nath, Dipjyoti & Shukla, S. & Dyal, R. (1988). Abortifacient activity of a medicinal plant Moringa oleifera. Ancient science of life. 7. 172-4.

Shukla S., Mathur R., Prakash AO. (1988). Biochemical and physiological alterations in female reproductive organs of cyclic rats treated with aqueous extract of Moringa oleifera Lam. Acta Eur Fertil. 1988 Jul-Aug;19(4):225-32.

Shivangi Srivastava, Vinay Kumar Pandey, Kshirod K. Dash, Deen Dayal, Pranay Wal, Biplab Debnath, Rahul Singh, Aamir Hussain Dar. (2023). Dynamic bioactive properties of nutritional superfood Moringa oleifera: A comprehensive review. Journal of Agriculture and Food Research, Volume 14, 2023, 100860. ISSN 2666-1543,

https://doi.org/10.1016/j.jafr.2023.100860.
(https://www.sciencedirect.com/science/article/pii/S2666154323003678)

Stockmann, R. (2018). Nutritional composition of Moringa leaves. Principal Research Scientist/Engineer & Team Leader – Food: Separation Sciences, Agriculture and Food, CSIRO. (Unpublished report - commissioned by DPIRD).

Stohs SJ., Hartman MJ. (2015). Review of the Safety and Efficacy of Moringa oleifera. Phytother Res. 2015 Jun;29(6):796-804. doi: 10.1002/ptr.5325. Epub 2015 Mar 24. PMID: 25808883; PMCID: PMC6680322.

Trigo, C., Castelló, M.L., Ortolá, M.D., García-Mares, F.J., Desamparados Soriano, M. (2021). Moringa oleifera: An Unknown Crop in Developed Countries with Great Potential for Industry and Adapted to Climate Change. *Foods,* 10, 31. https://dx.doi.org/10.3390/foods 10010031 Received: 9 November 2020 Accepted: 16 December 2020 Published: 24 December 2020.

Trigo, Carla & Castelló, María & Ortolá, María. (2022). Potentiality of Moringa oleifera as a Nutritive Ingredient in Different Food Matrices. *Plant Foods for Human Nutrition*, 78. 1-13. 10.1007/s11130-022-01023-9.

Verem, T.B., Dooshima, I.B., Ojoutu, E.M., Owolabi, O.O. and Onigbajumo, A. (2021) Proximate, Chemical and Functional Properties of Wheat, Soy and Moringa Leaf Composite Flours. *Agricultural Sciences*, 12, 18-38. https://doi.org/10.4236/as.2021.121003.

Wilkinson, V., Morris, T., & Hughes D. (2021). The next wave of emerging industry opportunities 2020. *AgriFutures Australia*, Wagga Wagga, NSW, Australia. https://www.agrifutures.com.au/wp-content/uploads/2021/05/21-052-2.pdf.

Zade V., Pare S., Dabhadkar D., Chendekar R. (2010). Abortifacient efficacy of Moringa oleifera in albino rats. Int. J. Pharmacol. Biol. Sci. 4(2) 2010, 133-138.

Zhang, H., Tian, Y., Wang, W., Gao, X., Luo, Q., Sheng, J. and Zeng, Q. (2021). Research and development of moringa in China. *Acta Hortic*, 1306, 363-370, DOI: 10.17660/ActaHortic.2021.1306.47, https://doi.org/10.17660/ActaHortic.2021.1306.47.

Zvinorova PI., Lekhanya L., Erlwanger K., Chivandi E. (2014). Dietary effects of Moringa oleifera leaf powder on growth, gastrointestinal morphometry and blood and liver metabolites in Sprague Dawley rats. J Anim Physiol Anim Nutr (Berl). 2015 Feb;99(1):21-28. doi: 10.1111/jpn.12182. Epub 2014 Mar 24. PMID: 24661493.