Factsheet Fava bean

Cosun
Nutrition Center

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From both a nutritional and environmental sustainability perspective, fava bean can help the shift towards a more sustainable and healthy diet. This factsheet discusses the nutritional properties of fava bean, the environmental footprint of fava bean and the food safety of fava bean.

The fava bean (Vicia faba L.), also known as faba bean or broad bean, is one of the oldest crops in the world. It is an important source of protein in the diet in Northern and Eastern Africa, Western and Eastern Asia and the Middle East. Fava beans can be consumed both raw and processed. The shift from a more animal-based to a more plant-based diet has brought renewed attention to the fava bean. This is because fava bean is a sustainable protein source, with a great potential for nutritional and functional properties. This makes fava bean very suitable for industrial food applications[1-4].

Nutritional properties of fava bean

The fava bean contains dietary fibers, vitamins (i.e. folic acid, niacin, and vitamin C), and minerals (i.e. calcium, iron, magnesium, potassium). Furthermore, fava bean is low in fat and has a high protein content (up to 35% in dry seeds)[1, 5, 6].

Protein quality

The quality of the protein in a food depends on a number of criteria[7]:

1. The amount of protein in the food;
2. The amount of essential amino acids in the protein;
3. The extent to which the protein is digested in the intestine and the amino acids released are absorbed into the body.

There are different methodologies for determining protein quality. The most scientifically valued method is the Digestible Indispensable Amino Acid Score (DIAAS, see **Textbox 1**).

Textbox 1: Determination of protein quality.

Multiple measures have been developed to calculate the quality of a protein. Since 2011, the Food and Agriculture Organization of the United Nations (FAO) has recommended the use of the Digestible Indispensable Amino Acid Score (DIAAS). DIAAS reflects the percentage of the total daily requirement for the most limiting dietary indispensable amino acid (DIAA) and can be calculated as follows[8]:

$$DIAAS\ (\%) = 100 \times lowest\ value \frac{\text{mg of digestible DIAA in 1 g of the dietary test protein}}{\text{mg of the same amino acid in 1 g of the reference protein}}$$

The digestible DIAA content is calculated as the content of each amino acid of the protein multiplied by their respective digestibility coefficients

A classification of proteins using quality categories based on the DIAAS value has been proposed by the FAO: <75 (no quality claim); 75–99 (high-quality protein); and ≥100 (excellent quality protein)[8].

In general, the quality of plant protein is lower than that of animal protein. This is generally caused by the fact that in many plant products certain essential amino acids are only present in smaller amounts or completely absent. Furthermore, the bioavailability of plant-based protein is limited by the presence of so-called anti-nutritional factors. These anti-nutritional factors negatively affect the digestion and absorption of amino acids[9, 10]. By processing a product (for example cooking, soaking, fermenting) the bioavailability can be improved.

The DIAA values and DIAAS of various plant-based protein sources including fava bean, are shown in **Table 1**. The data in the table show that the majority of these plant-based protein sources have a DIAAS below 75, meaning they are of low quality. However, because these protein sources have a different amino acid profile, they can complement each other in a meal or a daily diet. For instance, the limiting amino acids for fava bean are the sulfur-containing amino acids (i.e. methionine and cysteine). Incorporating wheat, corn and/or potatoes into the diet will ensure that these amino acids are no longer limited. Vice versa, corn is low in lysine and adding fava bean into the diet will improve the overall lysine intake. Hence, it is important to consume a combination of various plant-based protein sources when following a plant-based diet. In a diet which also includes meat and/or dairy, the protein quality of plant-based protein sources will be less of an issue, since the animal-based protein sources will provide the limiting digestible indispensable amino acids[11].

"It is important to consume a combination of various plant-based protein sources when following a plant-based diet."

Table 1: Digestible indispensable amino acid scores of fava bean and various other plant-based protein sources*[12].

Essential amino acids**	Fava bean	Corn	Wheat	Pea	Soy	Potato
Methionine + Cysteine	55	126	127	70	91	115
Tryptophan	68	52	127	77	132	128
Valine	83	90	92	83	95	138
Threonine	91	86	78	94	105	165
Leucine	95	162	87	87	102	143
Lysine	95	36	48	110	96	122
Isoleucine	106	90	91	101	124	156
Histidine	108	110	118	99	119	100
Fenylalanine + Tyrosine	119	140	109	116	147	210
DIAAS	55	36	48	70	91	100
Limiting AA	Met+Cys	Lys	Lys	Met+Cys	Met+Cys	NA

**= Based on reference pattern scores of children aged 0.5–3 years.*
***= Ranked from lowest to highest DIAA for fava bean.*
Abbreviation: DIAAS = Digestible Indispensable Amino Acid Score; AA = amino acid; NA = not applicable in case of DIAAS ≥100.

Fava bean as an ingredient

Besides its nutritional properties, the fava bean has very interesting functional properties. Ingredients from the fava bean (e.g. flour, concentrate, isolate) have the potential to be used as foaming, emulsifying, and gelling agents in dairy and meat alternatives[4]. One example of a high-quality fava bean protein isolate is Tendra® Fava Protein Isolate from Cosun Protein (see **Textbox 2**).

When fava bean is used as an ingredient the protein quality of a product can be improved by using multiple protein sources. For example, using a mixture of fava bean/corn/soy (ratio: 10/20/70) can improve the DIAAS to 85 and with a mixture of fava bean/corn/potato (ratio: 15/20/65) it is possible to reach a DIAAS of 100[12]. When using mixtures it is important to consider all dietary indispensable amino acids, since a second limiting amino acid can also be below the level of requirement[13].

Fava bean as part of a healthy diet

Since fava bean has a high protein content, and also contributes to fiber, vitamin and mineral intake, it can be part of a healthy diet. When fava bean is used as an ingredient, the nutritional properties of the end product determine if it is a healthy alternative for meat or dairy. The Netherlands Nutrition Centre indicates that a good meat substitute contains the following nutrients[14]:

- Protein (more than 20% of the total energy in the product)
- Iron (more than 0.8 milligrams per 100 grams)
- Vitamin B1 (more than 0.06 milligrams per 100 grams), and/or vitamin B12 (0.24 micrograms per 100 grams)
- Not too much saturated fat (no more than 2.5 grams per 100 grams)
- Not too much salt (no more than 1.1 grams per 100 grams)
- No added sugars

Nutrition and health claims for fava bean

In the European Union two nutrition claims on protein have been approved by the European Commission[15]:

- Source of protein
- High protein

The “source of protein” claim may be made when at least 12% of the energy value of the food is provided by protein. The “high protein” claim may be made when at least 20% of the energy value of the food is provided by protein. If the use of fava bean ingredients leads to a protein content of ≥12en%, it is allowed to make a nutrition claim.

No health claim for fava bean has yet been authorized in the European Union.

Textbox 2: Tendra® Fava Protein Isolate

Tendra® Fava Protein Isolate is a high-quality fava protein isolate produced by Cosun Protein. It contains 85 ± 3 % protein and is low in carbohydrates, salts, fats and sugars. Tendra® Fava Protein Isolate has a neutral taste, high solubility and good nutritional value. It is highly suitable as a functional protein ingredient in products like dairy alternatives, functional drinks, vegan ice creams and dressings. Tendra® Fava Protein Isolate is hypoallergenic and does not require allergen labeling. More details can be found at **https://www.cosunprotein.com/**

A sustainable plant protein source

From a sustainability point of view the fava bean can be considered a good plant-based protein source to partly replace proteins from animal sources. Its greenhouse gas emission and global average water footprint are relatively low. It is well adapted to various climates and fava bean has the ability to bind atmospheric nitrogen (i.e. converting nitrogen in the atmosphere into forms that plants can absorb through their root systems), reducing the application of synthetic fertilizers[1, 16-18].

Greenhouse gas emission

The total CO_2-eq emission for fava bean is estimated to be between 0.23 - 0.58 kg CO_2-eq per kg food, depending on the yield scenario that is modelled (i.e. the amount of agricultural production harvested per unit of land area). Lower emissions are observed with higher fava bean yield[19]. In comparison, for beef the total CO_2-eq emission is 26.6 kg, for cheese 8.55 kg and pork 5.77 kg CO_2-eq per kg food (see **Table 2**)[20].

Global average water footprint

The global average water footprint of fava bean is 2,018 m^3 per ton of crop. This is comparable to soy beans and peas (respectively 2,145 and 1,979 m^3 ton^{-1})[18]. In comparison, the global average water footprint of beef is 15,712 m^3 ton^{-1}, of chicken 4,987 m^3 ton^{-1} and of egg 3,863 m^3 ton^{-1} (see **Table 2**)[21].

Table 2: Greenhouse gas emission and global average water footprint of selected protein sources[18-21].

	Greenhouse gas emission kg CO_2-eq/kg food	Global average water footprint, m^3 ton^{-1}
Potatoes	0,18	287
Fava bean	0,23 - 0,58	2.018
Peas	0,38	1.979
Corn	0,47	1.222
Soy beans	0,49	2.145
Wheat	0,52	1.827
Chickpeas	0,77	4.177
Egg	3,46	3.863
Chicken	3,65	4.987
Pork	5,77	6.226
Cheese	8,55	4.743
Beef	26,61	15.712

Food safety

The fava bean has been consumed as food around the world for many centuries[22].
For people with a glucose-6-phosphate dehydrogenase (G6PD) deficiency, the consumption of raw or cooked fava bean can be a hazard, because it can induce favism (i.e. severe hemolysis after fava bean ingestion). This is caused by the anti-nutritional compounds vicine and convicine that are present in fava beans[23]. G6PD deficiency affects over 400 million people worldwide, mainly in Africa, South America, the Mediterranean region, and South-East Asia[24].
Through various breeding strategies fava beans low in vicine and convicine have been developed[25]. Furthermore, several processing treatments have been identified to minimalize vicine and convicine such as heat processing; and soaking in acid, alkaline, or water[23, 26].
Studies have shown that people with G6PD deficiency are able to ingest fava beans with low levels of vicine and convicine safely[27, 28].

When fava bean is added to a product as an ingredient, the intake of vicine and convicine will generally be far below the levels of intake that were demonstrated to be safe in the studies mentioned above. This is because there is very little fava bean in the final product, the vicine and convicine content has been minimized by specific processing techniques and/or the use of low vicine and convicine fava bean varieties. As a result, a product such as Tendra® is considered safe for the consumer, including those with G6PD deficiency.

Applications of Tendra®, a high-quality protein isolate from the fava bean, produced by Cosun Protein.

Conclusion

From both a nutritional and environmental sustainability perspective, fava bean can help the shift towards a more sustainable and healthy diet. Fava beans, both raw and processed, contain much protein. Because, levels of methionine and cysteine are relatively low, it is important to mix various plant-based protein sources in a diet. Finally, as an ingredient, fava bean has very usefull functional properties.

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