Famine in Afghanistan, threat of a new Lathyrism epidemic?

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Introduction

A famine warning for Afghanistan was issued Friday, 8 June 2001 by FAO: http://www.fao.org/giews/english/alertes/2001/SRAFG601.htm

Its summary is attached to this communication (Appendix 1).

The current food crisis in Afghanistan provides the classic conditions for the outbreak of a lathyrism epidemic. Indeed, a search of the Internet revealed that lathyrism had become a problem in Nawor and Malistan [Navor and Malestan] during 1998.

Johnson (2000) reports: "With [a] history of limited food resources, micro nutrient deficiencies are likely. The accumulative effects on women, consequently being passed on to their babies, may be one of the reasons for high maternal and infant mortality. Anaemia (iron deficiency) and goitre (iodine deficiency) are common, **lathyrism, caused by eating the plant *Lathyrus sativus*, was reported[2] as becoming a problem in Nawor and Malistan.** The plant, formerly used as animal feed, was becoming an increasing addition to the diet of the community[3]".

Arya et al. (1988) have reported previously on lathyrism in Afghanistan[4]

The need for a lathyrism warning system

Following the 1998-1999 epidemic of lathyrism in Ethiopia where food relief did not reach inaccessible regions in the highlands (Getahun et al., 1999), a similar scenario may be avoidable by drawing attention to similar situations i.e. regions with poverty and *Lathyrus sativus* consumption as soon as they arise.

The food shortage warning for Afghanistan has therefore prompted me to map the distribution of *Lathyrus sativus* in that country, based on passport data from the database of ICARDA's Genetic Resources Unit. The resulting map is shown in Fig 1.

The vetchling *Lathyrus sativus* L. has no wide spread in Afghanistan but separate patches of its cultivation may be frequently met with in the mountainous districts, as if interspersed among crops of other *Leguminosae* (Vavilov and Bukinich, 1929, Agricultural Afghanistan, Bull. Appl. Bot. Pl. Breed. Suppl. 33, page 579)

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[2] ACF, 1998 is given as a reference (ACF= Action Contre la Faim = Action Against Hunger) http://www.acf-fr.org/
ACF works in Sharistan, Dai Kundi and Panjao. It runs clinics in Panjao and Sharistan, is rehabilitating the hospital in Waras and plans to develop health work in Dai Kundi in 2000. It also aims to open community health posts in sub-districts and to work with other agencies to improve access to health services. In addition to its health work and nutritional surveillance, it is involved in research on agriculture systems and food security. ACF also undertakes emergency work and last year did cash for work and food distribution programmes.

[3] Chris Johnson (March, 2000) Hazarajat Baseline Study — Interim Report. For the UN Co-ordinator's Office, page 38
http://www.afghan-politics.org/Reference/United_Nations/UN_Hazarajat_Report/3_access_to_services.htm

[4] Arya, L. S.; Qureshi, M. A.; Jabor, A., and Singh, M. Lathyrism in Afghanistan. Indian Journal of Pediatrics. 1988; 55(3):440-442

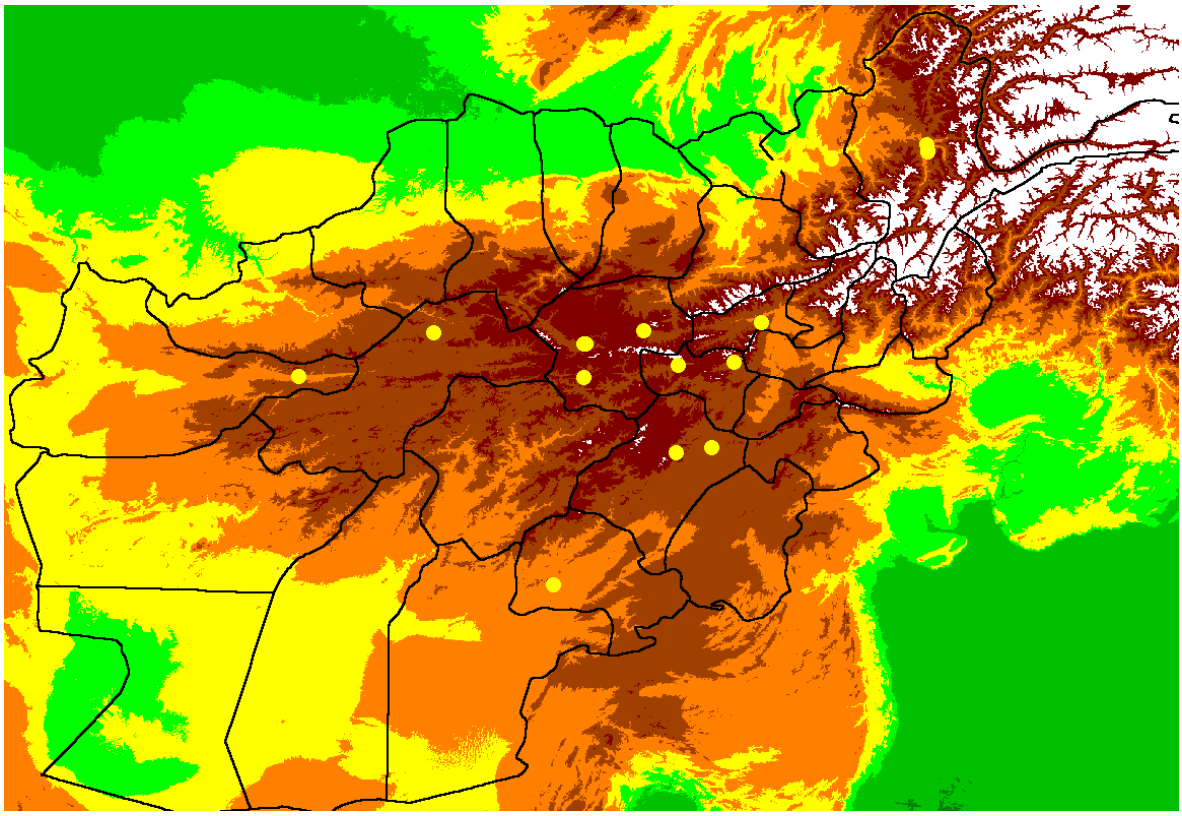

Fig 1. High risk areas for lathyrism, based on the distribution of *Lathyrus sativus* accessions collected in Afghanistan (source: ICARDA passport data)

The yellow circles indicate areas where *Lathyrus sativus* was collected during the 1970s and may still be grown today. In the absence of other food sources *L. sativus* will be used as a staple food in these regions. Excessive consumption of the seed coupled with malnutrition leads to the development for a permanent paralysis of the lower limbs.

Additional geographic locations for *L. sativus* in Afghanistan are provided in Tables 1-3.

Background information to Neurolathyrism

Raloff, J. (2000) Detoxifying Desert's Manna. Science News 158:5
http://www.sciencenews.org/20000729/bob1.asp

Researchers develop non-toxic variety of drought hardy pea. Front Lines 40(5): 15
http://www.usaid.gov/pubs/front_lines/aug_sept_fl_00.pdf

The following is some background information about Lathyrism, taken from the introduction to the *Lathyrus* bibliography (Enneking, 1998, 2000) with some additions in [ ].

Lathyrism, famine and poverty

The scourge of neurolathyrism, known since ancient times, today affects mainly the poorer rural classes especially in India, Bangladesh, Ethiopia[5], Nepal and Pakistan during drought caused famines. Historic outbreaks of this neurological crippling disease have also been documented for Spain, Algeria, Ukraine, Russia, Germany, Italy, France, Syria. [Recent lathyrism epidemics have occurred in China (1972-1974), Bangladesh (1976), Ethiopia (1976), Afghanistan (1998, unpublished), Nepal (1998, unpublished) and Ethiopia (1997-1999)].

[Mitchell (1971) investigated the geographical distribution of lathyrism[6]]

The cause of neurolathyrism is the continued consumption of *L. sativus* seed as a staple food.

The occurrence of neurolathyrism is intricately linked to drought caused famine, poverty and malnutrition. The hardy *L. sativus* may provide most of the food for survival during drought in areas where neurolathyrism is prevalent.

Toxicity

The presence of toxic non protein amino acids (NPAAs) in the seeds of *Lathyrus* species have restricted their agricultural development in several countries

Chemotaxonomic studies in the early 1960s established the presence of several toxic amino acids in the seeds of different taxonomic groups. This work provided a useful frame of reference to delineate groups of species with different seed toxins.

Three NPAAs of concern are the neurotoxins Beta-oxalyl-diamino-propionic acid (Beta-ODAP) (*L. sativus*), Diamino-butyric acid (DABA) (*L. sylvestris*) and the nitrile containing beta-amino-propionitrile (BAPN) (*L. odoratus*).

The bone deforming (osteolathyrogenic) properties of *Lathyrus odoratus* are due to the presence of BAPN. This compound affects the cross-linking of collagen during bone and connective tissue formation. The resultant disease is known as osteolathyrism. Recent studies in Bangladesh suggest that a metabolic precursor for this compound, 2-cyanoethyl-isoxazolin-5-one is present in the vegetative parts and immature seeds of *L. sativus*. It

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[5] For the 1998 situation in Ethiopia (South Welo) see the report by Joachim D. Ahrens, Senior Field Officer, UNDP Emergencies Unit for Ethiopia (EUE)
http://www.sas.upenn.edu/African_Studies/Hornet/welo0598.html (email: undp-eue@telecom.net.et)

2. Getahun H, Mekonnen A, Tekle Haimanot R, Lambein F. (1999) Epidemic of neurolathyrism in Ethiopia. Lancet 354(9175):306-7
Abstract: After a drought and famine, overconsumption of the drought-tolerant grasspea triggered an epidemic of neurodegenerative neurolathyrism in Northeast Ethiopia. Environmental, nutritional, and medical factors seem to affect the susceptibility.

[6] Mitchell, R. D. The grass pea: distribution, diet, and disease. Ass Pacific Coast Geogr Yearbook. 1971; 3329-46

appears responsible for the osteolathyrogenic symptoms observed in some neurolathyrism patients who had consumed vegetative parts of *L. sativus*.

The neurotoxicity of *Lathyrus sylvestris* and related species is caused by the toxic NPAA DABA.

With the identification of the amino acid beta-ODAP as a toxin, it has become possible to select low ODAP genotypes of *L. sativus*. Such cultivars are now available from Canadian and, to a limited extent, from Indian research programs. Their existence has renewed interest in the further development of this species as a pulse crop.

Lathyrism

There are two different types of lathyrism, neurolathyrism and osteolathyrism, affecting the nervous system and bone formation respectively. The term "Human Lathryism syndrome" (HLS or HULAS) was coined to describe the rather diverse clinical and biochemical symptoms (incl. osteolathyrism) caused by *L. sativus* (Cohn, 1995).

Cohn and Streifler (1981, 1983) have described, in addition to neurological damage, osteolathyrogenic symptoms in lathyrism patients who had 35 years earlier consumed food prepared from *L. sativus* seed in a German forced labour camp. This finding suggest that extreme care is needed with the toxicity assessment of low-ODAP strains of *L. sativus* because other toxins may be present in the seeds under certain conditions e.g. seed immaturity.

Medical scientists are interested in the causes of neurolathyrism as a model for neurodegenerative diseases striking the more affluent sections of the human population. Other *Lathyrus* species used as food have also occasionally been linked with neurolathyrism e.g. *L. cicera*, *L. ochrus* and *L. clymenum*. These species all contain beta-ODAP in their seeds.

Table 1. Details about *Lathyrus sativus* collecting sites and markets

COL_DATE	PROVINCE	SITE	LON	LAT	ALT
1974/07/11	Konduz	Khanabad; Kabul market	E69 08	N36 42	
1974/07/12	Vardak	Haider Chala; on main rd. 15 km from Kabul towards Kandahar	E68 41	N34 30	
1974/07/12	Zabol	Shop sample from Jaldak, 26 km from Kabul-Kandahar main road	E66 39	N32 00	
1974/07/23	Ghazni	Kabul-Kandahar; 87 km from Kabul	E68 02	N33 30	2250
1974/07/23	Ghazni	Ghazni market; 47 km from Soloar	E68 26	N33 33	2180
1974/07/13	Parvan	27 km north of Kabul-Baghlan main road	E69 00	N34 57	1725
1974/08/06	Takhar	Kalifgan; 11km from Atin-Jilao	E69 47	N36 48	1610
1974/08/08	Badakhshan	Kairabad; 35 km from Feyzabad	E70 53	N36 53	1525
1974/08/08	Badakhshan	Kairabad; 35 km from Feyzabad	E70 53	N36 53	1525
1974/08/08	Badakhshan	Barak; 38 km from Feyzabad	E70 52	N36 58	1540
1974/08/08	Badakhshan	Jorm; 21km from Barak	E70 53	N36 54	1580
1975/08/15	Vardak	Dani-audela; 5km from junction on the old road	E68 03	N34 28	2900
1975/08/17	Bamian	5 km from Nayak (Yaka-wlang area) to Naitak	E67 00	N34 43	2450
1975/08/18	Bamian	Sabz Darrah (green valley); 13km W of Naitak road to Solich	E67 01	N34 43	2415
1975/08/19	Bamian	Fuladi village; 12km from Bamian	E67 40	N34 52	2600
1976/09/12	Herat	Chiste Sharif	E63 46	N34 21	1500
1976/09/14	Ghowr	Ghldara-Ghalmin; 58km N of Chakcharan Korak (Dault Yar)	E65 18	N34 50	2450
1954/08/21	Bamian	55 miles S of Panjab	E67 00	N34 20	2800

Table 2. *Lathyrus sativus* collecting sites listed in Flora Iranica (Rechinger, 1979)

ADMIN1	SITE1	Phrase	DIST1	DIR1	SITE2	DIST2	DIR2	SITE	Alt
Kabul	Kabul	near, inter segetes, cult							
Kabul	Gulbahar	inter segetes							
Kabul	Kabul	in direction of [SITE2] ; in cultis irrigatis	30	S	Ghazni				
Kabul	Maidan valley								2200
Kabul	Ghorband								2400
Kabul	Gardez								2300
Jaji	Kotal-e Shuturgardan	cul.							
Nuristan	Ramgel valley	between Pushol and Nalu							
Wakhan	Qala-i Panja								2800
Wakhan	Warg								2600
Wakhan	Qala-e Ust								3000
Kataghan	Kost-o Fereng								
Kataghan	Fergan-Bul valley								2050
Kataghan	Farkhar								1440
Bamian	Bamian		10	E	Bulola				2350
Bamian	Bamian								2500
Behzud	Kajao valley								
Behzud	Hazarajat								
Ghorat	Darrah-i Tarbolaq	inter Panjao et Lal							2800

Table 3. *Lathyrus sativus* collection sites in Afghanistan ex Vavilov Institute, St. Petersburg (VIR) passports

		Kakul	Klol	Langash	Langosh	Lyangash	Mestnyi	Patok	Patok (kukul)	Patok goroh	Grand Total
No site information	16		1			1	1			1	20
Badakhshan	3							1	1		5
Herat	4			1	1						6
Kabul	6	1									7
Grand Total	29	1	1	1	1	1	1	1	1	1	38

Apendix 1. **FAO/WFP CROP AND FOOD SUPPLY ASSESSMENT MISSION TO AFGHANISTAN**[7]

This report is prepared on the responsibility of the FAO and WFP Secretariats with information from official and unofficial sources. Since conditions may change rapidly, please contact the undersigned for further information if required.

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Mission Highlights

• Afghanistan faces a much more serious food crisis this year than last year as a consequence of severe drought for the third consecutive year and intensifying economic problems. The food situation is rapidly deteriorating and will continue to worsen as the current marketing year (2001/02) progresses.

• There is mounting evidence of emerging widespread famine conditions in the country, reflecting substantially reduced food intakes, collapse of the purchasing power of the people, distress sales of livestock, large-scale depletion of personal assets, soaring foodgrain prices, rapidly increasing numbers of destitute people, and ever swelling ranks of refugees and internally displaced persons.

• With the 2001 drought-affected cereal output forecast at about 2 million tonnes, cereal import requirement will amount to some 2.2 million tonnes, close to last year's unprecedented high level. Even if the planned volume of food aid (386 000 tonnes -) and a low case scenario of projected commercial imports (760 000 tonnes) materialize, there would remain a large uncovered cereal deficit of over 1 million tonnes. Given the scale and magnitude of the food crisis facing Afghanistan, the Mission urges the most urgent international response to cover this large gap to avert an imminent catastrophe.

• Three consecutive years of drought have dealt a serious blow to livestock in Afghanistan which is in the process of continued decimation with catastrophic livelihood consequences for the Kuchi (nomads) and serious adverse impact on the livestock-holding farmers. Appropriate veterinary and feed-related measures are needed to protect the remaining livestock population and to ensure the survival of the breeding stock for rebuilding the livestock population.

• About one half of "irrigated" area has gone out of use as a result of breakdown of irrigation systems. Substantial assistance is required to start and carry forward the rehabilitation of the collapsed irrigation infrastructure as well as to improve and expand the provision of quality seeds towards rehabilitating the agricultural sector.

• With the abandonment of poppy cultivation in 2001, the world is rid of 3 000-4 000 tonnes of opium and derivatives this year. This exceptionally positive development, however, comes at a time when intensifying economic problems provide little opportunities for alternative income sources for poppy farmers and workers, or for support measures by the Authorities. The people of Afghanistan can sustain the negative economic implications only if immediate, commensurate international support is provided

[7] http://www.fao.org/giews/english/alertes/2001/SRAFG601.htm

Appendix 2 References regarding the Detoxification of Lathyrus sativus through processing

Processing of *Lathyrus sativus* to eliminate the toxicity of the seed may provide the most pragmatic *ad hoc* solution to prevent lathyrism during drought-caused famines, provided that sufficient water is available.

1. Ahmad, K. and Jahan, K. (1984). **Khesari (Lathyrus sativus) detoxified**. Nutrition News **2** (8):1-2
Lathyrus sativus detoxification/ Detoxification L sativus/ Lathyrus sativus/ Detoxification/ Khesari/ Nutrition.

2. Anonymous (1967). **Simple measures for removing the toxic factors from Lathyrus sativus.** Nutrition Reviews **25** (8):231-233
Certain soaking, steeping and cooking procedures were found to remove the toxic factors from *L. sativus* seeds. In all methods the excess water is discarded. Suggests Vitamin supplementing foods to compensate for loss of Vitamins during leaching of *L. sativus* for detoxification. Advocates detoxification rather than banning L. sativus consumption, since it is eaten by necessity in drought affected areas.
Source: Medline (66-69) 68091672; reprintDE
India/ Cookery India/ Lathyrism etiology/ Lathyrus sativus processing/ Processing India L sativus detoxification/ Lathyrus sativus detoxification/ Homeeconomics/ Socioeconomics/ Antinutritional factors/ Economics/ Lathyrus sativus/ Climate/ Cookery/ Detoxification L. sativus/ Drought/ India L. sativus/ India L. sativus consumption/ India lathyrism/ Lathyrism/ Lathyrism economics/ Lathyrism India/ Lathyrism nutrition/ Lathyrus toxicity/ Nutrition/ Processing/ Review/ Seed/ Soaking/ Spain/ Spain L. sativus/ Toxicity L. sativus/ Toxicity/ Toxin/ Varieties/ Vitamins/ Water detoxification/ Water/ reprint.

3. Dwivedi, M. P. and Mishra, S. S. (1975). **Recent outbreak of lathyrism and experience with propagation of detoxified *Lathyrus sativus***. Proc. Nutr. Soc. India **19**:23-30
Lathyrism India/ India lathyrism/ Lathyrus sativus low ODAP/ Lathyrus sativus detoxification/ Detoxification L. sativus/ Lathyrus sativus/ Detoxification/ India/ India L. sativus/ Lathyrism.

4. Forbes, G. B. (1967). **Simple measures for removing the toxic factors of *Lathyrus sativus***. Nutrition Reviews **25**:231-233
Lathyrus sativus detoxification/ Detoxification L. sativus/ Lathyrus sativus/ Detoxification/ Lathyrus toxicity/ Nutrition/ Review/ Toxicity L. sativus/ Toxicity/ Detoxification.

5. Ghosh, C.; Singh, J. P.; Mehra, R. B., and Barat, G. K. (1991). **Detoxification of khesari dal (Lathyrus sativus L.)**. Sharma, B.; Mehra, R. B.; Puri, R. P.; Raju, D. B.; Ram, H.; Kant, K., and Mathur, D. S. (Eds). **Golden Jubilee Celebrations: Symposium on Grain Legumes February 9-11, 1991 I.A.R.I., New Delhi** , New Delhi: Indian Society of Genetics and Plant Breeding, Indian Agricultural Research Institute, pp. 109-114.
Source: reprintDE
Lathyrus sativus detoxification/ Processing L. sativus/ Detoxification L. sativus/ Lathyrus sativus/ Agriculture/ Delhi/ Detoxification/ Dhal/ Genetics/ Grain legumes/ Pulses/ India/ India L. sativus/ Khesari/ Processing/ reprint.

6. Gupta, Y. P. (1983). **Neurotoxin in khesari dal (Lathyrus sativus).** International Journal of Tropical Agriculture **1** (3):175-185 (author affiliation: Div. of Biochem., Indian Agric. Res. Inst., New Delhi 110 012, India)
In this review, the chemical nature and biosynthesis of neurotoxic compounds in *L. sativus* seeds and their detoxification are discussed. The beta-N-oxalyl-L-alpha, beta-diamino propionic acid content of seeds is in the range 0.1-2.5%.
Source: Copyright CAB Abstracts (84-86) G669453
Seed/ Composition/ Neurotoxins/ Metabolism plant Organic acids/ Lathyrus/ ODAP/ Review/ NPAA/ Biosynthesis/ Lathyrus sativus/ Agriculture/ Delhi/ Detoxification L. sativus/ Detoxification/ Dhal/ India/ India L. sativus/ Khesari/ NPAA biosynthesis/ NPAA review/ ODAP biosynthesis/ Tropics.

7. Jahan, K. and Ahmad, K. (1983). **Detoxification of Lathyrus sativus**. Food and Nutrition Handbook.
Source: CGC_95_2
Nutritive Quality L. sativus/ Lathyrus sativus detoxification/ Detoxification L. sativus/ Incomplete/ Lathyrus sativus/

Detoxification/ Food/ Nutrition/ Nutritional value/ Quality.

8. Jahan, K. and Ahmad, K. (1984). **Detoxification of Lathyrus sativus.** Food and Nutrition Bulletin **6** (2):52-53 (author affiliation: Inst. Nutrition, Dhaka Univ., Dhaka, Bangladesh)
Decorticated seed of *Lathyrus sativus* was steeped in water and boiled and the water was rejected; the seed still retained some toxic beta-N-oxalyl-L-alpha,beta-diaminopropionic acid. Decorticated ground seed, 200 g, was soaked overnight in enough saturated lime-water to be absorbed and soak the seeds, with no excess to be drained off. Treated seed was dried, ground again and used to make unleavened bread and other products. Another lot of seed was treated with lime-water and autoclaved 10 min at 15 lb/mm2/. Simple soaking in lime-water overnight followed by boiling destroyed the toxin and the trypsin inhibitors. Lime is usually available in the household for use with betel leaf.
Source: Copyright CAB Abstracts (84-86) N702186
Seed/ Detoxification/ Antinutritional factors/ Trypsin inhibitor/ Protease inhibitor/ Economics/ Lathyrus sativus/ Bangladesh/ Bread/ Food/ Household/ Lathyrus toxicity/ Leaves/ Lime/ Nutrition/ Soaking/ Toxicity L. sativus/ Toxicity/ Toxin/ Water detoxification/ Water/ Detoxification L. sativus/ Lathyrus sativus detoxification.

9. Jahan, K. and Ahmed, K. (date?). **Detoxification of Lathyrus sativus**. Dhaka: Institute of Nutrition, Dhaka University.
Source: ref ex Kaul et al. (1989)
Lathyrus sativus detoxification/ Lathyrus sativus/ Detoxification/ Nutrition/ Detoxification L. sativus/ Lathyrus sativus detoxification.

10. Jha, K. (1987). **Effect of the boiling and decanting method of Khesari (Lathyrus sativus) detoxification, on changes in selected nutrients.** Archivos Latinoamericanos De Nutricion **37** (1):101-7 (author affiliation: College of Basic Sciences and Humanities, Rajendra Agricultural University, Pusa, Samastipur, India)
It is a well-known fact that the legume Khesari (*Lathyrus sativus*) causes lathyrism, a disease characterised by paralysis of the lower limbs in human beings. The toxic constituent is an amino acid identified as B-Oxalyl-Amino L-Alanine (BOAA). It has been reported that if the legume is boiled for two hours and the water is then decanted, almost 85% of the toxic amino acid is eliminated. Therefore, this investigation constitutes an effort to prevent the loss of other nutrients, simultaneously to the elimination of toxicity. As has been observed, as much as half the protein content, as well as 80.36% total sugars, 63.13% reducing sugars, 86.05% amino acids, and all thiamine, riboflavin and niacin are lost from dhal (dehulled, separated cotyledons), while the respective losses from the whole seeds are 47.25%, 45.73%, 74.69% and 80.00%, and all vitamins, in just a one-hour treatment. The losses of the toxic amino acid from dhal and whole seeds are 71.46% and 68.74%, respectively. The data for losses occurring in the two-hour and three-hour treatment are also described.
Source: reprintDE
Lathyrus sativus detoxification/ Lathyrus sativus nutritive value/ Processing L. sativus/ Toxicity/ ODAP/ Nutritional value/ Lathyrus sativus/ Agriculture/ Amino acids/ Cotyledons/ Detoxification/ Dhal/ India/ India L. sativus/ India lathyrism/ Khesari/ Lathyrism/ Lathyrism India/ Lathyrus toxicity/ Humans/ Nutrients/ Paralysis/ Processing/ Protein/ Protein content/ Riboflavin/ Seed/ Thiamine/ Toxicity ODAP/ Toxicity L. sativus/ Vitamins/ Water detoxification/ Water/ reprint/ Detoxification L. sativus/ Lathyrus sativus detoxification.

11. Kebede, B.; Urga, K., and Nigatu, A. (1995). **Effect of processing methods on the trypsin inhibitor, tannins, phytic acid and ODAP contents of grass pea seeds**. Ethiop. J. Health. Dev **9** (1):97-103.
Grass pea seeds were given different treatments including cooking, boiling, autoclaving, dryheating and fermentation into tempeh.
Source: reprintDE
Lathyrus sativus processing/ Processing methods L. sativus/ NPAA/ Lathyrus sativus detoxification/ Detoxification L. sativus/ ODAP/ Antinutritional factors/ Trypsin inhibitor/ Protease inhibitor/ Polyphenols/ Tannins/ Lathyrus sativus/ Cookery/ Detoxification/ Fermentation/ Processing/ Seed/ Tempeh/ reprint.

12. Kuo, Y. H.; Bau, H.-M.; Khan, J. K., and Lambein, F. (1995). **Detoxification of Lathyrus sativus meal by fermentation without loss of nutritive value**. In : Yusuf, H. K. M. and Lambein, F. (Eds). **Lathyrus sativus and Human Lathyrism: Progress and**

Prospects, Dhaka: University of Dhaka, pp. 231-234.
Source: reprintDE
Fermentation/ Fermentation L. sativus/ Fermentation L. sativus detoxification/ Aspergillus oryzae/ Rhizopus oligosporus/ SDS PAGE/ Protein/ Protein electrophoresis/ ODAP/ ODAP analysis/ Nutrition/ Nutritive value/ Processing/ Processing L. sativus/ Processing methods L. sativus/ Tempeh/ Post harvest processing L. sativus/ Postharvest detoxification/ Detoxification/ Detoxification L. sativus/ Detoxification L. sativus fermentation/ Lathyrus sativus/ reprint.

13. Kuo, Y.-H.; Bau, H.-M.; Quemener, B.; Khan, J. K., and Lambein, F. (1995). **Solid-state fermentation of *Lathyrus sativus* seeds using *Aspergillus oryzae* and Rhizopus oligosporus sp T-3 to eliminate the neurotoxin beta-ODAP without loss of nutritional value**. Journal of the Science of Food and Agriculture **69**:81-89.
The reduction of beta-ODAP to less than 10% of the original content has been achieved by fermenting *Lathyrus sativus* cv. Jamalpur seeds with *Aspergillus oryzae* NRRL 1988 for 48 h, followed by fermentation with *Rhizopus oligosporus* sp. T-3 for 48 h. Other nutritional qualities were also improved in the fermented seed meal: increased content of protein, higher amino acid scores for sulphur containing and aromatic amino acids, better resistance to high temperature and to oxidation, and a drastic reduction in flatulence factors.
Source: reprintDE
Detoxification L. sativus fermentation/ Fermentation L. sativus detoxification/ Nutritional value fermented L. sativus/ Rhizopus oligosporus/ Aspergillus oryzae/ Flatulence reduction by fermentation/ ODAP elimination fermentation/ Nutritional value/ Lathyrus sativus/ Agriculture/ Flatulence/ Amino acids/ Aspergillus/ Detoxification/ Disaccharides/ Fermentation/ Food/ Fungi/ Mycology/ Microbiology/ Neurotoxins/ ODAP/ Oxidation/ Protein/ Resistance/ Rhizopus/ Seed/ Sulfur/ Sulfur amino acids/ Temperature/ reprint/ Detoxification L. sativus/ Lathyrus sativus detoxification.

14. Mohan, V. S.; Nagarajan, V., and Gopalan, C. (1966). **Simple practical procedures for the removal of toxic factors in Lathyrus sativus (Khesari dhal)**. Indian Journal of Medical Research **54**:410-414
Source: reprintDE
Lathyrus/ Detoxification/ Processing/ Lathyrus sativus/ Dhal/ India/ India L. sativus/ Khesari/ Lathyrus toxicity/ Toxicity L. sativus/ Toxicity/ reprint/ Detoxification L. sativus/ Lathyrus sativus detoxification.

15. Moslehuddin, A. B. M. and Hang, Y. D. (1987). **Effect of processing methods on the nutritional value of Lathyrus sativus seeds**. Nutrition Reports International **36**:1099-1103.
Lathyrus sativus seeds were soaked in water overnight, washed once and steamed for 10 min; soaked, washed, steamed and fermented for 30 h by Klebsiella pneumoniae present in commercial tempeh inoculum; soaked, washed, steamed and autoclaved for 10 min at 121°C. Vitamin B-12 values were 176, 283 and 401 ng/100 g, respectively. Processing gave high amino acid scores, but the sulphur-containing amino acids were the most limiting in all the processed seeds; leucine, valine and isoleucine were deficient in fermented seeds. It was concluded that the increased vitamin B-12 content by tempeh fermentation may be useful in preventing pernicious anaemia, but fermented seed products must be supplemented with other protein sources for optimum nutrition.
Lathyrus sativus detoxification/ Processing L. sativus/ Nutritional value/ Lathyrus sativus/ Amino acids/ Anaemia/ Detoxification/ Fermentation/ Nutrition/ Processing/ Processing methods L. sativus/ Protein/ Reports/ Seed/ Sulfur/ Sulfur amino acids/ Tempeh/ Valine/ Vitamin B/ Vitamins/ Water detoxification/ Water/ Detoxification L. sativus/ Lathyrus sativus detoxification.

16. Moslehuddin, A. B. M.; Hang, Y. D., and Stoewsand, G. S. (1987). **Evaluation of the toxicity of processed Lathyrus sativus seeds in chicks.** Nutrition Reports International **36** (4):851-855 (author affiliation: Dep. Food Science and Technology, Cornell Univ., Geneva, NY 14456, USA)
Lathyrus sativus seeds were processed for removal or destruction of their natural toxins. Partly purified concentrates from those seeds were injected intraperitoneally into 1-day-old male White Leghorn chicks as a bioassay of the effectiveness of the processing methods. When the raw seed concentrate was given to the chicks, they showed typical neurological signs such as head retraction, neck bending and stiffening followed by immediate death. Similar symptoms were observed in chicks injected with the concentrates of the seeds soaked overnight in water or in saturated calcium carbonate followed by steaming, autoclaving and fermenting at 30°C for 30 h. All chicks died within 4 h of treatment. There were 31% and

39% survivals with the concentrates of seeds soaked overnight in water followed by washing and steaming, and seeds soaked overnight in water followed by washing, steaming and fermenting at 30° for 30 h, respectively. Results from these chick bioassays showed that washing *L. sativus* seeds partly removes its neurotoxins. Fermentation, steaming or autoclaving seemed to have little effect on toxin removed.
Source: Copyright CAB Abstracts (87-89) N055865 reprintDE
Lathyrus sativus toxicity/ Bioassay chicks/ Poultry diseases/ Detoxification L. sativus/ Processing L. sativus/ Lathyrus sativus detoxification/ Antinutritional factors/ Lathyrus sativus/ Bioassay/ Agriculture/ Bioassay L. sativus/ Lathyrus sativus bioassay/ Lathyrism symptoms/ Calcium/ Chickens/ Detoxification/ Evaluation/ Fermentation/ Food/ Food processing/ Food processing L. sativus/ Fowls/ Injections/ Lathyrism/ Lathyrism Bioassay/ Lathyrism nutrition/ Lathyrus toxicity/ Males/ Neurotoxins/ Nutrition animal/ Nutrition/ Poultry/ Processing/ Processing methods L. sativus/ Purification/ Reports/ Seed/ Symptoms lathyrism/ Toxicity L. sativus/ Toxicity L. sativus poultry/ Toxicity/ Toxin/ USA/ Water detoxification/ Water/ Reprint.

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Lathyrus sativus detoxification/ Detoxification L. sativus/ Processing L. sativus/ Aflatoxins L. sativus/ Lathyrus sativus aflatoxins/ Lathyrus sativus/ Mycotoxins/ Aflatoxins/ Cereals/ Contamination/ Delhi/ Detoxification/ Grain legumes/ Pulses/ Neurotoxins/ Postharvest/ Processing/ Toxin.

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Source: reprintDE
INILSEL/ Lathyrus sativus detoxification/ Detoxification L. sativus/ Post harvest processing L. sativus/ India L. sativus/ Lathyrus sativus India/ Lathyrus sativus/ Detoxification/ India/ India lathyrism/ Lathyrism/ Lathyrism India/ Postharvest/ Processing/ reprint.

19. Singh, L. (1980). **New light on Lathyrus Non toxic varieties, detoxification of seeds.** Intern Agric. New Delhi, Directorate of Extension, Ministry of Agri. and Irrigation **17** (11):10-11
Source: Agricola (79-84) IND 80131030
Lathyrus sativus detoxification/ Processing L. sativus/ Lathyrus sativus/ Delhi/ Detoxification/ Extension/ Irrigation/ Lathyrus toxicity/ Processing/ Seed/ Toxicity L. sativus/ Toxicity/ Varieties/ Detoxification L. sativus/ Lathyrus sativus detoxification.