Nutritional Value of Sprouted Mung Beans

by G. P. SAVAGE, Ph.D.

Mung bean sprouts are an interesting and nutritious food. They have been used by the Chinese for centuries, and they are now widely accepted in our diet. The possibilities of enhancing their nutritional qualities through plant breeding are great.

Dr. Savage holds a Ph.D. in Nutritional Biochemistry from The University of Newcastle upon Tyne, United Kingdom. Currently he is Senior Lecturer at Lincoln University, Canterbury, New Zealand. He is the editor of the Proceedings of the Nutrition Society of New Zealand. His research interests include the nutritional value of legumes and colour development in salmonids.

Mung beans (*Vigna radiata* var. *aureus*) are an important constituent of human diets in central, southern and eastern Asia and have been cultivated in this region for centuries. More recently mung beans have become widely used in the tropics and subtropics of Africa, the West Indies, North America and Australasia. Mung beans provide a major source of protein in many cereal-based diets. The dried seeds may be eaten whole or split, cooked or fermented or parched, milled and ground into a flour. Whole or split seeds are used to make dhal, soups and curries and are added to various spiced or fried dishes. The popular fermented foods of India, such as idli and dosa, are made from mixtures of rice and mung bean ground together. The ground flour can be used to make noodles, breads and biscuits. Germinated mung bean sprouts are extensively used in Chinese cooking and are becoming popular in Western countries where they are used as a garnish in mixed diets or as a valuable source of protein in vegetarian diets.

The genus *Vigna* consists of several related species which have been cultivated in central, southern and eastern Asia for a very long time. The two most important species in the genus *Vigna* are the cowpea (*Vigna unguiculata*), an important grain legume of the African lowland tropics and mung bean (*V. radiata*), which is grown extensively in India and Southeast Asia.

The taxonomic history of the Asiatic *Vigna* species has been confused at both generic and specific levels. The group was formerly placed in the genus *Phaseolus*, but it is now generally accepted that it belongs in the genus *Vigna*. Debate continues as to whether var. *aureus* and var. *mungo* which share many morphological similarities are indeed separate species. Verdcourt[1] considers that these two groups are in fact variants within one species, but he has recommended the retention of the separate designations. The current scientific and common names are listed in Table 1 along with previously used names for these varieties.

The naming of these two species has been very unclear in the literature to date. Unless the common names are accompanied by the appropriate scientific names, it is very difficult to differentiate between the two *Vigna* species and consequently important scientific data cannot be properly attributed to the correct variety.

There is no doubt that the two

Changes in Nutritional Qualities during Sprouting

Decreased

- Indigestible raffinose
- Phytic acid
- Tannin

Increased

- Glucose
- Galactose
- Sucrose
- Folic acid
- Ascorbic acid
- Inorganic phosphorus
- Bioavailability of iron
- Digestibility of protein
- Stability of lipid to processing and storage

species *V. radiata* var. *aureus* and *V. radiata* var. *mungo* are close relatives. Cytogenetical and hybridization studies suggest that they were derived by selections from the wild species *Vigna sublobata* (Syn. *V. radiata* var. *sublobata* (Roxb.) Verdc.), which is widely distributed throughout the Indian subcontinent, Indochina and Australasia. The two distinct races of *V. sublobata* bear some morphological similarity to var. *aureus* and var. *mungo*.

It is clear that mung bean has been widely cultivated in the Indian subcontinent and adjacent regions for several thousand years and to have spread at an early time to other Asian countries and northern Africa. Its current wide distribution through the tropics and subtropics of Africa, the West Indies, North America and Australasia is relatively recent. It has become the most important grain legume in Thailand and the Philippines, it ranks second in Sri Lanka and third in India, Burma, Bangladesh and Indonesia. It is a minor crop in Australia, China, Iran, Kenya, Korea, Malaysia, the middle East, Peru, Taiwan and in United States.

The two most important species are the cowpea and the mung bean.

Urd bean is a more recent crop, but it is an important pulse crop in India, Burma, Bangladesh, Pakistan and Thailand and of minor importance in Sri Lanka. It is grown in a limited scale in other parts of Southeast Asia, Australia and Fiji.

COMPOSITION OF MUNG BEANS

Mung beans, apart from being a good source of protein in the diets of millions of people also contain useful amounts of fiber, soluble fiber, potassium and B vitamins. They contain low levels of fat, cholesterol and sodium. The overall composition of mung beans is similar to that of other grain legumes.[2–4] Dehusking, a common process in the preparation of mung beans for consumption, generally raises the protein content of the seeds and lowers the fiber content. Mung beans provide a wide range of mineral elements to supplement the dietary requirements of humans. The total phosphorus content of the seed is relatively high, but much of this is present as phytate. The phytate ion complexes with divalent cations of zinc, calcium, magnesium and iron and ferric ions, making insoluble compounds that are not absorbed from the gastrointestional tract. Experiments have shown that the bioavailability of iron for instance is extremely low (2.6%) in mung beans. Germination, soaking, fermentation and cooking all reduce the effect of phytate in legumes.

Protein content ranges from 18 to 36% and, in common with that in many other legumes, is markedly deficient in sulfur amino acids, particularly methionine. It is also a poor source of tryptophan. In contrast, the lysine content of mung beans is high and readily available. Therefore, mixtures of mung bean and cereal give a more balanced amino acid profile and biological value than the two foods separately. Cooking and processing generally improve the protein quality and moist heat methods of processing improve the quality to a greater extent than do dry heat methods.[5] Fermentation and germination do not appear to alter the quality of the protein significantly when compared with the raw seed. Savage and Deo[4] clearly showed a considerable variation in methionine content between different cultivars of mung bean. Only small additions of methionine are required to achieve a large improvement in the biological value of the raw or cooked beans when fed to rats. They went on to show that the addition of 0.15% methionine to raw mung bean seeds appears to give maximum response in terms of improved biological value while cooked seeds required 0.2% methionine for maximum response.[4] In these feeding experiments it was clear that tryptophan was not the second limiting amino acid, in contrast to lentil protein.[2]

The mung bean has been widely cultivated for several thousand years.

Both mung beans and urd beans can be germinated to produce bean sprouts which are extensively used

Table 1
Species and Common Names of the Two Important Species of *Vigna radiata*

Species	Synonyms	Common Names
Vigna radiata var. *aureus*	*Vigna radiata* (L.) Wilczek	Mung bean, green gram, golden gram,
	Phaseolus radiatus (L.)	Orgeon pea, Moong, Jerusalem pea,
	Phaseolus aureus Roxb.	Newman pea
Vigna radiata var. *mungo*	*Vigna mungo* (L.) Hepper	Urd, urd bean, black gram,
	Phaseolus mungo (L.)	mash, mungo bean, woolly pyrol, black mapte

in Chinese cooking. Bean sprouts are becoming more popular in western countries where they are used as a garnish in mixed diets or used as a valuable source of protein and vitamins in vegetarian diets.

MUNG BEAN SPROUTS

Dried mung bean seeds can be stored for long periods of time and sprouts can be easily obtained by germinating the seeds in the dark for up to 4 days. This process has been used by the Chinese for centuries. Sprouting does not require soil or solar radiation and is not limited to seasonal growth. Large amounts of sprouts can be obtained in a relatively short time. Sprouts are a cheap source of certain vitamins in the diet and some vitamins are synthesized in the germinating seeds.

Mung beans are low in methionine and tryptophan but high in lysine.

Sprouted mung beans contain similar amounts of lipids, protein, starch, polysaccharides other than starch, lignin and ash compared to the raw bean, but sprouted seeds contain less raffinose family oligosaccharides as they are used as a source of available energy in the germination process.[6,7] As the $\alpha(1\rightarrow6)$ linkages are indigestible by mammalian enzymes, the reduction of these oligosaccharides during germination leads to a reduction of the flatus potential of the beans caused by the action of intestinal anaerobic microorganisms. Jaya and Venkataraman[7] noted that as the raffinose family oligosaccharides were degraded during sprouting a significant increase in glucose, galactose and sucrose also occurred.

It is well known that the sprouting process results in an improvement in the vitamin content. Magaram et al.[8] showed that whole dry mung bean seeds contained 2.69 mg/kg of folic acid. 1.78 mg/kg (wet weight) of folic acid content was observed after 5 days of germination, indicating that considerable synthesis of folic acid occurs during germination. The germination of mung beans for 3 to 4 days resulted in a significant increase in the ascorbic acid content from 30 to 54 mg/kg in the seed to between 73 to 383 mg/kg in the sprouts.[9]

Germinating mung bean seeds yield sprouts after 4 days in the dark.

Germination of mung beans for 72 hours results in a fall in the phytic acid content from 2.05 g/kg of dry beans to 1.42 g/kg for soaked and germinated beans.[10] Tabekhia and Luh[10] showed that while the total phosphorus content of the beans remained constant (4·4 g/kg) during germination, the proportion of inorganic phosphorus rose as germination proceeded. Reddy *et al.*[11] point out that during germination phytase breaks down phytic acid in the seed, yielding a source of phosphorus, cations and inositol to the germinating seeds. It can be assumed that the phosphorus content of germinated seeds is more available than in ungerminated seeds.

Germination of mung beans for 48 hours resulted in significant reductions in the phytate and tannin contents with a consequent increase in the ionizable iron content.[12] While the removal of the seed coat may be a practical way to reduce the tannin content of mung beans seeds, it should also be noted that the tannin content can be reduced by germination, with a useful increase in iron availability. This increase in iron availability may be quite significant in areas where iron deficiency is widespread and mung beans form a significant portion of the local diet.

Prudente and Mabesa[13] showed that the protein quality of mung beans was considerably improved after 60 hours of sprouting. The nutritive value of the sprouts did not appear to be affected by whether the sprouts were grown under dark or illuminated conditions. Noor *et al.*[14] observed an improvement in the true digestibility of protein in sprouted mung beans but also observed a small decrease in the protein quality on germination (net protein utilization 28.0 raw to 26.0 in germinated seed).

Venkataraman *et al.*[15] showed that the true digestibility of the nitrogen of cooked mung beans improved significantly ($p < 0.01$) when the seeds were allowed to germinate for 24 or 72 hours (Table 2). The biological value of the protein was unaffected by germination, but the net protein utilization of the 72-hour germinated seeds was significantly greater than the ungerminated or 24-hour germinated seeds.

Blanching has very little effect on amino acid, proteins and lipid contents of sprouted seeds.[16] While the amino acid composition of the protein remained reasonably stable on storage, the free amino acids were quickly lost on bottling and storage. The lipids of the processed sprouted seeds remained relatively stable to processing and storage, but there was an increase in simple lipids as complex lipids were slowly degraded.

Folic acid content is enhanced by synthesis during germination.

Blanching mung beans has little effect on the total carotenoid content of sprouts,[16] but results in a 50% loss of vitamin C. Canning and bottling of sprouts led to considerable losses of vitamin C, while the carotenoid content remained relatively stable. Storage of bottled or

Table 2
Protein Quality of Cooked Mung Beans*

	Ungerminated	24-Hr Germinated	72-Hr Germinated
True digestibility (%)	68.4	72.2	81.2
Biological value (%)	62.0	59.0	63.0
Net protein utilization (%)	42.4	42.6	51.2

* Adapted from Venkataraman *et al.*[15]

canned bean sprouts led to further losses of vitamin C and total carotenoid content.

CONCLUSIONS

Although mung beans are consumed by millions of people, little research has been carried out on improving their nutritional value. Priority should be given to screening lines for high essential amino acid content, particularly methionine. Strains should be identified that contain lower levels of antinutritive factors and selections should be made to reduce their flatus potential. An increased consumption of mung bean sprouts, particularly by people consuming western-type diets, could have a significant effect on cardiovascular disease, which is a major problem for these people. An increased consumption of plant seeds would provide a more economical way to feed people than via the animal industry.

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