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FOSRIN

Food Security through Ricebean Research in India and Nepal

Report 5: Ricebean food preparation and diets

Report on ricebean food preparation and diets

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Executive summary

The existing scientific literature has established that the nutritional value of ricebean (*Vigna umbellata*) in many respects is impacted by different methods of food preparation. In particular, anti-nutritional factors such as phytic acid, tannin and trypsin inhibitor, and the content of indigestible saccharides are reduced considerably if the beans are subject to common, low cost, pre-cooking and cooking procedures. The effects of overnight soaking, sprouting, de-hulling and pressure cooking all tend to reduce anti-nutritional factors, and in effect make the important micronutrients more bio-available and the beans more digestive.

Field evidence shows that the widespread use of pressure cookers for common preparations of ricebean is, unfortunately, leading to widespread neglect of soaking and sprouting. The evidence in scientific literature clearly suggests that a combination should be advocated, for ricebean as well as for other grain pulses.

The most common preparation of ricebean in both India and Nepal is as *dhal*, a soup or sauce which is served with a staple of rice, wheat or maize, and various vegetable curries in addition to dairy produce. However, ricebean is also served using a number of other recipes, including mixed bean sprout soup, ricebean stuffed items, and grinding soaked ricebean into a paste to make various shapes of deep fried nuggets. Many of these recipes are existing local ones, and field demonstrations show that ricebean is a versatile raw material which can substitute other pulses in common recipes that are locally popular. Thereby, ricebean has potentials when it comes to value added products which can be produced at a local market place and tea-shop level.

The field evidence also shows that there are large variations in the diets in different sites, both in terms of staple composition (the balance between rice, maize and wheat) and the consumption of different grain pulses. In the four areas in the nutritional survey, ricebean was recorded as the sixth most common grain pulse.

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Contents

Preface

The present report is an output of work carried out under FOSRIN WP5 Nutrition and health, with inputs from partners from other work packages in the FOSRIN consortium. The report is to be followed by more results from the dietary survey which has been the bulk of the work in WP5, based on dietary recalls from 800 women in four locations in Nepal and India.

1. Introduction

Our aim in studying methods of preparing food from ricebean is to document its use, both as a crop, and as a component of the daily diet of people in India and Nepal, and to investigate new potential uses for the species. Specific attention is paid to the impact of food processing on the bioavailability of various nutrients, for example inhibition of the uptake of zinc (Zn), calcium (Ca), iron (Fe) and other minerals by phytic acid, tannins and fibres. This is a particular problem for people of vegetarian or largely vegetarian diets. (Harland & Oberleas, 1987; Hunt, 2003; Lönnerdal, 2000). Anti-nutrients are often found in high concentrations in grains, and in particular in legume grains, but their concentrations are affected by the cooking method. Several studies have addressed these issues with respect to ricebean. The report is based on inputs from several partners in the FOSRIN project, as well as some preliminary results from the dietary survey which was carried out in WP5 in four different regions of India and Nepal.

2. Scientific literature on the effects of food preparation methods on nutritional aspects of ricebean

Saikia *et al* (1999) assessed the nutrient composition of four different ricebean cultivars which were uncooked, boiled for 50 minutes or pressure cooked for 15 minutes. They found that cooking resulted in a substantial reduction in protein, fat, fibres, starch and ash due to leaching into the boiling water, whereas the content of total soluble sugars increased through the degradation of starch into simple soluble sugars. For most nutrients, leaching was less under pressure cooking than under boiling. Some minerals were more leachable than others, for example Ca losses under pressure cooking were negligible, while those of phosphorus (P) and Fe were in the range of 35-55% under boiling.

Regarding antinutrients, Saikia *et al* (1999) measured phytic acid, tannin and trypsin inhibitor activity. Phytic acid lowers the availability of P, Zn and Ca as well as other minerals. The phytic acid content of ricebean was around 2000 mg/100 g, consistent with what has been found in other literature. Pressure cooking reduced phytic acid by 15-18%, while boiling reduced it by 13-15%. Tannins reduce the digestibility of protein and the uptake of some minerals. Tannins were reduced by 30-37% by pressure cooking and 34-45% by boiling.

Trypsin inhibitors affect the enzymatic activities in the intestines, and thereby not only affect protein digestibility, but also induce unpleasant symptoms after eating. The level of trypsin inhibitor activity in uncooked ricebean was around 2500 TIU (Trypsin Inhibitor Units)/g, but was reduced by 64% by pressure cooking and by 52-55% by boiling. In their discussion, the authors concluded that *"The antinutritional factors, TIA and phytic acid, though showing a high concentration, should not pose a problem in human consumption if the beans are properly processed."*

In a study from the Philippines comparing different grain legumes, Laurena *et al* (1994) found that trypsin inhibitor activity in ricebean was low compared to other legumes.

Another factor which can deter people from eating ricebean is the content of indigestible sugars, leading to flatulence. Kaur & Kawatra (2000) studied the impact of soaking, sprouting, roasting, open pan cooking and pressure cooking on the ricebean raffinose and stachyose content. All processing methods led to significant reductions in the flatus producing sugars, and combinations of the methods reduced them further. The best results were obtained by sprouting and pressure cooking combined, which reduced the raffinose content from 1.48 to 0.29 g/100g dry matter (DM), and the stachyose content from 3.29 to 0.68 g/100g DM.

Saharan *et al* (2001a) studied the effects of cooking methods on Ca, Fe and P. Soaking and sprouting reduced the content of these minerals slightly, probably due to leaching into the soaking medium. However, inexpensive and simple treatments had significant positive impact on the *in vitro* availability of the minerals, most likely due to a reduction in anti-nutrients such as phytic acid. The authors concluded that this type of processing should be recommended in projects advocating ricebean and similar foods.

Table 1: Effect of soaking and sprouting on mineral availability, derived from Saharan *et al* (2001)

Mean values	**Ca mg/100g**		**Fe mg/100g**		**P mg/100g**	
	Total	% available	Total	% available	Total	% available
Raw bean	311.7	59.8	6.6	37.9	257.1	33.4
Soaked 12 hours	303.0	62.1	6.4	39.3	255.0	37.7
Sprouted 24 hours	299.2	67.5	6.4	41.5	255.8	38.8

Saharan *et al* (2001b; probably using the same data set) calculated that dehulling, soaking and sprouting would reduce phytic acid content in ricebean by 13, 16 and 57 % respectively. The different processes increased the extractability of Ca by 5, 7 and 18 %, Fe by 9, 5 and 10 % and P by 12, 10 and 13 %. In a later paper (Saharan *et al*, 2004) they assessed ricebean and faba bean to develop an understanding of the interactions between hard seeds, antinutrients, cooking time and digestibility. They tested the effects on starch digestibility in ricebean by soaking (12 hours) and sprouting (24 hours). While the untreated beans had a mean digestibility of 30.8 mg maltose released per g, soaking increased this figure to 42.4 and sprouting to 61.3. Dehulling was not used for ricebean as it was thought too cumbersome due to the small size of the grains.

In an *in vivo* study of anaemic rats, Kaur & Kawatra (2002a) found that soaking and pressure cooking, sprouting and roasting of ricebean significantly increased haemoglobin gain compared to rats fed on raw beans. The study also included dehulling, which apparently made little impact on the iron uptake. This indicates again that altered biochemical properties resulting from soaking and sprouting are highly beneficial in terms of iron uptake. In a similar study (Kaur & Kawatra, 2002b) they studied the intake, absorption and retention of Zn in rats fed with ricebean. The findings (Table 2) showed substantially higher absorption and retention in all types of processing, but, in contrast to the Fe study, dehulling had a major positive impact on Zn uptake, even more so when combined with other preparation methods. The explanation for this is likely to be high concentrations of antinutrients in the hull.

Table 2: Zn uptake as affected by processing, based on Kaur & Kawatra 2002b

Ricebean processing	**Mean apparent absorption (%)**	**Mean apparent retention (%)**
Whole raw	45	42
Soaked, pressure cooked	54	53
Sprouted, pressure cooked	63	61
Roasted	54	52
Raw, dehulled	57	54
Dehulled, soaked, pressure cooked	65	63

Again, this study confirms the importance of processing for the nutritional value of ricebean.

3. Common preparations of ricebean in different field sites

In the baseline study in connection with the dietary survey (Andersen, 2009), one question was asked concerning the methods used in various districts for the preparation of pulses in general. The results are presented in Table 3.

Table 3. Preparations of pulses recorded in baseline study of dietary survey.

Method of preparation, %	Gulmi	Dolakha	Assam	HP
Boiling	10	0.5	66	1
Soaking	0	0	0	0.5
Pressure cooking	14	0.5	1.5	92.5
Frying	0	2	0.5	0.5
Combination	76	97	31	5.5

The question was asked with respect to pulses in general, so it is likely that one of the reasons for the large differences between the records from the sites could be differences in the pulses eaten in the different places (see below). Some, such as lentils, are relatively easy to cook in a pressure cooker, while others invariably require prior soaking or sprouting. Ricebean sprouts do not reach a salad-ready, crisp state like mungbean. The seed part of the sprouts continues to be somewhat tough to chew, so will still need to be cooked after sprouting.

The study design did not reveal further what combinations of the various methods were used, but they were most likely to be soaking + boiling, soaking + pressure cooking or soaking + frying. The very high figure for pressure cooking in HP is, according to field observations by Dr Naveen Kumar, reflecting the common practice: ricebean and other pulses are predominantly pressure cooked without any prior soaking. This is the practice when ricebean is processed as *dhal* (pulse sauce/soup to be served with staple foods), whereas further refined recipes turning ricebean into a paste for deep fried nuggets etc., do require prior soaking.

In Assam, people generally soak many pulses like red kidney bean (*Phaseolus vulgaris*), soybean (*Glycine max*), gram (*Vigna mungo*, *V. radiata*) etc. before boiling, but some “tribal” people do not soak ricebean before boiling (Dr S B Neog, Assam Agricultural University, pers. comm.)

In the Nepalese sites included in the nutrition survey, the predominant practice appears to be soaking and boiling or pressure cooking. In Dang District, soaking whole ricebean before further cooking is the most common practice (Acharya, 2008). In a field survey, 40 households were asked about common preparation practices. The results were:

- 35 soaking
- 23 sprouting
- 31 soaking and dehulling
- 17 dehulling

This reflects, of course, the fact that several practices are used by households on various occasions.

In Dang, ricebean is consumed at all meals, but more is eaten in the morning and midday meals than in the evening. Here, there is tradition of taking *dal bhat* in the morning while in the evening *dal* is rarely cooked. Instead, a staple such as bread or rice is generally taken with some vegetables. However, when green pods are available, they are used as a vegetable for the evening meal.

Different food items are prepared from ricebean in Dang, based on the social and cultural setting and food habits of the local people. Green pods are largely used as a vegetable: *Tharu* people call it *Thusa*. Bold grain ricebean is more commonly used as a vegetable, but small grain varieties are also used in some places. Other food items are prepared from the dry seed. *Dal, Biraula*, and *Pakauda* are the most common food items prepared from the ricebean. *Dal* is a curry prepared with different kinds of pulses to supplement rice in the morning meal and is central to the rice-based food system. It is normally consumed with pickles and a vegetable curry.

Biraula is made from soaked ricebean, either fried or steamed and consumed as a snack for the midday meal. *Pakauda* is made from legume flour, mixed with water and spices, and deep fried and served as a snack. Sometimes *pakauda* is prepared by soaking beans and grinding them into a paste, which is seasoned and shaped into patties. Ricebean *pakauda* is popular in the *Tharu* community and is locally called *khariya*. In other parts of the country it is known as *batuk*.

Most of the constraints on consumption reported were related to processing aspects such as long cooking time, poor taste, hard seeds, or poor digestibility. Farmers feel that ricebean normally takes longer to cook than other common pulses. Although the introduction of pressure cookers has reduced this, ricebean still needs 3 to 4 "blows”, more than other common pulses. Poor and marginal households who cannot afford a pressure cooker still cook legumes in an open *kasaudi* pan, and for them the problem is the same as it was before. Ricebean is generally soaked for one night before cooking, which significantly reduces cooking time. Gulmi people perceive that indigestible grains cause flatulence, and sick children are not served ricebean. However, in Ilam and elsewhere the perception of ricebean is the opposite – it is felt to be easily digestible compared to other grain legumes, and is often served to children, the elderly and the sick.

Quantee (kwanti/kwati) is a mixed bean sprout soup consisting of eight or in some versions nine different pulses, one of which is ricebean. This dish has to some extent a ritual role, being served at the Hindu festival *Janai purnima* and at other festive occasions.

Ricebean has considerable socio-cultural importance in the *Tharu community* in the Nepal *Terai*, where it is required for religious ceremonies during the *Dashain* festival. It is also offered to guests at special occasions and social gatherings. The availability of ricebean increases the variety of legume grains which are considered essential to be served to guests at social gatherings. According to the *Tharu* people, the greater the variety of the food offered, the greater the social status and respect being shown to the guest. Therefore most *Tharu* people grow at least a small amount of ricebean in their field. They have a preference for ricebean as a vegetable at social gatherings. In all communities there is tradition for making soup from ricebean if one gets cold in the winter, due to its perceived medicinal value.

4. Field observations by LI-BIRD

The records from Dang are largely confirmed by the work reported by LI-BIRD (Khanal *et al* 2009.). They write that ricebean in Nepal largely is eaten as a *dal* – soup, served with rice or *chapattis*. Ricebean is rarely milled or broken up, unlike most other legumes. *Biramla* is either made by boiling and then drying ricebean, or by soaking whole grains overnight and frying in oil with spices. *Batuk roti* and *furaula* are snacks made from soaked ricebean ground into a paste, shaped in larger or smaller sizes and deep fried. *Masaura* nuggets are made from legume flour, mixed with taro, made into a paste and sun dried for storage, to be used as a vegetable or for soup when green vegetables are scarce. Khanal *et al* (2009) also report that ricebean generally is referred to as a *sardi* – cold – food in the Nepalese hot-cold dichotomy. This has some impacts on which other food items ricebean is cooked with, in order to ‘balance’ the ingredients. In addition, it has some bearings on cultural rules, such as not serving cold legumes to lactating mothers for the first two or three months of breastfeeding.

5. Results from organoleptic trials and demonstration of cooking methods in Himachal Pradesh

Objective:

1. To impart training to local people regarding preparation of various ricebean recipes with a view to make it more acceptable.
2. To study the organoleptic qualities of various ricebean products.

The locations were in the Trilokpur and Khundian areas, and the work was carried out by CSK HPKV, Palampur. The trials were undertaken from November 2007 to January 2008, in order to raise awareness of ricebean’s nutritional quality, and provide training in the preparation of different ricebean products, including value added products.

In December 2007, training sessions were carried out in the Trilokpur area, in villages, Mangal Tika, Nagrota, Kholi, and Trilokpur, and in the Khundian area in the villages of Ramnagar, Garana, Thill and Dhanai. In all, 497 farmers including women aged 20-40, men aged 18-50, and children (6-16) attended the programmes. In Trilokpur, there were 5 training sessions, with 300 trainees attending, while in Khundian there were 12 sessions with a total of 297 trainees.

The materials used were locally available ricebean seeds, and the utensils and cooking aids used by the families for their daily cooking.

5.1. Recipes prepared and demonstrated

Ten recipes were prepared and demonstrated :

i) *Dhal mori* – dhal with onions
ii) *Dhal khatti* – sour dhal
iii) Stuffed *Bhaturu* – deep fried, ricebean paste stuffed wheat bread
iv) *Pokoras* – deep fried balls of ricebean paste ("ricebean falafel")
v) *Namkeen* – deep fried snacks
vi) Nugget curry – curry with ricebean nuggets
vii) *Kandal* veg. – taro stem rolled in ricebean paste, dried and deep fried
viii) *Poha* – pan fried with spices
ix) *Chilla* - pancake
x) *Patora* – ricebean paste in taro leaf rolls, steam cooked and fried

5.2 Organoleptic rating

The preparation of these recipes was first demonstrated to the groups. Participants then prepared them, and the organoleptic qualities were judged by the villagers themselves on a 9- point hedonic scale with 1 being worst and 9 being best. Results are shown in Table 4.

Table 4: Hedonic rating among ricebean recipes in the Khundian and Trilokpur areas of Himachal Pradesh, India (Rating of the preparation by % of respondents; 9 is the most favoured, 1 is least. Mean is a weighted average calculated by multiplying rating with the percentage who thought so, then summarising per dish and dividing by 100.)

Points	9	8	7	6	5	4	3	2	1	Mean
					Khundian					
Dhal Mori	34	27	6	-	33	-	-	-	-	7.29
Dhal Khati	42	41	7	-	10	-	-	-	-	8.05
Stuffed *Bhaturu*	37	33	15	2	13	-	-	-	-	7.29
Pakora	37	25	18	2	15	3	-	-	-	7.58
Namkeen	32	28	20	4	10	6	-	-	-	7.50
Nugget curry	34	33	19	3	7	4	-	-	-	7.72
Khandal veg.	34	25	19	3	12	8	-	-	-	7.49
Poha	33	32	15	-	15	7	-	-	-	7.61
Chilla	33	27	10	11	15	4	-	-	-	7.40
Patora	32	29	20	2	15	2	-	-	-	7.55
					Trilokpur					
Dhal Mori	34	33	22	6	5	-	-	-	-	7.85
Dhal Khati	36	27	5	3	16	10	-	-	3	7.16
Stuffed *Bhaturu*	37	39	6	5	11	2	-	-	-	7.80
Pakora	44	40	6	4	6	-	-	-	-	8.12
Namkeen	45	42	8	3	1	-	-	-	-	8.20
Nugget curry	44	38	9	3	2	5	-	-	-	8.11
Khandal veg.	39	31	15	4	9	2	-	-	-	7.81
Poha	37	31	4	5	13	10	-	-	-	7.44
Chilla	27	24	10	3	14	13	9	-	-	6.72
Patora	36	33	6	2	12	11	-	-	-	7.46

Since the different recipes included spices etc., the trials were not a test of the preferences for ricebean varieties as such. Instead, they reflect that ricebean is a versatile raw material that can play many different roles in daily consumption, using locally recognised and preferred recipes. In this respect, ricebean has potential to add to food security. The testing also shows that ricebean can be used for production of value added products that could be produced at the tea-shop level, aimed at local markets.

6. Variation in composition of diets

Finally, ricebean and other pulses are always only one part of the diet, and the effects of processing and so on must also been seen in relation to the totality of the diet. While there is a good deal of similarity between diets at the field sites, there are also differences, as evidenced by the nutritional survey.

One major issue is around the staple foods. Food frequency analysis showed how Assam was dominated by rice (*Oryza sativa*) as the staple cereal, while the Nepalese sites had a larger intake of wheat (*Triticum aestivum*), maize (*Zea mays*) and millet (*Pennisetum glaucum*) (Table 5). In Himachal Pradesh, rice is taken on a daily basis, but wheat bread (*chapatti*) is also eaten. Due to their dominance, in the whole diet, the differences in staples are important for the nutrient density of the meals. However, the Assamese women were reporting a higher intake of fish and meat than for instance the women from HP who are largely vegetarians.

Table 5. Frequency of staple cereals, out of 600 recalls per site. WP5 nutritional survey.

	Dolakha (Nepal)	Gulmi (Nepal)	HP (India)	Assam (India)
Rice	572	424	554	558
Beaten rice	172	23		
Wheat and bread	107	175	608	24
Maize flour	164	155	16	2
Green maize	62	121		21
Millet	63	68		
Noodles, pasta	28	31	2	

A short typology of the diet in the different field sites can be described as:

- Dolakha: *Dal bhat* + maize and wheat, some non-vegetarian
- Gulmi: *Dal bhat* + more maize and wheat, some non-vegetarian
- HP: Rice + wheat bread + *dal* + more pulses, vegetarian
- Assam: Rice, leafy vegetables, fish, pork + pulses but not in every meal

In addition to these main ingredients, the reported intake of dairy produce is significant, especially in the Himalayan sites where it is a major source of vitamin B12 and other essential nutrients.

The reported frequency of pulse consumption differs markedly between the sites (Table 6). Lentils (*Lens culinaris*) are the most widely consumed except in Gulmi, where field beans (*Vicia faba*) and cowpea (*V. unguiculata*) were more common. In HP, several pulses are reported per recall, indicating that the diet consists of *dal*, rice, chapatti as well as a second pulse, in addition to vegetables.

Table 6: Frequency of different pulses, out of 600 recalls per site. WP5 nutritional survey.

	Dolakha (Nepal)	Gulmi (Nepal)	HP (India)	Assam (India)
Lentil	200	133	445	340
Field bean	138	193	13	13
Cowpea	77	153	6	29
Chickpea (*Cicer arietinum*)	8	6	232	
Pigeon pea (*Cajanus cajan*)	47	69	37	8
Ricebean	29	12	80	23
Soybean, raw	60	15	16	11
French bean (*Phaseolus vulgaris*)	17	4	37	5
Soybean, black	29	6	6	21
Mung bean (*V. radiata*)	4		56	
Horsegram (*Macrotyloma uniflorum*)	7	1	2	

It is important to recall that ricebean as well as other pulses always will provide only a minor fraction of the nutrients and anti-nutrients in the total diet. While pulses in general have higher concentrations of phytate than cereal grains, the quantity of cereals consumed is much higher, and so cereal grains will provide the major part of the phytate supply. While raw ricebean contains around 2000 mg/100g of phytate, the daily consumption of ricebean and other pulses will only be 25-40 g. Although the phytate content of cereal grains is lower, for example 284 mg/100 g in polished rice and 320 mg/100 g in all-purpose wheat flour (Harland & Oberleas 1987), the amount of phytate consumed through cereal grains is typically 10-20 times higher than from pulse consumption. The mean supply of phytate in the WP5 dietary recall was calculated to be between 1871 mg (Dolakha, second recall) and 2925 mg (Gulmi, third recall). This represents very high values compared to western, omnivorous diets. Harland & Oberleas (1987) mention values of 750, 6-800 and even down to 395 mg per day in the case of non-pregnant, non-lactating young women, from western countries.

We shall not go into the full details of the diets found in the study areas in the present report as that was recorded in Andersen (2009), but summarise the findings from there about the contribution of different foods to the total supply of phytate. It should be noted that the values for phytate content applied in the calculations are based on the Indian food tables used in the WorldFood2 programme, some of which appear rather suspicious. The phytate table values appear to be underestimated compared to, for instance, the values presented by Harland & Oberleas (1987). Still, some of this variation will be averaged out between the different pulses and it is believed that Table 8 is generally indicative of the greater picture.

Table 8: Contribution (%) of different foods to total phytate provision. WP5 nutrition survey, all sites.

Rice, grain or flour, raw, local, milled	53.9
Wheat, flour, local or HYV	18.0
Maize, grain or flour, local	11.5
Pulses other than lentil	3.0
Lentil	2.6
Pearl millet, flour, local	2.2
Potato	2.0
Mustard	2.0
Rice flakes	1.9

Likewise, although cereal grains and especially white rice in general are not rich sources of micronutrients, their dominance in the total diet still ensure that they are the main sources of minerals such as Zn, as shown in Table 9. According to the information on WorldFood2, the values for Zn are calculated as bioavailable Zn, using an algorithm which takes the anti-nutrient effect of phytate into consideration.

Table 9. Contribution of different foods to total Zn provision. WP5 nutrition survey, all sites.

Rice, grain or flour, raw, local, milled	44.4
Wheat, flour, local or HYV	16.3
Maize, grain or flour, local	6.9
Pulses other than lentil	3.6
Milk, buffalo	3.0
Lentil	2.5
Spices, mixed	2.0
Potato	2.0
Mustard	1.9
Pork	1.8
Buttermilk	1.7
Pearl millet, flour, local	1.6
Poultry	1.5
Beef, all types	1.5
Goat	1.4
Rice flakes	1.2

The findings concerning the relative contribution of the different food items to phytate and Zn can be compared to a study by Chandyo *et al* (2009) from Bhaktapur in the Kathmandu Valley, Nepal, an area dominated by *Newar* people eating a traditional *dal bhat* diet, which can be assumed to be not too different from the Nepalese Hill field sites studied in this work. Table 10 presents excerpts of this publication.

Table 10. Food frequencies and contribution of Zn and phytate in diets of women in Bhaktapur, Kathmandu Valley, after Chandyo *et al* 2009.

Foods	Eaten at least once a week, %	Zn contribution %	Phytate contribution %
Rice products	100	50	68
Wheat products	65	15	18
Meat	40	15	0
Green vegetables	81	6	5
Pulses	65	3	3
Potatoes	88	3	4
Milk products	66	3	0
Eggs	33	1	0

The overall mean intake of phytate in the Bhaktapur study was around 2200 mg/d. which compares well to the 1871-2925 mg/d found in the FOSRIN dietary recalls.

7. Conclusion

The most common cooking method of ricebean is soaking, boiling or pressure cooking, to be served as a *dhal*. This is favourable from a nutritional point of view, since it reduces the content of anti-nutrients, makes other nutrients more digestible, and reduces the losses of leachable vitamins, minerals and other nutrients. In addition, thorough processing reduces the effects of flatus-producing sugars and trypsin inhibitors which may otherwise make some people feel unwell after eating ricebean.

The trend towards pressure cooking without prior soaking or sprouting should be discouraged, and information disseminated as to why this is important. The problem is not pressure cooking *per se*, but relates to the beneficial effects of pre-processing before cooking. This is an issue that affects all grain legumes, and the grains of staple cereals may require lees cooking time and be more digestible if they are soaked first.

Many other preparations are possible, which also require various kinds of pre-processing to enhance nutrient bioavailability, and ricebean has acceptable qualities that can be used in development of commercial products. However, the dominance of cereal grains in the diets of South Asia also means that improved supply of pulses, and changes to their processing or preparation, will not in itself be enough to alter the typical nutrition in the region dramatically, so it is important to bring the whole of the diet into consideration.

8. References

Acharya BK (2008). *Cultivation and use of ricebean. A case study of Dang District, Nepal.* M.Phil thesis, Department of Geography, University of Bergen, Norway. https://bora.uib.no/bitstream/1956/2768/1/Masterthesis_Acharya.pdf

Andersen, P (2009). Food Security through Ricebean Research in India and Nepal (FOSRIN). Report 4. *Nutritional qualities of ricebean* (Ed PA Hollington). Bergen, Norway, Department of Geography, Universitet Bergen and Bangor, Wales, UK, CAZS Natural Resources, College of Natural Sciences, Bangor University.

Chandyo RK, Strand TA, Mathisen,M, Ulak M, Adhikari RK, Bolann BJ & Sommerfelt H (2009). Zinc deficiency is common among healthy women of reproductive age in Bhaktapur. *The Journal of Nutrition* **139**: 594-597.

Harland BF & Oberleas D (1987). Phytate in foods. *World Review of Nutrition and Dietetics* **52**: 235-259.

Hunt JR (2003). Bioavailability of iron, zinc, and other trace minerals from vegetarian diets. *American Journal of Clinical Nutrition* **78**(suppl): 633S–9S.

Khanal AR, Khadka K, Poudel I, Joshi KD & Hollington PA (2009) Food Security through Ricebean Research in India and Nepal (FOSRIN). Report 3. *Farmers' local knowledge associated with the production, utilization and diversity of ricebean (*Vigna umbellata*) in Nepal*. Pokhara, Nepal, Local Initiatives for Biodiversity, Research and Development, Rampur, Chitwan, Nepal: Institute of Agriculture and Animal Sciences, and Bangor, Wales, UK: CAZS Natural Resources, College of Natural Sciences, Bangor University.

Kaur M & Kawatra BL (2000). Effect of domestic processing on flatus producing factors in ricebean *(Vigna umbellata). Nährung* **44:** 447-450.

Kaur M & Kawatra BL (2002a). Evaluation of iron bioavailability from ricebean *(Vigna umbellata)* by using anaemic rats. *Nutrition Research* **22**: 633-640

Kaur M & Kawatra BL (2002b). Effect of domestic processing on zinc bioavailability from ricebean *(Vigna umbellata)* diets. *Plant foods for Human Nutrition* **57**: 307-318

Laureana AC, Revilleza MJR & Mendoza EMT (1994). Polyphenols, phytate, cyanogenic glycosides, and trypsin inhibitor activity of several Philippine indigenous food legumes. *Journal of Food Composition and Analysis* **7**: 194-202

Lönnerdal B (2000). Dietary factors influencing zinc absorption. *The Journal of Nutrition* **130**: 1378S - 1383S.

Saharan K, Khetarpaul N & Bishnoi S (2001a). Processing of newly released ricebean and fababean cultivars: changes in total and available calcium, iron and phosphorus. *International Journal of Food Sciences and Nutrition* **52**: 413-418.

Saharan K, Khetarpaul N & Bishnoi S (2001b). HCl-extractability of minerals from ricebean and fababean: influence of domestic processing methods. *Innovative Food Science & Emerging Technologies* **2**: 232-325.

Saharan K, Khetarpaul N & Bishnoi S (2004). Content and digestibility of carbohydrates of ricebean and fababean as affected by simple inexpensive processing methods. *Nutrition and Food Science* **34**, 13-16.

Saikia P, Sarkar CR & Borua I (1999). Chemical composition, antinutritional factors and effect of cooking on nutritional quality of rice bean [*Vigna umbellata (Thunb; Ohwi and Ohashi)*]. *Food Chemistry* **67**: 347-352.