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An Analysis of B Vitamins in Selected Indian Rice Landraces

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Abstract

We present here the first quantitative record of seven B complex vitamins in the grains of 363 native landraces of *Oryza sativa* ssp. *indica*.

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Introduction

Rice (*Oryza sativa*) is a major source of starch for half of the population worldwide. Like any cereal, rice has a low protein content, but contains many micronutrients, including metals stored especially in the bran (Sengupta et al. 2017; Suganya et al. 2019; Ray et al. 2021). However, almost all published studies of nutrient contents in rice have so far been conducted on modern high yielding varieties, while the thousands of landraces of Indian rice (*O. Sativa* ssp. *indica*) have hardly been examined. To address this serious lacuna in scientific information about nutrients in rice landraces, we undertook a thorough investigation into the contents of B vitamins in the grains of a wide range of endangered rice landraces whose pure lines are maintained at Basudha conservation farm.

We present here the first-hand reports of the B vitamin analyses in 200 *indica* rice landraces.

Materials

A total of 363 rice landraces, from the accession of Vrihi (http://cintdis.org/vrihi) gene bank were used for analyses. This collection comprises pure line landraces from different States of India, Bangladesh and Sri Lanka. In addition, 3 modern cultivars were also procured from Rice Research Station, Chuchurah, West Bengal.

Methods

Preparation of samples

In the laboratory, all freshly harvested rice samples were decorticated manually, by grating the raw rice against pumice stone, keeping the bran layer intact, and pulverised into fine particles using ceramic mortar and pestle, and stored at – 20°C. Subsequently, 1 g of rice powder was taken in a 100 ml conical flask and digested in 10 ml of 0.1N HCl in a boiling water bath for 1 h. After cooling at room temperature, the pH was adjusted at 4.5 using 2.5M sodium acetate. 0.5 G of the α-amylase enzyme (Himedia) was added to the solution and the flask was placed in an incubator at 35°C for overnight. After 24 hours, the solution was filtered through Whatman1 filter paper and stored in – 20°C until analysis. All reagents were analytical grade. Thiamine hydrochloride (B1), riboflavin (B2), nicotinic acid (B3), d-pantothenic acid (B5), pyridoxine (B6), biotin (B7) and cyanocobalamin (B12)

were purchased from Sigma-Aldrich (India). Methanol, chromatographic grade water and hydrochloric acid were obtained from Merck (India).

Preparation of stock solution

All B vitamins were diluted in chromatographic grade water at a concentration of 1mg/ml. Stock solutions were prepared daily before experiment.

Extraction of B complex vitamins

The method described in Puwastien et al., (2011) was adopted, with slight modification. Acid digestion was carried out with 1 g of powered rice sample in a 100 mL conical flask in presence of 10 mL 0.1 (N) HCl in a boiling water bath for 1 hr. The pH was adjusted at 4.5, using 2.5 (M) sodium acetate after cooling at room temperature. The solution was incubated at 35°C for overnight, followed by the addition of 0.5 g α-amylase enzyme (Himedia). Next day, after filtering the solution through Whatman1 filter paper, the solution was stored in at -20°C until analysis.

Chromatography

High-Performance Liquid Chromatographic (HPLC) technique was used for the analysis of B complex vitamins from the extracted rice samples. The reverse-phase -HPLC (RP-HPLC) method reported by Heudi, Kilinc and Fontannaz (2005) was taken for method standardization with slight modification. A gradient elution technique was employed to get the baseline separation of the B complex vitamins. Gradient of two mobile phases were: methanol (M) and water (W) with 0.02% aqueous H_3PO_4 in each solvent set and the gradient were set at: 0% M + 100% W for 3min; 10% A + 90% B for 10 min; 30% M + 70% W for 15 min and 25% M + 75% W for 30 min. The injection volume was 20 µl. The solvent flow rate was maintained at 1 ml/min and scanned at 210 nm. Considering a large number of samples and quick completion of the analysis, we have carried out the experiments using three different liquid chromatographic machines. However, the method was identical for B complex vitamin analyses in all the instruments. The instrumental details were (i) Agilent HPLC (USA) attached with Zorbax SB-C18 column (4.6x150mm, 3.5 micron, Agilent, USA) with Photo Diode Array Detector, (ii) Waters HPLC (USA) attached with Atlantis dC18 column (100Å, 5 µm, 3.9 mm X 150 mm) and UV-Vis detector, and (iii) Shimadzu Prominence UFLC (Ultra-Fast Liquid Chromatography, Japan), attached with Zorbax SB-C18 column (4.6x150mm, 3.5 micron, Agilent, USA) with dual-channel UV-Vis detector. In all the cases, the separated peaks were

calculated by comparing the relative retention time with the right peak integration, standard co-chromatography and absorption spectra calibration obtained from the authentic compounds (Sigma-Aldrich, India).

Detection of B vitamins

Based on the UV spectra of each vitamin, it was possible to choose a single wavelength for the detection of all seven B complex vitamins in the standard mix and samples. All the seven B vitamins in our study were detected at 210 nm in our experiment. The elution order was thiamine (vitamin B1), nicotinic acid (B3), pyridoxine (B6), d-pantothenic acid (B5), biotin (B7), riboflavin (B2) and cyanocobalamin (B12). All seven B complex vitamins were separated to the base line and eluted as sharp peak within 20 mins.

The reproducibility of the retention time was checked thrice and only after getting an acceptable standard deviation value the method was adopted.

Results

We present the results in **Table 1** below, showing the vitamin contents in 363 landraces. Each figure given here is the average of 3 replicated samples. For comparison, vitamin contents of three modern cultivars are given separately in **Table 2**.

Our data presented here are the first quantitative report of B vitamin contents of 363 *indica* rice landraces, and reveal that a significant number of landraces of Indian rice is considerably rich in different B complex vitamins, compared to 3 modern cultivars with poor levels of the same vitamins. The proportion of landraces containing > 0.1mg/100 g of the different B vitamins quantified in this study is summarized in **Fig. 1**, which shows that most of the landraces are rich in vitamin B1 (thiamin), whereas high vitamin B12 (cyanocobalamin) content is found in 5 (2.4%) of the landraces examined.

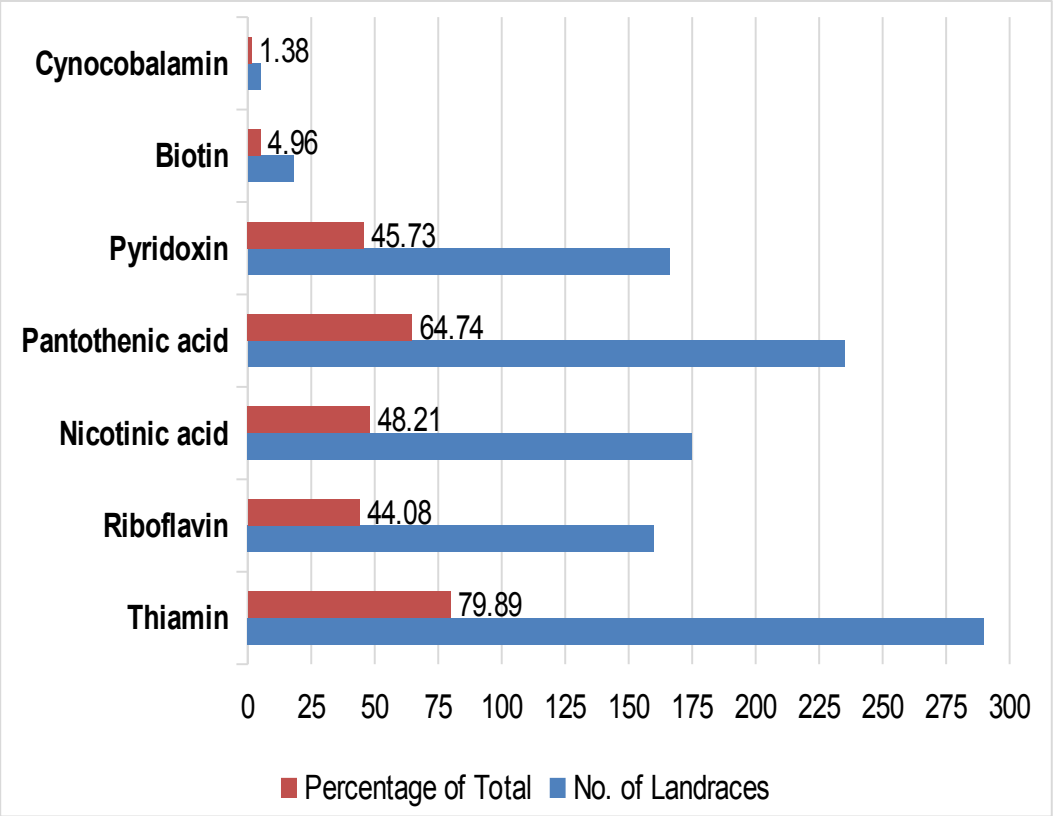

Fig. 1: The Number of Landraces (blue bars) and their Proportions (red bars), Containing > 100 µg of Cyanocobalamin in 100 g of Sample. Figures beside the red bars indicate the % of $N = 363$ landraces examined.

Table 1: Concentrations of Seven B Vitamins in 363 Rice Landraces and 3 Modern Cultivars.

(* Mean of three determinations. ** Not detected)

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
1	Aash	1.17	0.31	0.11	2.88	0.15	0.01	**
2	Abor xali	0.11	0.16	0.18	1.87	0.15	0.01	**
3	Ahana	0.38	0.05	0.02	0.06	0.03	**	**
4	Ajipa	1.54	0.28	0.14	2.32	0.10	**	**
5	Akshay rani	1.42	**	0.04	0.06	0.04	**	**
6	Alta pati	0.38	0.06	0.02	0.05	0.03	**	**
7	Amar-sal	0.43	**	0.11	0.06	0.01	**	**
8	Amit	0.58	0.12	0.09	1.08	0.05	**	**
9	Ampakhi bora	2.71	0.26	0.05	4.11	0.13	0.01	**
10	Anandi	0.12	0.15	0.19	1.80	0.11	0.01	**
11	Anandur sanna	3.49	0.31	0.04	2.91	0.14	0.01	**
12	Artharayi	0.48	**	**	0.06	0.01	**	**
13	Arunurvadllu	3.67	**	0.14	18.55	0.54	**	**
14	Aryan	4.45	**	0.11	1.36	0.07	**	**
15	Asanchuri	**	0.02	**	9.54	0.16	**	0.14
16	Asanleya	1.09	0.32	0.13	0.48	0.10	**	**
17	Ashphal	0.63	0.14	0.07	1.51	0.04	**	**
18	Ashwin jharia (P)	0.39	**	0.02	0.16	0.02	**	**
19	Athi karaya	0.50	0.01	0.05	0.07	0.02	**	**
20	Aurar	1.64	0.47	0.30	1.49	0.29	**	**
21	Ausha bonkata	0.42	0.06	0.02	0.06	0.01	**	**
22	Bada dhan	0.41	**	0.09	0.06	0.02	**	**
23	Badabona	4.95	0.01	0.08	1.67	0.14	**	**
24	Bagh jhapta	1.14	0.05	0.19	1.54	0.24	**	**
25	Bahurupi	**	**	**	**	0.02	**	**
26	Baid dhusuri	1.19	0.12	0.13	1.30	0.19	**	**
27	Baid dulah	1.40	0.63	0.29	7.43	0.42	0.02	**
28	Baid kalamkathi	0.53	0.08	0.06	0.47	0.06	**	**
29	Baidras	**	0.06	0.08	0.47	0.07	**	**
30	Bakul phool	0.01	0.02	**	3.60	0.86	0.14	0.08
31	Balaram-sal	1.14	0.15	0.15	1.32	0.16	**	**
32	Bangar sanna	**	0.02	**	7.99	**	**	**
33	Bank chur	1.36	0.32	0.15	2.59	0.08	**	**
34	Bankui	0.64	0.29	0.09	3.13	0.10	0.01	**
35	Bankuli	3.56	0.34	0.05	3.54	0.13	0.01	**
36	Banmae jo	1.46	0.17	0.20	1.19	0.14	**	**

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		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
37	Bansh kathi	1.07	0.04	**	**	0.33	**	**
38	Bansh mugur	0.95	1.05	0.08	1.86	0.05	0.01	**
39	Bansh pati	0.55	**	0.02	0.13	0.03	**	**
40	Bansh tara	8.32	0.09	0.09	3.13	0.13	0.01	**
41	Banya-sal	**	**	0.04	0.04	0.04	**	**
42	Basan kayal	5.53	0.02	0.06	1.05	0.08	**	**
43	Basumati	**	**	0.29	0.04	0.38	**	**
44	Baya gunda	1.12	0.25	0.19	1.07	0.14	**	**
45	Belgam sanna	1.06	0.32	0.12	3.96	0.15	**	**
46	Benajhuri	0.39	0.02	0.07	0.05	0.03	**	**
47	Bhaboli joha	**	0.06	**	0.02	0.04	**	**
48	Bhalki	1.26	**	0.04	0.05	0.08	**	**
49	Bhalu dubraj	4.06	**	0.28	**	0.24	**	**
50	Bhaluki	**	0.20	1.02	14.27	2.34	**	**
51	Bhasa kalmi	0.40	**	**	0.16	0.11	**	**
52	Bheral	0.67	0.24	0.03	0.15	0.08	**	**
53	Bhog dhan	0.39	**	**	0.04	0.17	**	**
54	Bhoglaya	0.84	0.31	0.29	1.51	0.29	**	**
55	Bhuri	1.34	0.08	0.11	0.99	0.05	**	**
56	Bhusihara	1.99	**	0.11	0.03	0.07	**	**
57	Bhut moori	**	**	0.27	**	1.23	**	**
58	Bhutta churi	0.84	0.31	0.29	1.51	0.29	**	**
59	Bita kaberi	1.04	0.27	0.13	4.42	0.18	0.01	**
60	Biti dhadi budda	2.75	0.19	0.25	0.42	0.30	**	**
61	Boddimani	1.14	0.15	0.15	1.32	0.16	**	**
62	Bogi xali	1.91	0.18	0.11	1.16	0.11	**	**
63	Bokra	**	**	0.28	0.03	0.44	**	**
64	Boloi genti	1.86	**	0.07	0.05	0.03	**	**
65	Bor jahingia	2.12	0.14	0.05	1.49	0.05	0.01	**
66	Bora	1.76	0.02	0.02	1.13	0.03	0.03	**
67	Bou bhog	0.94	0.26	0.12	2.03	0.05	**	**
68	Burma black-a	2.75	0.19	0.25	0.42	0.30	**	**
69	Chak hao poireithon	0.40	**	0.02	0.21	0.02	0.01	**
70	Chakramala	1.26	**	0.04	0.05	0.01	0.01	**
71	Chamarmani	0.52	**	0.45	**	**	**	**
72	Champa	0.70	**	0.03	3.28	0.09	**	**
73	Chandrakanta	3.94	0.01	0.13	1.07	0.86	0.01	**
74	Cheena kamini	0.97	0.18	0.13	1.16	0.12	**	**
75	Chenga	2.10	0.10	0.15	1.93	0.30	0.04	**

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		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
76	Chenga rangi	2.04	0.16	0.11	1.10	0.10	**	**
77	Chengeeran	**	**	**	0.05	0.02	0.01	**
78	Cheng-sal	1.26	**	0.04	0.07	**	**	**
79	Chennellu	0.65	0.13	0.07	2.55	0.09	**	**
80	Chhota	2.17	0.15	0.08	1.16	0.10	**	**
81	Chhoto nuniya	0.77	0.27	0.12	3.32	0.16	**	**
82	Chiittiga	1.83	0.12	0.09	1.55	0.05	**	**
83	Chila meteh	2.38	0.01	0.19	2.44	0.26	0.03	**
84	Chila patnai	2.83	0.02	0.06	1.40	0.19	**	**
85	Chinna poni	1.17	0.33	0.18	1.92	0.19	0.01	**
86	Choura goda	**	0.01	0.31	4.02	0.42	**	**
87	Churnokathi	9.43	0.22	0.14	3.75	0.13	0.04	**
88	Dambar salé	1.19	0.39	0.15	3.69	0.13	0.01	**
89	Danaguri	**	0.04	**	8.89	0.12	**	**
90	Darka-sal	4.82	**	0.22	1.96	0.08	**	**
91	Dar-sal	1.07	0.19	0.16	1.75	0.17	**	**
92	Dashra mathiya	0.82	**	0.03	16.89	0.14	**	**
93	Dayal madina	1.55	0.30	0.16	3.77	0.10	**	**
94	Dehradun	1.22	0.02	0.16	2.94	0.33	0.01	**
95	Dehradun gandheswari	**	0.03	**	**	**	**	**
96	Dehradun-bas	5.51	0.06	0.15	4.12	0.27	0.05	**
97	Deulabhog	3.00	0.35	0.05	4.47	0.12	0.01	**
98	Dewri baw	1.23	**	0.04	0.03	0.02	**	**
99	Dhanashree	0.77	**	**	0.04	0.02	0.01	**
100	Dhankadi deepa	3.21	0.46	0.06	3.70	0.15	0.01	**
101	Dheki mala	0.67	0.03	0.28	**	**	**	**
102	Dhowa-sal	1.34	0.34	0.14	3.69	0.15	**	**
103	Dhula dhusuri	2.37	0.17	0.12	1.83	0.14	**	**
104	Dhusuri	0.70	0.08	0.17	0.96	0.08	**	**
105	Dodda vallya	0.41	**	0.13	0.04	0.03	**	**
106	Dokra mesa	0.41	**	0.05	0.05	0.02	**	**
107	Dopeh	0.81	0.24	0.10	3.17	0.10	**	**
108	Dorangi	1.90	0.02	0.32	3.04	0.39	0.01	**
109	Dudhe bolta	10.55	0.05	0.16	4.24	0.26	0.05	**
110	Dukhi darbar	3.41	**	0.06	3.30	0.11	**	**
111	Durga sundari	1.43	0.13	0.03	0.84	0.04	**	**
112	Ekahari	**	**	**	**	**	**	**
113	Ekdalia	**	**	0.10	**	0.36	**	**
114	Elchir	0.97	0.34	0.14	1.40	0.15	**	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
115	Eri	**	0.05	0.54	**	**	**	**
116	Gaada dhan	0.97	0.20	0.20	1.32	0.14	**	**
117	Gajabunda	**	**	0.21	**	0.17	**	**
118	Gandheswari	1.08	0.05	0.10	0.34	0.05	**	**
119	Garia	0.55	**	**	0.05	0.03	**	**
120	Garib-sal	0.41	0.02	0.10	**	**	0.14	**
121	Garo joha	0.86	0.14	0.10	0.46	0.06	**	**
122	Gentu	1.00	**	0.03	0.07	0.03	0.03	**
123	Ghaiya	0.62	0.13	0.15	0.77	0.08	**	**
124	Ghasraiz	0.73	0.30	0.14	1.07	0.12	**	**
125	Ghasraji	0.73	0.30	0.14	1.07	0.12	**	**
126	Ghoi bir	1.41	**	0.04	1.33	0.06	**	**
127	Ghunsi	1.02	0.38	0.28	0.56	0.20	**	**
128	Gidda batha	1.00	0.24	0.10	1.90	0.08	**	**
129	Gidda gowri	9.21	0.03	0.16	3.25	0.27	0.01	**
130	Gidhan dhan	**	**	0.28	0.02	0.40	**	**
131	Gita	0.81	0.27	0.10	2.13	0.07	**	**
132	Gobinda	**	0.06	0.07	5.43	1.85	**	**
133	Gochari patnai	0.92	0.22	0.11	1.75	0.06	0.02	**
134	Gopalbhog	1.65	0.87	0.37	9.45	0.56	0.03	**
135	Government churi	0.62	0.07	0.07	0.25	0.06	**	**
136	Gulvady sanna	1.19	0.15	0.14	0.97	0.14	0.01	**
137	Hagmuni	**	0.01	0.21	4.69	0.32	**	**
138	Haldi guri	0.11	0.51	0.22	4.50	0.29	0.01	**
139	Hamilton	1.05	0.10	0.16	4.77	0.26	**	**
140	Hanseswari	1.71	**	0.02	0.01	0.04	**	**
141	Harfoni = Salpuna	1.03	0.17	0.09	0.23	0.09	**	**
142	Hari shankar	1.25	0.06	0.16	3.74	0.35	0.03	**
143	Hati dhan	0.81	0.08	0.08	0.61	0.04	**	**
144	Heerai joha	0.45	**	0.02	0.14	0.02	**	**
145	Hende baba	0.40	**	0.04	0.14	0.03	**	**
146	Hettalu mnie	0.50	0.22	0.13	0.17	0.02	**	**
147	Hinche saroo	2.61	0.02	0.16	0.81	0.29	0.01	**
148	Hudar	1.31	0.39	0.17	3.16	0.16	**	**
149	Huggi bhatta	0.67	0.04	0.19	**	**	0.25	**
150	Jaba gouri	**	0.17	0.25	21.06	**	**	0.35
151	Jabra = Bor dhan	0.02	0.32	0.20	2.60	0.21	0.01	**
152	Jagannath bhog	1.15	**	0.03	0.07	0.02	**	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
153	Jahingia	2.30	0.33	0.12	5.95	0.11	0.01	**
154	Jarhan baihar	0.38	**	**	0.05	0.03	0.01	**
155	Jata	**	0.06	**	25.19	**	**	0.08
156	Jata leta-sal	1.31	0.46	0.24	2.82	0.08	**	**
157	Jhanti	1.34	0.19	0.08	0.56	0.04	**	**
158	Jhuli (n)	1.30	**	0.07	0.04	0.03	**	**
159	Jhuloor	1.62	0.11	0.04	0.74	0.05	**	**
160	Jhulpo	3.65	0.17	0.05	1.63	0.12	0.01	**
161	Jhumpuri	0.97	0.30	0.12	1.40	0.15	**	**
162	Jira sari	**	0.03	0.45	**	1.91	1.62	**
163	Jugal	1.42	**	**	0.03	0.01	0.10	**
164	Juna kolam	0.38	**	0.03	0.05	0.01	**	**
165	Kaberi	**	**	**	0.06	0.16	**	**
166	Kabiraj-sal	1.18	0.31	0.18	1.56	0.21	0.01	**
167	Kadaliya	0.07	0.72	0.22	2.46	0.19	**	**
168	Kaggi salla	0.43	**	0.04	0.07	0.03	**	**
169	Kajal kathi	0.75	0.19	0.08	0.47	0.09	**	**
170	Kala malli	0.01	0.09	0.12	1.07	0.10	**	**
171	Kala namak	1.23	0.16	0.12	0.69	0.13	**	**
172	Kalam dani	2.21	0.20	0.06	0.54	0.13	**	**
173	Kalam kathi	0.25	0.07	0.06	0.79	0.04	**	**
174	Kaleswar	1.24	0.03	0.08	0.80	0.05	**	**
175	Kali jira	0.88	0.10	0.11	0.68	0.09	**	**
176	Kali komad	0.03	0.48	0.21	1.75	0.13	0.01	**
177	Kalishankar	1.06	0.21	0.08	0.54	0.10	**	**
178	Kalo bhat	**	**	**	0.19	**	0.10	**
179	Kalo dhepa	1.28	0.89	0.32	4.80	0.35	0.21	**
180	Kalo joha	0.34	0.13	0.29	**	**	**	**
181	Kalo meteh	0.35	0.12	0.12	0.34	0.07	**	**
182	Kalo nuniya	**	0.09	0.13	1.06	0.11	**	**
183	Kalo tulsi	4.16	0.16	0.08	1.46	0.07	**	**
184	Kamini	0.18	0.05	0.54	**	**	**	**
185	Kankhiri	**	**	**	0.53	0.01	0.01	**
186	Kankhria	0.89	0.15	0.14	0.85	0.08	**	**
187	Kariga javeli	**	**	**	0.03	0.03	0.01	**
188	Karni	0.63	0.22	0.08	2.11	0.10	0.01	**
189	Kartik-sal	0.65	0.12	0.07	0.36	0.04	**	**
190	Kashi phool	1.42	**	0.10	0.06	0.03	**	**
191	Kata raini	1.44	0.17	0.06	0.49	0.03	**	**
192	Kaya	**	**	0.26	**	1.34	**	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
193	Kba lyngkot	1.02	0.16	0.19	0.93	0.11	**	**
194	Kelas	**	0.03	0.38	**	**	**	**
195	Keleh	3.63	**	**	**	0.01	0.11	**
196	Kempu purigo nellu	**	**	0.02	0.07	0.02	0.01	**
197	Kermal	0.34	0.13	0.08	0.34	0.04	**	**
198	Keshab-sal	0.80	**	0.02	0.09	0.02	0.01	**
199	Ketsarü	0.03	0.42	0.24	2.34	0.13	0.01	**
200	Kharisha bhog	1.79	0.25	0.15	1.06	0.12	**	**
201	Khas dhan	**	**	0.72	**	0.52	**	**
202	Khatia tika	2.07	**	0.06	0.09	**	0.01	**
203	Kichedhi samba	**	**	0.64	**	0.35	**	**
204	Kinari	0.85	**	**	1.09	**	**	**
205	Kokua baw	0.37	0.61	**	0.07	0.04	0.02	**
206	Kola amona baw	1.38	0.25	0.20	2.39	0.18	**	**
207	Koliya lengri	1.18	**	0.04	0.11	0.02	0.01	**
208	Kona musori	1.31	**	0.03	0.08	0.07	0.01	**
209	Koshi kamon	1.65	0.20	0.06	0.28	0.06	**	**
210	Kotpe	0.58	**	0.06	0.05	0.03	**	**
211	Krishnabhog	**	0.16	**	**	**	0.30	0.02
212	Kulthi kayame	0.40	**	0.05	0.08	0.02	**	**
213	Kumrogorh	0.65	0.32	0.08	2.70	0.11	0.01	**
214	Kundapullan	0.93	0.32	0.13	3.27	0.09	**	**
215	Kurai	1.02	0.16	0.19	0.93	0.11	**	**
216	Ladari	5.88	**	0.19	3.78	0.17	**	**
217	Laha raja	**	0.10	0.23	**	**	**	**
218	Lakkhan-sal	**	0.07	**	**	**	**	0.05
219	Lakshmi chura	1.03	0.17	0.14	1.28	0.15	**	**
220	Lakshmi kajal	0.51	**	0.05	0.12	0.01	**	**
221	Lal bahal	6.47	**	0.24	0.02	**	**	**
222	Lal dhan patla	**	**	0.17	0.14	0.01	**	**
223	Lal getu	2.23	**	0.21	**	**	**	**
224	Lal gobindabhog	1.17	0.31	0.19	1.91	0.21	0.01	**
225	Lal jhulur	1.52	**	**	0.17	0.01	0.01	**
226	Lal kamal	0.39	**	**	0.05	0.01	0.01	**
227	Lal kamini	0.90	0.08	0.16	4.83	0.10	**	**
228	Lal pua	**	0.01	0.58	**	**	**	**
229	Lalu dhan	**	**	**	0.05	0.01	**	**
230	Langka	0.82	**	0.03	0.29	0.02	**	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
231	Lankeswari	**	**	0.04	0.08	0.01	**	**
232	Laser	**	**	**	0.07	0.01	0.01	**
233	Lata-sal	1.17	0.35	0.18	1.69	0.10	**	**
234	Lebu-sal	0.64	0.17	0.16	1.00	0.08	**	**
235	Lohajangi	0.49	0.13	0.15	0.83	0.07	**	**
236	Lugdhi-sal	0.89	**	0.03	0.02	0.01	0.14	**
237	Maadu	0.40	**	**	0.04	0.02	**	**
238	Madhumita	3.68	0.34	0.05	2.88	0.14	0.01	**
239	Madhuri	0.42	0.10	0.09	0.33	0.02	**	**
240	Madraraj	0.43	0.07	0.09	0.50	0.02	**	**
241	Mahadi	0.57	0.23	0.21	0.51	0.11	**	**
242	Mahula khushi	**	0.24	**	19.39	**	**	0.11
243	Mala	0.33	2.63	0.13	2.25	0.18	0.01	**
244	Malabati (=Orameteh)	0.44	0.05	0.05	0.34	0.02	**	**
245	Malgudia kalam	0.35	0.10	0.10	0.25	0.04	**	**
246	Mallika	0.13	0.33	0.13	2.00	0.15	0.01	**
247	Mami dhan	0.76	**	0.14	0.03	0.02	**	**
248	Mangu gadi	0.38	**	**	0.15	0.02	**	**
249	Manipura batta	1.10	0.31	0.24	1.07	0.19	**	**
250	Marich boot	**	0.36	**	13.36	0.80	**	**
251	Marich mukul	0.40	**	**	0.15	0.04	**	**
252	Masineh = Kalo tudey	**	**	0.09	**	0.08	**	**
253	Maskati	1.06	0.36	0.23	2.70	0.16	**	**
254	Mathallaga	1.11	0.90	0.19	5.53	0.21	0.30	**
255	Matla	**	0.03	0.12	1.74	0.21	**	**
256	Mavilon	1.37	**	0.04	0.23	0.01	**	**
257	Maw thlen	**	**	0.03	0.31	0.06	**	**
258	Meese batta	2.01	0.19	0.03	1.11	0.03	**	**
259	Mehdi	1.85	0.25	0.09	1.91	0.11	0.01	**
260	Melhitte	2.00	0.26	0.12	0.87	0.18	**	**
261	Mendi	**	0.01	**	**	**	**	0.11
262	Mohanbhog	0.19	0.23	0.15	2.11	0.16	0.04	**
263	Mohanmala	0.45	0.10	0.11	0.86	0.09	**	**
264	Mohanras	0.19	0.25	0.12	1.58	0.11	**	**
265	Moynaguri	1.02	0.28	0.40	1.50	0.19	**	**
266	Muttu gulla	**	**	**	0.31	0.09	**	**
267	Nagaland kalo	1.64	0.30	0.27	1.65	0.19	**	**
268	Nagra	1.45	0.21	0.37	1.23	0.18	0.01	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
269	Najirma	0.38	**	0.04	0.27	0.02	**	**
270	Nalwa	0.46	**	**	0.16	0.01	0.02	**
271	Narahasoi	1.08	0.39	0.32	0.71	0.27	**	**
272	Nekera	1.07	0.23	0.19	0.98	0.24	**	**
273	Nellur pisthal	**	**	**	0.12	0.02	**	**
274	Niyali godi	**	0.02	0.10	**	1.67	**	**
275	Noichi	2.55	**	0.22	3.85	**	**	**
276	Nona	**	**	**	0.17	0.01	0.02	**
277	Nona khirish	1.50	0.33	0.16	1.27	0.15	**	**
278	Nona-sal	2.02	0.38	0.16	1.31	0.15	**	**
279	Nuinya	**	**	0.32	**	0.19	0.16	**
280	Nyavara	**	0.02	0.32	**	0.07	2.44	**
281	Olee	0.39	**	**	0.28	0.02	**	**
282	Orah	**	**	**	0.16	0.02	**	**
283	Paan	0.67	**	0.09	**	**	**	**
284	Paloi thopa	2.20	**	0.06	0.09	0.01	0.01	**
285	Panati	5.73	0.05	0.07	0.34	0.17	**	**
286	Panirui	**	**	0.04	0.09	0.01	0.01	**
287	Paramita	1.81	0.17	0.07	1.61	0.05	**	**
288	Parmai-sal	**	0.07	0.88	**	2.33	**	**
289	Pateni	0.73	0.15	0.09	0.51	0.10	**	**
290	Phul mugri	1.40	**	0.03	0.06	0.03	0.03	**
291	Pittasalé	0.43	0.05	**	0.06	**	**	**
292	Pokkali	**	0.13	0.60	**	**	**	**
293	Pusa badh	0.99	0.25	0.13	0.73	0.14	**	**
294	Putikali	0.57	0.12	0.06	0.15	0.01	**	**
295	Raban-sal	1.40	**	0.07	0.01	0.01	**	**
296	Radha jugal	**	**	**	0.07	0.02	**	**
297	Radhatilak	2.65	**	0.08	**	**	**	**
298	Radhuni pagal	1.31	**	0.03	0.06	0.12	**	**
299	Raj bako	**	**	**	0.06	0.02	0.01	**
300	Raj jhinga	0.38	**	**	0.08	0.01	0.01	**
301	Raj kamal	0.41	**	0.09	0.02	0.01	0.03	**
302	Ramigali	0.39	**	0.02	0.03	0.02	0.02	**
303	Ranga dhan	0.40	**	**	0.04	0.04	0.08	**
304	Rani akand	0.38	**	**	0.03	0.06	0.02	**
305	Rani siyali	0.43	**	**	0.06	0.02	0.06	**
306	Rani-51	1.08	**	0.06	0.04	0.09	0.05	**
307	Rassi	1.34	0.21	0.21	4.90	0.43	0.01	**
308	Ratnachuri	1.85	**	0.03	0.02	0.01	0.02	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
309	Reda dhan	0.12	0.56	0.20	2.94	0.20	0.01	**
310	Riso nano veronese	1.87	0.58	0.26	5.80	0.33	0.02	**
311	Sada chenga	1.32	**	0.07	0.05	0.06	**	**
312	Sada dhan	0.87	0.24	0.08	0.50	0.05	**	**
313	Sada dhepa	1.42	0.28	0.16	1.53	0.10	**	**
314	Sada getu	**	**	0.38	**	0.77	**	**
315	Sada jabra	0.52	**	**	0.04	0.03	0.09	**
316	Sada kaya	1.92	0.23	0.10	1.24	0.10	**	**
317	Sada meteh	5.34	0.14	0.03	2.63	0.14	0.03	**
318	Sada mota	0.38	**	**	0.05	0.03	0.11	**
319	Salaer	5.18	0.01	0.11	17.17	0.21	**	**
320	Sanna bhatta	0.37	0.06	0.07	0.42	0.03	**	**
321	Sanna vallya	0.02	**	0.39	2.76	0.60	**	**
322	Sarasbhog	0.38	**	0.03	0.04	0.03	0.01	**
323	Saroo gurguri	0.42	**	0.06	0.02	0.05	0.05	**
324	Sateen	0.39	**	0.14	0.01	0.01	0.07	**
325	Sesh phal	0.51	0.16	0.12	0.56	0.05	**	**
326	Shamla	2.65	0.21	0.09	0.90	0.10	**	**
327	Shankari komal	2.68	0.07	0.04	1.39	0.05	**	**
328	Shati jeleh	0.43	**	0.03	0.05	0.05	0.59	**
329	Shatia bhadoi	1.01	**	4.65	0.07	0.05	0.03	**
330	Shishaphal	1.83	**	**	0.04	0.03	0.01	**
331	Shiuli	0.69	0.15	0.08	0.71	0.04	**	**
332	Shivappu kuzhiadichan	0.61	0.57	0.08	4.05	0.11	0.01	**
333	Shiyal raj	0.38	**	**	0.04	0.03	0.41	**
334	Shua kalma	**	**	**	0.05	0.05	0.42	**
335	Siddha sanna	1.46	0.15	**	**	0.40	**	**
336	Sona pan	0.46	0.02	0.02	0.05	0.02	0.03	**
337	Sonajhuli	0.77	0.26	0.18	1.31	0.16	**	**
338	Soorakuruvai	0.40	**	**	0.03	0.06	0.01	**
339	Srabanti-sal	1.96	0.20	0.10	0.81	0.15	**	**
340	Subasita	1.13	0.12	0.04	0.67	0.01	**	**
341	Sundar mukhi	**	**	0.09	0.07	0.01	0.02	**
342	Supari	0.38	0.15	**	0.03	0.09	0.01	**
343	Tal mugur	**	**	0.41	**	1.50	**	**
344	Tangra patnai	0.77	**	0.03	13.57	0.12	**	**
345	Teloshing	0.39	**	0.03	0.04	0.05	**	**
346	Thakur-sal	0.39	**	0.04	0.03	0.07	0.02	**

Ser. #	Rice Landrace	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
347	Thavala kannan	1.50	0.28	0.14	1.57	0.24	**	**
348	Thevürü lha	0.99	0.17	0.10	0.42	0.07	**	**
349	Thonnuran	1.47	0.27	0.16	1.43	0.21	**	**
350	Thonnuran thondi	1.38	0.30	0.14	0.81	0.12	**	**
351	Thupa bora	2.68	**	0.07	3.41	0.19	0.01	**
352	Thupi-sal	2.01	**	0.02	0.03	0.06	**	**
353	Tike churi	0.11	0.20	0.22	0.64	0.09	**	**
354	Tikia patnai	0.81	**	0.14	0.05	0.07	**	**
355	Tsorünyü	1.11	0.18	0.06	0.30	0.10	**	**
356	Tulasi xali	9.03	0.10	0.06	3.72	0.26	0.01	**
357	Tulo pajoy	1.92	**	0.03	0.02	0.14	**	**
358	Tulsa	**	0.09	0.39	8.41	1.87	**	**
359	Tulsi mukul	**	**	**	**	0.37	**	0.16
360	Tulsibhog	0.49	**	0.20	0.03	0.05	**	**
361	Vella thondi	6.65	0.01	0.06	5.78	0.10	0.01	**
362	Vishnu bhog	6.85	**	0.23	0.01	**	**	**
363	Yella salli	0.80	0.24	0.17	1.21	0.15	**	**

Table 2: Concentrations of Seven B Vitamins in 363 Rice Landraces and 3 Modern Cultivars.

(* Mean of three determinations. ** Not detected)

Ser. #	Modern Cultivar	Concentrations of B complex vitamins (mg/100g)*						
		Thiamin	Ribo-flavin	Nicotinic acid	Panto-thenic acid	Pyri-doxine	Biotin	Cyano-cobalamin
I	BPT5204	0.37	0.02	0.05	**	**	**	**
II	IR36	3.5	0.25	0.21	1.5	**	0.03	**
III	IR64	0.41	0.08	0.29	**	0.09	**	**

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