Characterization of Indian-specific gut microbiota for micronutrient production

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Abstract

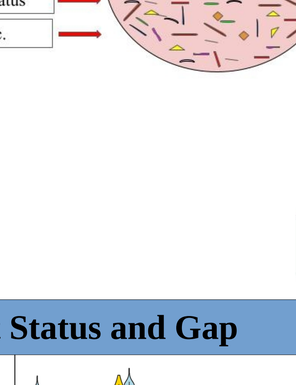
A comprehensive national nutrition survey of the Indian population (CNNS-2016-18) showed the prevalence of multiple essential micronutrients deficiency in the general population. Apart from the diet, the gut microbiota is also an important source of micronutrients such as B vitamins, and it has been predicted that at least a quarter of the suggested daily dietary intake of four vitamins (pyridoxine, folate, cobalamin, and niacin) is supplied by gut bacteria. India has unique gut microbial composition and there hasn't been any study examining the distribution of B-vitamin-producing microbes or the biosynthetic pathways in the Indian population. So the aim of this study is to explore the status of B-vitamin biosynthesizing bacterial species in the Indian population, and how the lifestyle or the diet affects these B-vitamin producers/pathways.

Background

Prevalence of B-vitamin deficiency in India

Vitamin	Pre-school children	School-aged children	Adolescents
B_{12}	14%	17%	31%
B_9	23%	28%	37%

Reasons for the deficiency?



a. Nutritionally inadequate, less diversified diet

b. Insufficient meal frequency

How are we loosing micronutrients present in food?

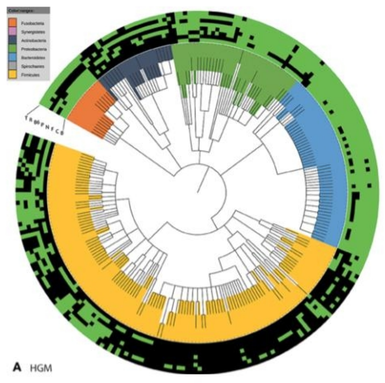
Processing methods: Cooking, washing, Refining

Efforts to enhance micronutrient content

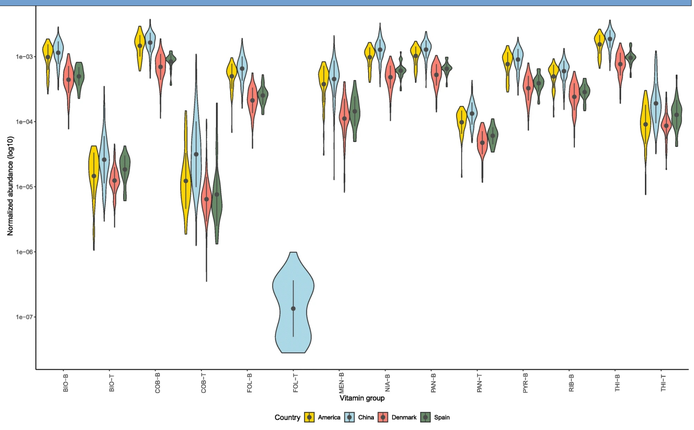
- Fortification
- Bio-fortification
- Micronutrient supplements

The Human Gut Microbiota: A natural source of B-vitamins

Current Status and Gap



Magnúsdóttir et al., (2015) predicted the B-vitamin biosynthesis of 256 known human gut bacteria and the majority of their predictions match published experimental data.



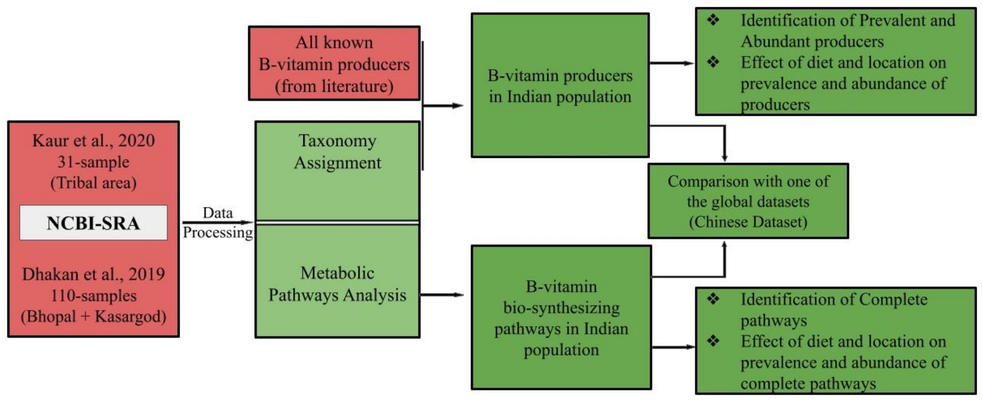
Das et al.,(2019) showed the abundance of B-vitamin biosynthesis pathways varies among different populations namely America, China, Denmark and Spain.

There hasn't been any study examining the distribution of B-vitamin-producing microbes or the biosynthetic pathways in the Indian population.

Objective

Explore the prevalence and abundance of B-vitamin producers and biosynthesis pathways in the Indian population, and how various factors affect them.

Methods



Prevalence: The proportion of samples in which a species is present

Abundance: The number of individuals of a particular species

Criteria used for modest Prevalence and Abundance
Prevalence >= 50%
Abundance >= 0.1%

Results

A total of 284 human gut B-vitamin producers identified from literature, out of which 38 were experimentally proven (Fig1 a). Most of the species were from Phylum Firmicutes (Fig1 b).

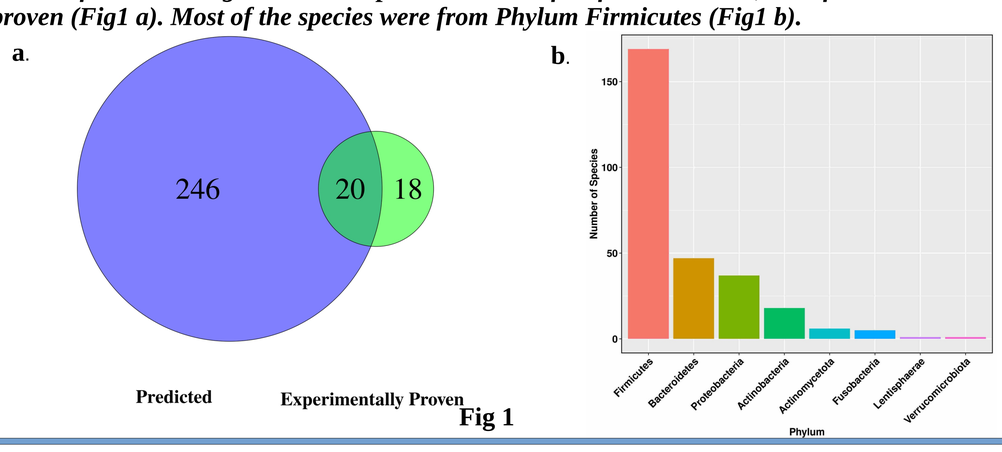


Fig 1

28 B-vitamin producers had modest abundance and prevalence in the Indian population (Fig 2a). Diet had a significant effect on the prevalence where omnivorous diet favoured high prevalence of 3 species, whereas vegetarian diet favoured high prevalence of one species namely P. Copri (Fig 2b) (p-value <=0.05). Red arrow shows significantly prevalent species. Their abundance didn't vary between two groups.

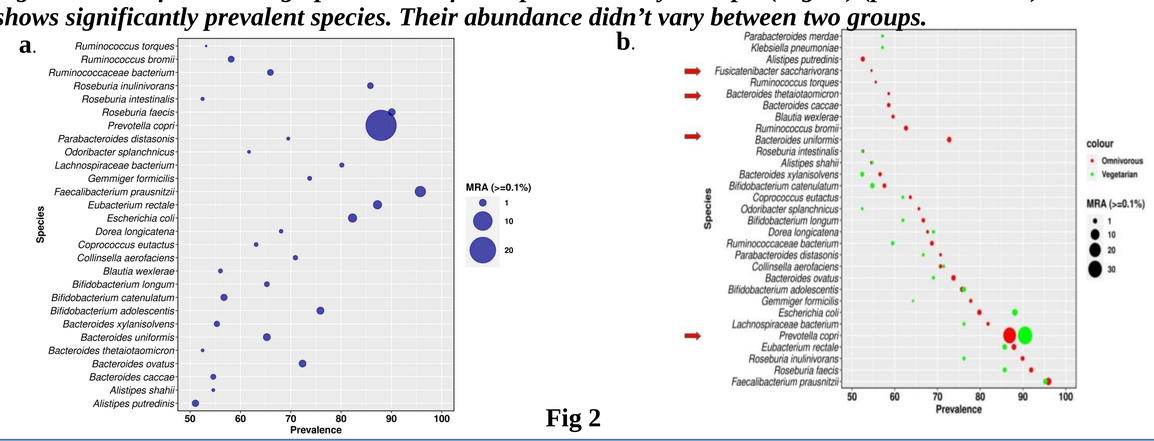


Fig 2

41 species showed modest prevalence and abundance in three locations (Fig 3a) and 30 of them were significantly prevalent (p-value<=0.05) (Fig 3b). Differentially abundant species in bhopal with respect to tribal population (p-value <=0.05) (Fig 3c).

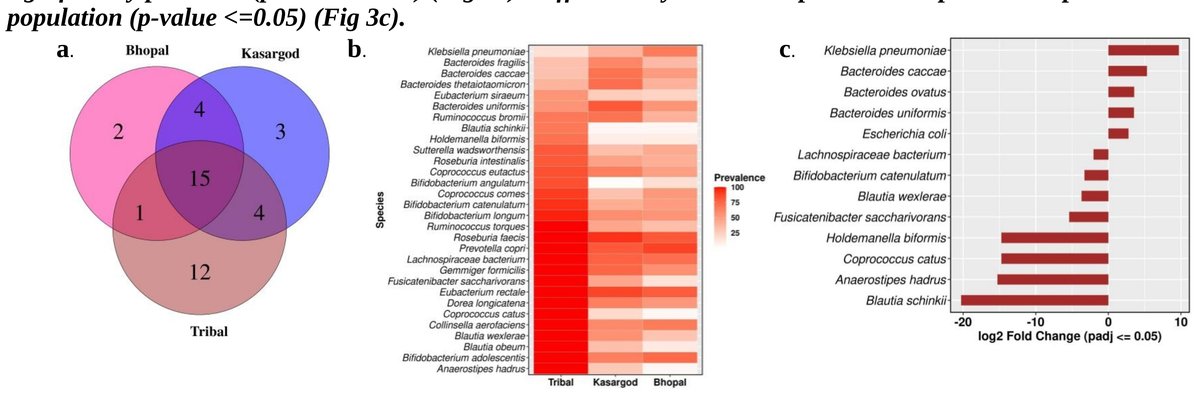


Fig 3

Four complete B-vitamin pathways were observed in Indian population. Fig 4a and 4b showed prevalence and abundance of pathways respectively. Prevalence of thiamin was significantly higher in Tribal (Fig 4c) and abundance of thiamin, folate and pantothenate were statistically significant in tribal population (Fig 4d). (sign. levels = 0.001 '**' 0.01 '*' 0.05). Different dietary groups didn't show the significant difference.

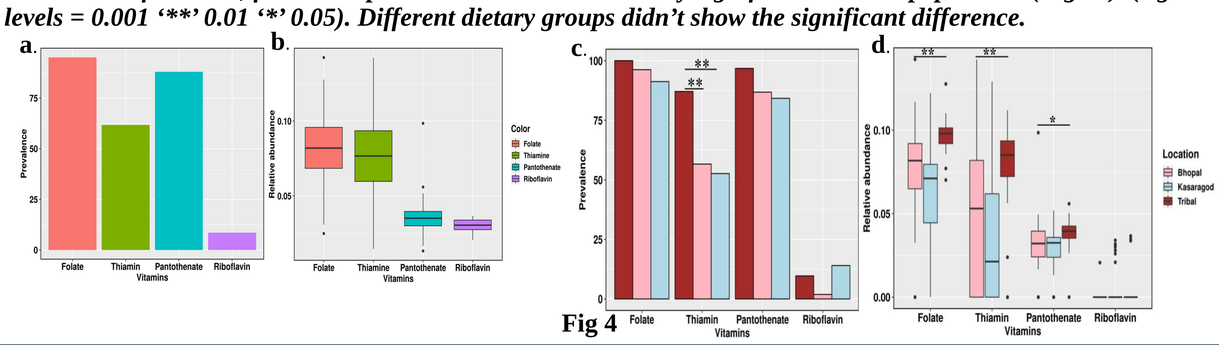


Fig 4

42 species showed modest prevalence and abundance in Chinese and Indian populations (Fig 5a), and majority of them were statistically highly prevalent (Fig 5b) and abundant (Fig 5c) in Chinese population. Pathways comparison showed higher prevalence of thiamin in Indian data (Fig 5d), and higher prevalence and abundance of pantothenate in Chinese population (Fig 5e) (p-value <=0.05).

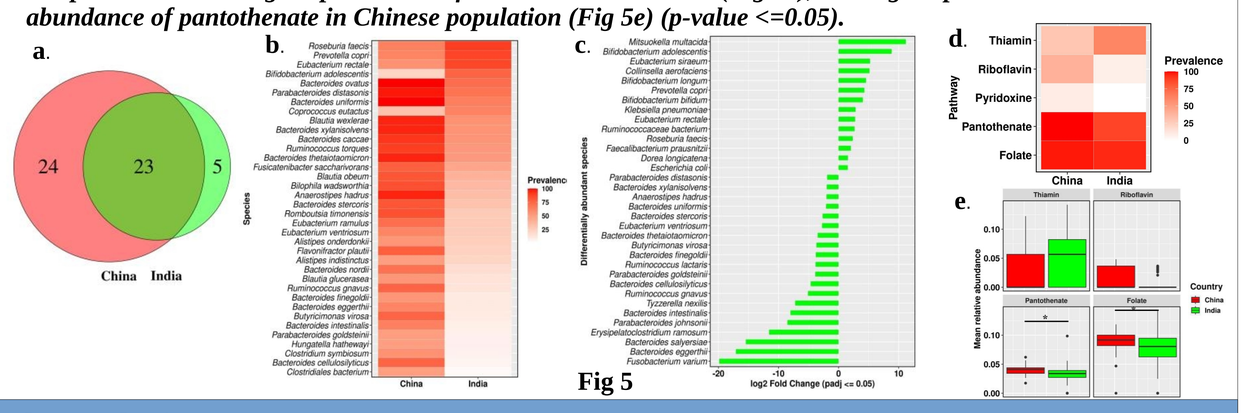


Fig 5

Discussion and Conclusion

Four out of all 28 species with modest prevalence and abundance in the Indian population have the potential to synthesize all b-vitamins; one of them also has experimental evidence. Around 89 % of the species could synthesize Niacin and Pyridoxine. Diet has no effect on the abundance of these species however their prevalence is affected. A significantly higher prevalence of 3 species in the omnivorous group indicates that omnivorous diet might provide raw material to these species. Similarly higher prevalence of *Prevotella copri*, which degrades plant polysaccharides in vegetarians was observed and it has also been reported in the previous studies. This species has been predicted to synthesize 6 b-vitamins. The location has shown a significant difference in both the prevalence and abundance of species, particularly the tribal population showed higher prevalence and abundance of these species as compared to the urban population. Similarly, the higher prevalence of thiamin and higher abundance of thiamin, folate, and pantothenate in tribal as compared to urban populations emphasizes investigating their dietary habits and lifestyle.

References

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