DOI: *10.15613/fijrfn/2022/v9i1/212401*
ISSN (Print) : 2349-8897
ISSN (Online) : 2350-1006
***FoodSci*: Indian Journal of Research in Food Science and Nutrition,** *Vol 9(1), 01-16, January-June 2022*

Changes in Nutrient Content in Indian Food Over Thirty Years

Daisy A. John[1]*, G. V. Ramanjaneyulu[1], T. Solomon[2] and K. Saravanaraj[2]

[1]Centre for Sustainable Agriculture, Tarnaka, Secunderabad, Telengana, India; daisyabujohn@gmail.com
[2]External Consultants, Centre for Sustainable Agriculture, Tarnaka, Secunderabad, Telengana, India

Abstract

There are a lot of changes in the nutrients as measured in the year 1987 in the Indian Food Composition Tables and the one in the year 2017. This paper looks into understanding the nutritional value changes in different kinds of food over time and also, tries to emphasize the need for anyone working in human nutrition or soil health to understand that there are significant changes in the nutrients before giving recommendations on diets or to explore the impacts of using fertilizers or pesticides and the nutrient level changes. This paper identified that there are significant changes in the nutrient contents, particularly energy, riboflavin and niacin and not negligible changes in the other nutrients such as calcium, iron, moisture, phosphorus, protein and thiamine of Indian food over the years 1987 to 2017.

Keywords: Food Composition, India, Nutrient Content

1. Introduction

Food composition tables are developed in each country based on the food consumption patterns. In India, food composition tables have been developed in the years 1937, 1951, 1971, 1989 and finally in the year 2017. The development of the first book which provides the nutritional value of the food items was during a time when there was an increased prevalence of Protein-energy Malnutrition (PEM). Also, the weight for height of Indian children was lesser than that of the American children and 14% of the Indian children showed signs of deficiency diseases. In addition to this, nutrient deficiency diseases such as beriberi, keratomalacia, night blindness, rickets, osteomalacia, dental caries, pellagra, pregnancy anemia and lathyrism were the most prominent ones. The initial reports on these components suggested that there is a need to emphasize the protein content and quality of Indian foods and diets. This was a time when there were not enough comprehensive and conclusive studies on epidemiological and nutritional deficiencies in India. Consequently, it was found out that nutrient deficiencies are due to inadequate consumption of diverse food items[1].

There are various revisions in the books developed for the fact that each time, new measures to calculate the nutrients has been invented or each time there have been advancements in the knowledge concerning the nutrients, where new components are added to the nutrient content or even the non-nutrient component of foods. But currently, across the world, it is found that there are changes in the nutritive value of the food items due to the changes in food cultivation practices and usage of fertilizers and pesticides[2]. In India also, the magazine Down to Earth found out that there is a similar change in the nutrient value of the fruits and vegetables cultivated[3]. In addition to this, the National Institute of Nutrition's

*Author for correspondence

(NIN) Indian food composition table of 2017 states that there are significant changes in nutrition as compared to the previous versions of the food composition tables[1].

Currently, the Indian Food Composition Table developed by NIN is the basis of any dietary and nutritional work that is being done in the country of India. Compositional values of foods are used in nutritional surveillance, consumer nutrition appraisal, nutrition labelling, etiology of disease prevalence, setting school menu standards-meal planning, issue of dietary guidelines - recommendations and even to estimate intake of toxic and non-nutritive components as well as to assess the environmental impact of foods[1], preparation of commercial food lists in special diets, recipe analysis, assessment of nutritional adequacy of hospital menus, etc[4].

There is a concern when the nutritive value of the food items changes over time especially about menu planning and while examining soil health or the impact of external inputs. The data available in the nutritive value of Indian foods in the year 1987 was obtained from various sources, including lab tests as well as literature review from the sources where they have done lab tests for particular products. The labs are National Institute of Nutrition, University College of Science and Technology, Calcutta, Haffkine Institute, Bombay, Central Food Technological Research Institute, Mysore, State Food and Drug laboratories, Ambala Cantonment and Nutrition Laboratory, Patna, etc. The data which are given in the book only relates to the edible portion of the food item and the percent of edible matter is also given wherever possible. The protein values were calculated from the nitrogen content. The values for fat relate to the total ether extractives and the carbohydrate content given is the difference between 100 and the sum of moisture, protein, fat, fiber, and ash contents. The food energy was calculated from the content of the proximate principles assuming that proteins, carbohydrates, and fats yield 4, 4, and 9 Kcals respectively per gm[5].

The Indian Food Composition Table 2017 uses the 'key foods approach' developed by the United States Department of Agriculture. Key foods are defined as those foods that contribute up to 75% of the nutrients intake by the population. The method combines food consumption data with its nutrient composition and ranks the foods by applying a scoring system to identify the key foods that contribute significantly to the diet in terms of their nutrients.

The method used to determine key food items for analysis is the nutrient consumption scoring approach. The first step is to find out the most common recipes consumed by each household. For this, initially, the whole of India was classified into six different regions from which the primary headquarters of 107 districts were selected along with retail shops in the main markets of the same town.

The samples used are non-fortified to estimate the most appropriate nutrient content in natural samples of the food items[1]. This version of the National Institute of Nutrition presented Vitamin D_2 content in plant food for the very first time in the world.

2. Materials and Methods

In this paper we are comparing the data from the nutrient component in the nutritive value of Indian foods which was published in 1989 and the Indian food composition tables which were composed in 2017, to understand the modifications that are needed while making diet recommendations and other relevant fields. In this paper, only the changes in macronutrient values are compared for obtaining preliminary level data.

Changes in the levels of moisture, protein, energy, thiamine, riboflavin, niacin, calcium, iron and phosphorus were analyzed. The food items are chosen for this analysis based on the availability of nutrient values of those items in both the 1987 and the 2017 databases. The inclusion criteria were that the food items and the nutrients should be available in both the 1987 and 2017 databases and also that the nutrients mentioned were for the raw food items and not for any cooked food items. There were a total of 54 food items that met the criteria. These products included all categories of vegetables and fruits z-test was used to determine if the means were significantly different from each other.

Similar methodology of assessing the changes in mineral content of food items has been done by Ann-Marie Mayor in the paper Historical changes in the mineral content of fruits and vegetables' data obtained

from the UK government's Composition of foods data[2]. Data analysis was done using the R software of the 4.0.5 version.

3. Results and Discussion

In the general comparison of the nutrients of the food items in the years 1987 and 2017, there were large increases in Calcium in Omum, Asafoetida, by a range of 400 mg and Beet greens, Cumin seeds in the range of 200 mg; curry leaves, drumstick leaves, chocho marrow, fenugreek leaves and parsley in the range of 100 mg. Similarly, bathua leaves and zizyphus have seen a reduction in Calcium by 61 and 42.55 mg respectively. The variations of the nutrients are shown in Figure 1.

Figure 2 represents the boxplot of the differences in each nutrient. The Interquartile Range (IQR) and Q1 and Q3 have been calculated for all the nutrients. The IQR for moisture was 3 with Q1 and Q3 as -2.4 and 0.6; for protein IQR is 0.8 and Q1 and Q3 are 0.3 and 0.8; for energy, Q1 and Q3 are 96 and 977.25 with IQR as 881.25. The values IQR, Q1, Q3 for thiamine are 0.05, -0.04 and 0.007 respectively; for riboflavin, the values are 0.08, -0.08 and 0. The IQR for niacin is 0.57, Q1 and Q3 are -0.4 and 0.07; for calcium, IQR is 32.6 and Q1 and Q3 are -32 and 0.59. For iron, Q1, Q3 and IQR are -1.29, 0.5 and 1.8 and for phosphorus, it is -24.6, 7.7 and 32.4 respectively. Energy has the highest IQR with a value of 96 and calcium has the least value of -32.02. This indicates that there is a large change in energy and the least change in calcium. All the

	Calcium		Energy		Iron		Moisture		Niacin		Phosphorus		Protein		Riboflavin		Thiamine	
Name of the food items	1987	2017	1987	2017	1987	2017	1987	2017	1987	2017	1987	2017	1987	2017	1987	2017	1987	2017
Asafoetida	690.00	2656.00	297.00	1,187.00	39.40	15.68	16.00	9.42	0.30	0.43	50.00	69.09	4.00	6.34	0.06	0.01	0.00	0.82
Ash gourd	30.00	19.39	10.00	73.00	0.80	0.47	96.50	92.17	0.40	0.12	20.00	29.07	0.40	0.79	0.01	0.01	0.06	0.03
Bael fruit	85.00	47.95	137.00	569.00	0.60	0.23	61.50	61.36	1.10	0.25	50.00	17.29	1.80	2.63	0.03	0.04	0.13	0.03
Bajra	42.00	27.35	361.00	1,436.00	8.00	6.42	12.40	8.97	2.30	0.86	296.00	289.00	11.60	10.96	0.25	0.20	0.33	0.25
Barley	26.00	28.64	336.00	1,321.00	1.67	1.56	12.50	9.77	5.40	2.84	215.00	178.00	11.50	10.94	0.20	0.18	0.47	0.34
Bathua leaves	150.00	211.00	30.00	116.00	4.20	2.66	89.60	88.77	0.60	0.54	80.00	37.55	3.70	2.50	0.14	0.51	0.01	0.06
Beet greens	180.00	211.00	46.00	165.00	16.20	5.80	86.40	86.68	1.30	0.43	30.00	36.02	3.40	2.38	0.56	0.17	0.26	0.02
Beet root	18.30	17.28	43.00	169.00	1.19	0.76	87.70	86.95	0.40	0.21	55.00	36.10	1.70	1.95	0.09	0.01	0.04	0.01
Celery stalk	30.00	38.73	18.00	69.00	4.80	1.36	93.50	92.87	0.30	0.48	38.00	44.84	0.80	0.98	0.05	0.04	0.12	0.03
Cherries red	24.00	21.88	64.00	250.00	0.57	0.36	83.40	83.61	0.30	0.19	25.00	25.13	1.10	1.49	0.08	0.02	0.08	0.07
Cho cho marrow	140.00	18.64	27.00	79.00	0.60	0.48	92.50	93.78	0.40	0.23	30.00	21.61	0.70	0.66	0.04	0.03	0.00	0.01
Coconut water	24.00	27.47	24.00	64.00	0.10	0.06	93.80	95.77	0.10	0.04	10.00	18.05	1.40	0.26	0.00	0.01	0.01	0.01
Colocasia	40.00	30.18	97.00	372.00	0.42	0.66	73.10	73.69	0.40	0.51	140.00	81.16	3.00	3.31	0.03	0.03	0.09	0.06
Coriander leaves	184.00	146.00	44.00	130.00	1.42	5.30	86.30	86.99	0.80	0.73	71.00	64.69	3.30	3.52	0.06	0.05	0.05	0.09
Cumin seeds	1,080.00	878.00	354.00	1,274.00	11.70	20.58	11.90	10.50	2.60	2.87	511.00	382.00	18.70	13.93	0.36	0.13	0.55	0.52
Currant black	130.00	40.32	316.00	227.00	8.50	1.36	18.40	83.27	0.40	0.35	110.00	78.80	2.70	1.51	0.14	0.03	0.03	0.03
Curry leaves	830.00	659.00	108.00	266.00	0.93	8.67	63.80	65.33	2.30	0.85	57.00	83.29	6.10	7.41	0.21	0.13	0.08	0.07
Drumstick leaves	440.00	314.00	92.00	282.00	0.85	4.56	75.90	75.65	0.80	0.82	70.00	109.00	6.70	6.41	0.05	0.45	0.06	0.06
Fenugreek leaves	395.00	274.00	49.00	144.00	1.93	5.69	86.10	86.73	0.40	0.70	51.00	53.05	4.40	3.68	0.31	0.22	0.04	0.11
Fenugreek seeds	160.00	115.00	333.00	961.00	6.50	8.47	13.70	7.82	1.10	1.39	370.00	435.00	26.20	25.41	0.29	0.14	0.34	0.28
Ginger fresh	20.00	18.88	67.00	210.00	3.50	1.90	80.90	81.27	0.60	0.42	60.00	44.36	2.30	2.22	0.03	0.04	0.06	0.04
Horse gram whole	287.00	269.00	321.00	1,379.00	6.77	8.76	11.80	9.28	1.50	1.82	311.00	298.00	22.00	21.73	0.20	0.24	0.42	0.32
Jowar	25.00	27.60	349.00	1,398.00	4.10	3.95	11.90	9.01	3.10	2.10	222.00	274.00	10.40	9.97	0.13	0.14	0.37	0.35
Lettuce	50.00	56.71	21.00	91.00	2.40	2.73	93.40	92.27	0.50	0.37	28.00	44.10	2.30	1.54	0.13	0.09	0.09	0.05
Mace	180.00	174.00	417.00	1,488.00	12.30	22.69	15.90	20.06	1.40	0.92	100.00	110.00	6.50	6.24	0.42	0.13	0.25	0.13
Maize dry	10.00	8.91	342.00	1,398.00	2.30	2.49	14.90	9.26	1.80	2.69	348.00	279.00	11.10	8.80	0.10	0.09	0.42	0.33
Mango ginger	25.00	11.74	51.00	177.00	2.60	2.31	85.00	84.55	0.00	0.45	90.00	68.10	1.10	1.45	0.03	0.07	0.01	0.02
Omum	1,521.00	1,014.00	363.00	1,495.00	12.50	13.65	7.40	9.71	2.10	1.23	443.00	329.00	17.10	15.89	0.28	0.23	0.21	0.30
Onion big	46.90	21.03	50.00	201.00	0.60	0.43	86.60	85.76	0.40	0.34	50.00	32.34	1.20	1.50	0.01	0.01	0.08	0.04
Onion small	40.00	19.92	50.00	217.00	1.20	0.53	84.30	84.67	0.50	0.21	60.00	39.65	1.80	1.82	0.02	0.02	0.08	0.07
Papaya ripe	17.00	11.02	32.00	100.00	0.50	0.23	90.80	91.47	0.20	0.33	13.00	17.75	0.60	0.42	0.25	0.11	0.04	0.03
Parsley	190.00	284.00	87.00	305.00	17.30	5.51	74.60	77.76	0.50	0.36	175.00	78.56	5.90	5.55	0.18	0.10	0.04	0.19
Parwar	30.00	30.76	20.00	101.00	1.70	0.50	92.00	91.57	0.50	0.67	40.00	33.81	2.00	1.40	0.06	0.05	0.05	0.05
Peas dry	75.00	75.11	315.00	1,269.00	7.05	5.09	16.00	9.33	3.40	2.69	298.00	334.00	19.70	20.43	0.19	0.16	0.47	0.56
Plantain flower	32.00	34.06	34.00	89.00	1.60	0.40	89.90	89.14	0.40	0.28	42.00	47.31	1.70	1.47	0.02	0.02	0.05	0.02
Plantain green	33.00	13.80	64.00	314.00	6.27	0.34	83.20	76.15	0.30	0.33	29.00	31.69	1.40	1.18	0.02	0.05	0.05	0.01
Plantain stem	33.00	11.24	42.00	165.00	1.10	0.26	88.30	87.53	0.20	0.18	30.00	16.31	0.50	0.35	0.01	0.02	0.02	0.02
Plum	10.00	7.61	52.00	216.00	0.60	0.25	86.90	84.64	0.30	0.44	12.00	13.83	0.70	0.64	0.10	0.02	0.04	0.02
Pummelo	30.00	14.03	44.00	210.00	0.30	0.06	88.00	86.97	0.20	0.23	30.00	13.99	0.60	0.68	0.03	0.02	0.03	0.06
Ragi	344.00	344.00	328.00	1,342.00	3.90	4.62	13.10	10.89	1.10	1.34	283.00	210.00	7.30	7.16	0.19	0.17	0.42	0.37
Rice flakes	20.00	9.29	346.00	1,490.00	20.00	4.46	12.20	10.36	4.00	1.60	238.00	195.00	6.60	7.44	0.05	0.04	0.21	0.12
Rice puffed	23.00	15.09	325.00	1,514.00	6.60	4.55	14.70	9.40	4.10	1.87	150.00	152.00	7.50	7.47	0.01	0.04	0.21	0.11
Rice raw milled	10.00	7.49	345.00	1,491.00	0.70	0.65	13.70	9.93	1.90	1.69	160.00	96.00	6.80	7.94	0.06	0.05	0.06	0.05
Sapota	28.00	17.87	98.00	307.00	1.25	0.49	73.70	73.64	0.20	0.24	27.00	22.26	0.70	0.92	0.03	0.03	0.02	0.01
Spinach	73.00	62.29	26.00	102.00	1.14	2.95	92.10	90.31	0.50	0.33	21.00	32.59	2.00	2.14	0.26	0.10	0.03	0.16
Strawberry	30.00	15.28	44.00	103.00	1.80	0.36	87.80	92.03	0.20	0.48	30.00	26.31	0.70	0.97	0.02	0.01	0.03	0.06
Tamarind leaves tender	101.00	66.93	115.00	299.00	0.30	2.84	70.50	71.69	4.10	0.79	140.00	86.86	5.80	5.84	0.17	0.03	0.24	0.12
Tapioca	50.00	25.89	157.00	334.00	0.90	0.81	59.40	75.23	0.30	0.45	40.00	42.55	0.70	1.03	0.10	0.02	0.05	0.07
Varagu	27.00	15.27	309.00	1,308.00	0.50	2.34	12.80	14.23	2.00	1.49	188.00	101.00	8.30	8.92	0.09	0.20	0.33	0.29
Wheat whole	41.00	39.36	346.00	1,347.00	5.30	3.97	12.80	10.58	5.50	2.68	306.00	315.00	11.80	10.59	0.17	0.15	0.45	0.46
Wood apple	130.00	55.71	134.00	327.00	0.48	0.45	64.20	79.16	0.80	0.55	110.00	84.32	7.30	3.54	0.17	0.01	0.04	0.04
Yam elephant	50.00	46.91	79.00	353.00	0.60	1.22	78.70	74.39	0.70	0.61	34.00	43.06	1.20	2.56	0.07	0.05	0.06	0.04
Yam wild	20.00	44.13	110.00	430.00	1.00	1.04	70.40	69.35	1.20	0.70	74.00	55.96	2.50	3.07	0.47	0.02	0.19	0.12
Zizyphus	4.00	46.55	76.00	204.00	0.50	0.40	81.60	84.39	0.70	0.33	9.00	32.38	0.80	1.34	0.05	0.02	0.02	0.01

Figure 1. Nutrient values of the products in the years 1987 and 2017. The increased value is shown in blue and the decreased values are shown in red, in the two years .

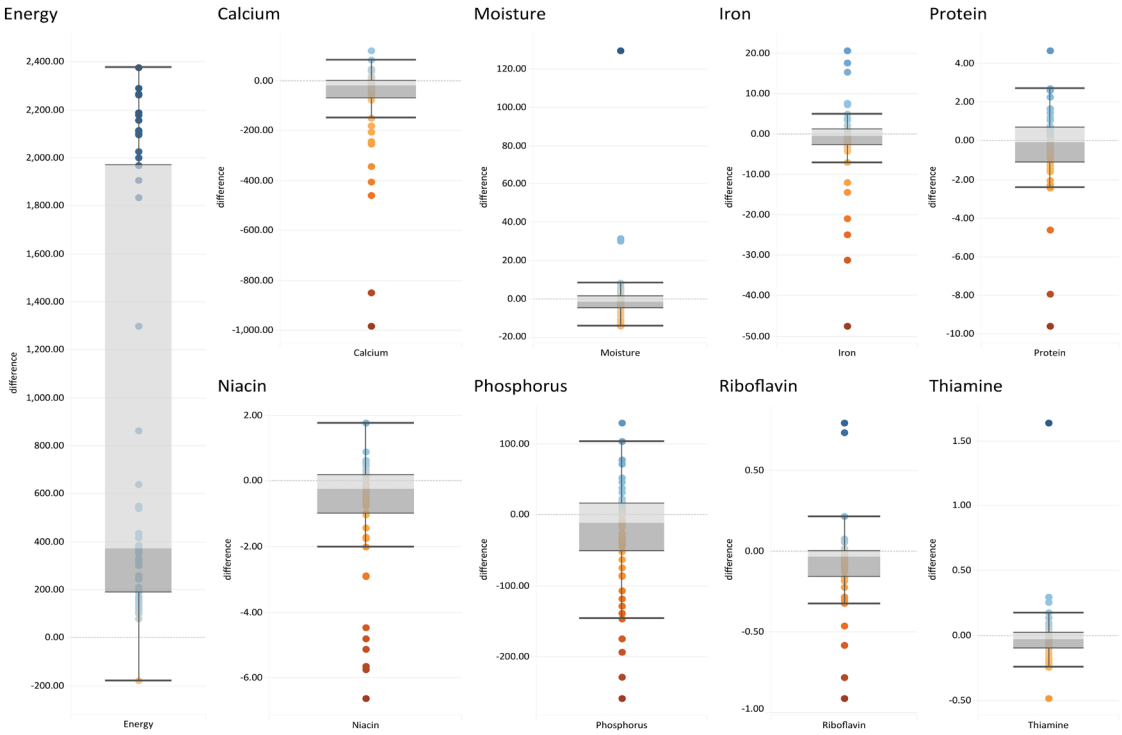


Figure 2. Boxplot of the differences in each nutrient.

nutrients except riboflavin and energy have had both increases and decreases in all the food items. Riboflavin is found to decrease or stay the same in all the food items in the year 2017 whereas energy is found to increase in all the food items in the year 2017 as compared to the food items in the year 1987.

Energy has been found to increase in most of the products, except black currant and the energy content in puffed rice has gone as high as 1189 KJ, along with rice raw milled, rice flakes, omum, bajra, asafoetida, varagu, horse gram whole, maize dry, mace, jowar, ragi, wheat whole, barley, peas dry, cumin seeds, etc. increased around 1000 KJs with slight variation in each of the food products.

Concerning moisture content, some of the products have had an increase and some other products have a decrease with almost the same variations on either side. Plantain green, peas dry, asafoetida, fenugreek seeds, maize dry, puffed rice, ash gourd, elephant yam, raw milled rice, bajra, jowar, barley, horse gram whole, plum, whole wheat, ragi, rice flakes, spinach, cumin seeds, lettuce and pumello had a decrease in the moisture content, whereas black currant had a decrease of 64 gms of water, tapioca and wood apple had a decrease of around 15 gms, strawberry, mace, parsley, zizyphus, omum, coconut water, curry leaves, varagu, Cho cho marrow, and tamarind leaves had a change of water content ranging from 1 to 4 gms, etc.

The niacin content in the food items has decreased in tamarind leaves, beet greens, wheat whole, barley, rice flakes, puffed rice, curry leaves, bajra and Jowar in a range of 1 to 4 mg. A various number of food items has a reduction in the niacin content by a range of 0-1. Meanwhile dry maize, mango ginger, horse gram whole, strawberry, cumin seeds, ragi, celery stalk, parwar,

Table 1. The nutrients which were analyzed and the results

Characteristics	Average - 1987	Average - 2017	Difference	Z-Score	P value
Moisture	59.53	60.29	0.77	0.12	0.452
Protein	5.40	5.20	-0.20	-0.18	0.429
Energy	155.11	579.30	424.19	5.42	**0.000**
Thiamine	0.15	0.14	-0.01	-0.19	0.425
Riboflavin	0.13	0.09	-0.04	-1.76	**0.039**
Niacin	1.28	0.85	-0.44	-2.02	**0.022**
Calcium	160.41	117.39	-43.02	-0.90	0.184
Iron	4.46	3.60	-0.86	-0.75	0.227
Phosphorus	119.44	105.75	-13.70	-0.61	0.271

tapioca, plum, papaya, asafoetida, colocasia, fenugreek seeds, sapota, plantain green, pummelo and drumstick leaves have seen an increase in the niacin content within a range of 0 to 1 mg.

Phosphorus content decreased in cumin by around 129 mg and in omum by 114 mg. In parsley, varagu, ragi, maize dry, raw milled rice, colocasia and tender tamarind leaves had a reduction of phosphorus by values ranging from 50 to 100 mg. Fenugreek seeds, jowar, drumstick leaves and peas dry had an increase of phosphorus by a value of 65, 52, 39 and 36 mg respectively.

There were significant changes in protein in many products. There was a reduction of protein by around 4.79 grams in cumin seeds, 3.96 in wood apple, 2.3 in maize dry and many other products had a reduction of 0 to 1 gram in protein. Asafoetida had an increase of 2.34 grams of protein; elephant yam, curry leaves, and raw milled rice had an increase of protein of around one gram.

Of all the nutrients, riboflavin and thiamine did not see much change in the nutrient content, as a majority of the food items had an increase and decrease in the items which ranges from 0 to 1 mg.

Tamarind leaves and curry leaves have seen a very high increase in iron contents and vary by a value of around 800 mg. Drumstick leaves have an increase of around 400 and mg and varagu and coriander leaves have an increase of around 300 mg. Fenugreek, spinach, and yam had an increase of around 200 mg. Pummelo, strawberry, black currant, and plantain green had a decrease in iron content by around 80 mg.

All the variations in the nutrients are represented in the data visualizations added in the annexure.

It was found that in the analysis of moisture, protein, energy, thiamine, riboflavin, niacin, calcium, iron and phosphorus, a statistically significant change was seen in energy, riboflavin and niacin. Measures such as moisture and energy have seen an increase over the years from 1987 to 2017, whereas the other measures protein, thiamine, riboflavin, niacin, calcium, iron and phosphorus, etc. had a decrease considering the average values, although measures other than energy, riboflavin, and niacin did not have statistically significant measures. This is represented in Table 1.

It is noted that there are significant changes in the values of nutrients over time. The reasons for this have to be understood considering all the factors that affect the plant growth as well as the technologies that assess the nutrient composition. For example, the usage of fertilizers could be a reason that there is a small variation in the protein content of some food items[6].

The reduction in nutrients is found to be because of the rigorous agricultural practices where chemical pesticides and fertilizers are used. Also, climatic changes pose a threat to the growth of plants. Higher carbon dioxide levels inhibit nitrogen intake and hence protein content in the food is affected. The Indian Institute of Soil

Sciences Bhopal reported that there is a deficiency of zinc, iron, magnesium and copper by 43, 12.1, 5.4 and 5.4% respectively in soil samples taken from India. It is found that the nutrients are depleted before the microorganisms flourish in the soil. It is thought that it can also be because of the increased harvest index. The uptake of the nutrients can be only from the soil which is available to the plants. It can also be because of the new varieties of crops that provide greater yield, pest resistance, climate adaptability, which would make the plants grow faster and bigger[7].

In the US, research by Donald Davis on 43 different vegetables and fruits data from the U.S. Department of Agriculture and Nutrition found out that there is a decline in the amount of calcium, phosphorus, iron, riboflavin, vitamin C over the past 50 years[8].

Similarly, Anne Marie-Mayer analyzed the composition of food items in the United Kingdom and found that there are significant changes in the food composition as recorded in the past and present. It was found that there were reductions of Ca, Mg, Cu, and Na, in vegetables and Mg, Fe, Cu, and K in fruits. The questions that arose from the research include the reliability of the data, diminishing quality of the soil where the plants are cultivated, contamination of soil with wastes, usage of different kinds of chemicals for increased chemical usage, etc[2]. Consumption of food items with less nutrient content might lead to micronutrient undernourishment which can also be called hidden hunger[9].

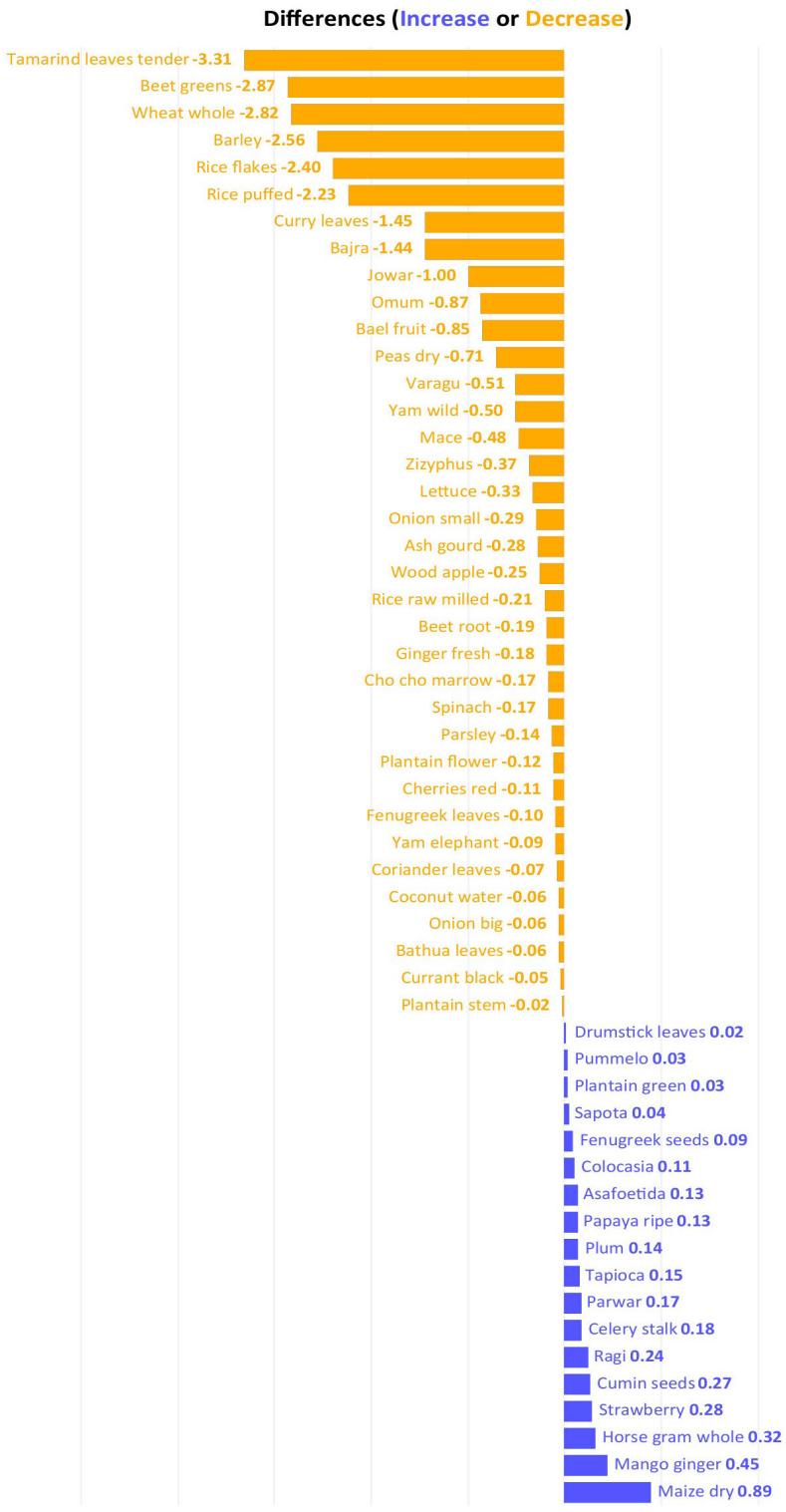
These findings are relevant for the policymakers, agriculturists, public health professionals, nutritionists, etc. to make necessary changes in policy as well as practice[8]. For instance, suggestions are coming up from the Indian Institute of Soil Science that micronutrient-rich fertilizers may be applied for the deficiency they found out in the soil samples collected from Madhya Pradesh, whereas researchers from the food and nutrition department consider fortification as the intervention[8,10]. It is also necessary to take a combined and holistic decision on what action has to be taken. Different concerned departments need to make a collaborative decision and should come to a consensus, else, there will be duplication of interventions and might even lead to adverse effects in the future. For many such issues affecting the food system, the best way suggested is to follow organic farming practices as well as the consumption of organic food items[11].

4. Conclusion

There are significant variations in nutrients over the period of 30 years. Further research into the reason for these changes in soil, plant health, and appropriate interventions is necessary to decide to continue practicing many of the interventions such as fertilizers and pesticides. The addition of organic or natural contents to the soil to enhance the soil nutrient can also be considered. Deeper studies are required regarding all of these for the overall effective functioning of the food system.

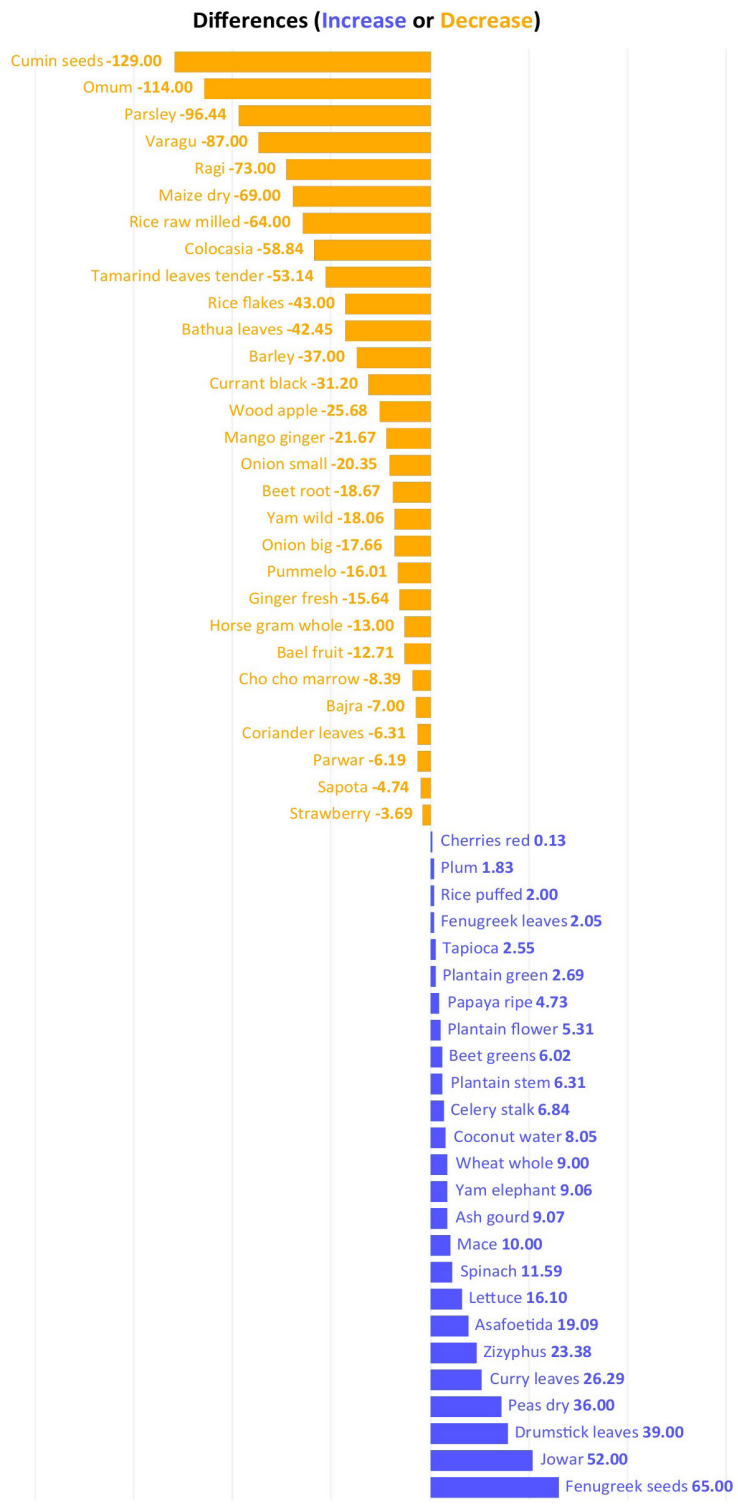
Annexture 1 Changes in Calcium from 1987 to 2017

Food Items	1987	2017
Tamarind leaves tender	4.10	0.79
Beet greens	3.30	0.43
Wheat whole	5.50	2.68
Barley	5.40	2.84
Rice flakes	4.00	1.60
Rice puffed	4.10	1.87
Curry leaves	2.30	0.85
Bajra	2.30	0.86
Jowar	3.10	2.10
Omum	2.10	1.23
Bael fruit	1.10	0.25
Peas dry	3.40	2.69
Varagu	2.00	1.49
Yam wild	1.20	0.70
Mace	1.40	0.92
Zizyphus	0.70	0.33
Lettuce	0.50	0.17
Onion small	0.50	0.21
Ash gourd	0.40	0.12
Wood apple	0.80	0.55
Rice raw milled	1.90	1.69
Beet root	0.40	0.21
Ginger fresh	0.60	0.42
Cho cho marrow	0.40	0.23
Spinach	0.50	0.33
Parsley	0.50	0.36
Plantain flower	0.40	0.28
Cherries red	0.30	0.19
Fenugreek leaves	0.80	0.70
Yam elephant	0.70	0.61
Coriander leaves	0.80	0.73
Coconut water	0.10	0.04
Onion big	0.40	0.34
Bathua leaves	0.60	0.54
Currant black	0.40	0.35
Plantain stem	0.20	0.18
Drumstick leaves	0.80	0.82
Pummelo	0.20	0.23
Plantain green	0.30	0.33
Sapota	0.20	0.24
Fenugreek seeds	1.10	1.19
Colocasia	0.40	0.51
Asafoetida	0.30	0.43
Papaya ripe	0.20	0.33
Plum	0.30	0.44
Tapioca	0.30	0.45
Parwar	0.50	0.67
Celery stalk	0.30	0.48
Ragi	1.10	1.34
Cumin seeds	2.60	2.87
Strawberry	0.20	0.48
Horse gram whole	1.50	1.82
Mango ginger	0.00	0.45
Maize dry	1.80	2.69



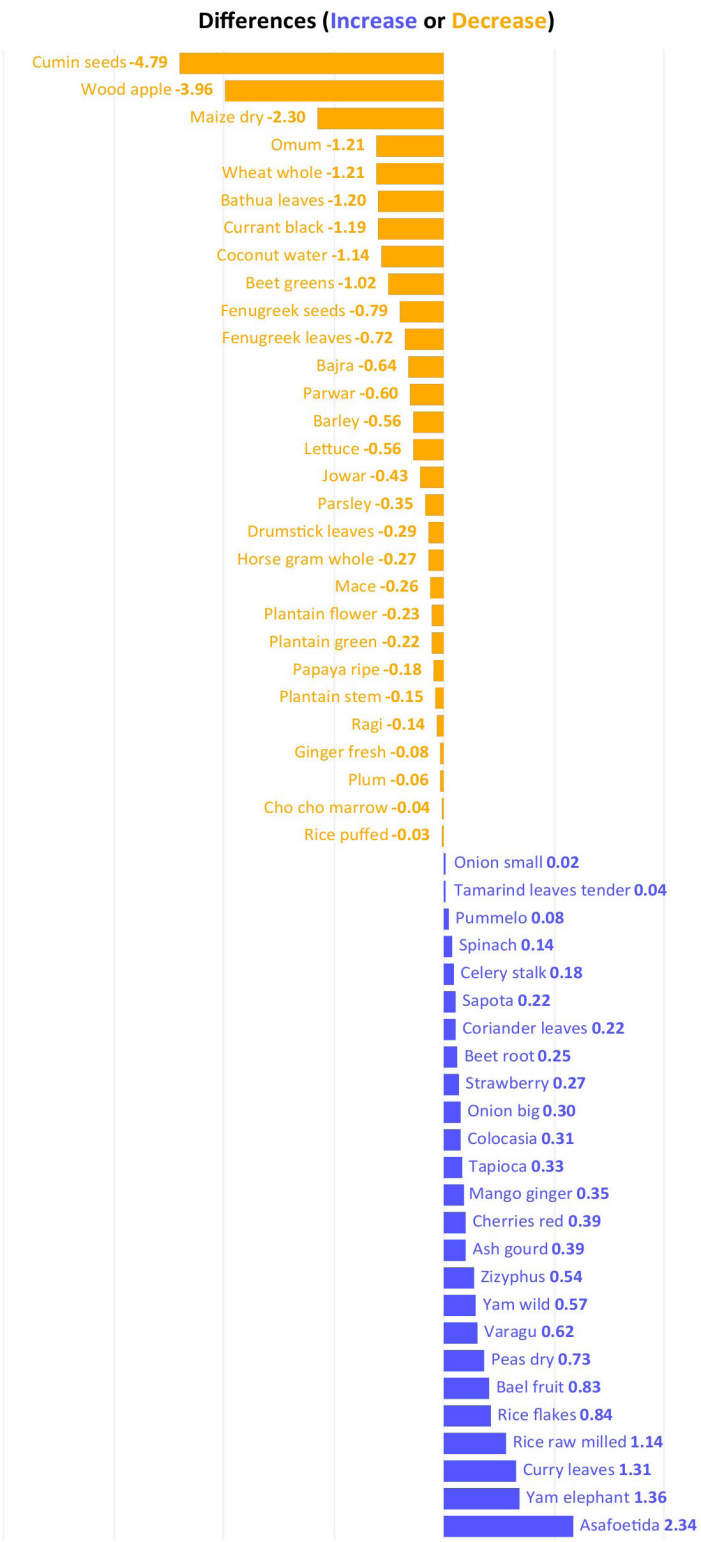
Annexture 2 Changes in Phosphorous from 1987 to 2017

Food Items	1987	2017
Cumin seeds	511.00	382.00
Omum	443.00	329.00
Parsley	175.00	78.56
Varagu	188.00	101.00
Ragi	283.00	210.00
Maize dry	348.00	279.00
Rice raw milled	160.00	96.00
Colocasia	140.00	81.16
Tamarind leaves tender	140.00	86.86
Rice flakes	238.00	195.00
Bathua leaves	80.00	37.55
Barley	215.00	178.00
Currant black	110.00	78.80
Wood apple	110.00	84.32
Mango ginger	90.00	68.33
Onion small	60.00	39.65
Beet root	55.00	36.33
Yam wild	74.00	55.94
Onion big	50.00	32.34
Pummelo	30.00	13.99
Ginger fresh	60.00	44.36
Horse gram whole	311.00	298.00
Bael fruit	50.00	37.29
Cho cho marrow	30.00	21.61
Bajra	296.00	289.00
Coriander leaves	71.00	64.69
Parwar	40.00	33.81
Sapota	27.00	22.26
Strawberry	30.00	26.31
Cherries red	25.00	25.13
Plum	12.00	13.83
Rice puffed	150.00	152.00
Fenugreek leaves	51.00	53.05
Tapioca	40.00	42.55
Plantain green	29.00	31.69
Papaya ripe	13.00	17.73
Plantain flower	42.00	47.31
Beet greens	30.00	36.02
Plantain stem	10.00	16.31
Celery stalk	38.00	44.84
Coconut water	10.00	18.05
Wheat whole	306.00	315.00
Yam elephant	34.00	43.06
Ash gourd	20.00	29.07
Mace	100.00	110.00
Spinach	21.00	32.59
Lettuce	28.00	44.10
Asafoetida	50.00	69.09
Zizyphus	9.00	32.38
Curry leaves	57.00	83.29
Peas dry	298.00	334.00
Drumstick leaves	70.00	109.00
Jowar	222.00	274.00
Fenugreek seeds	370.00	435.00



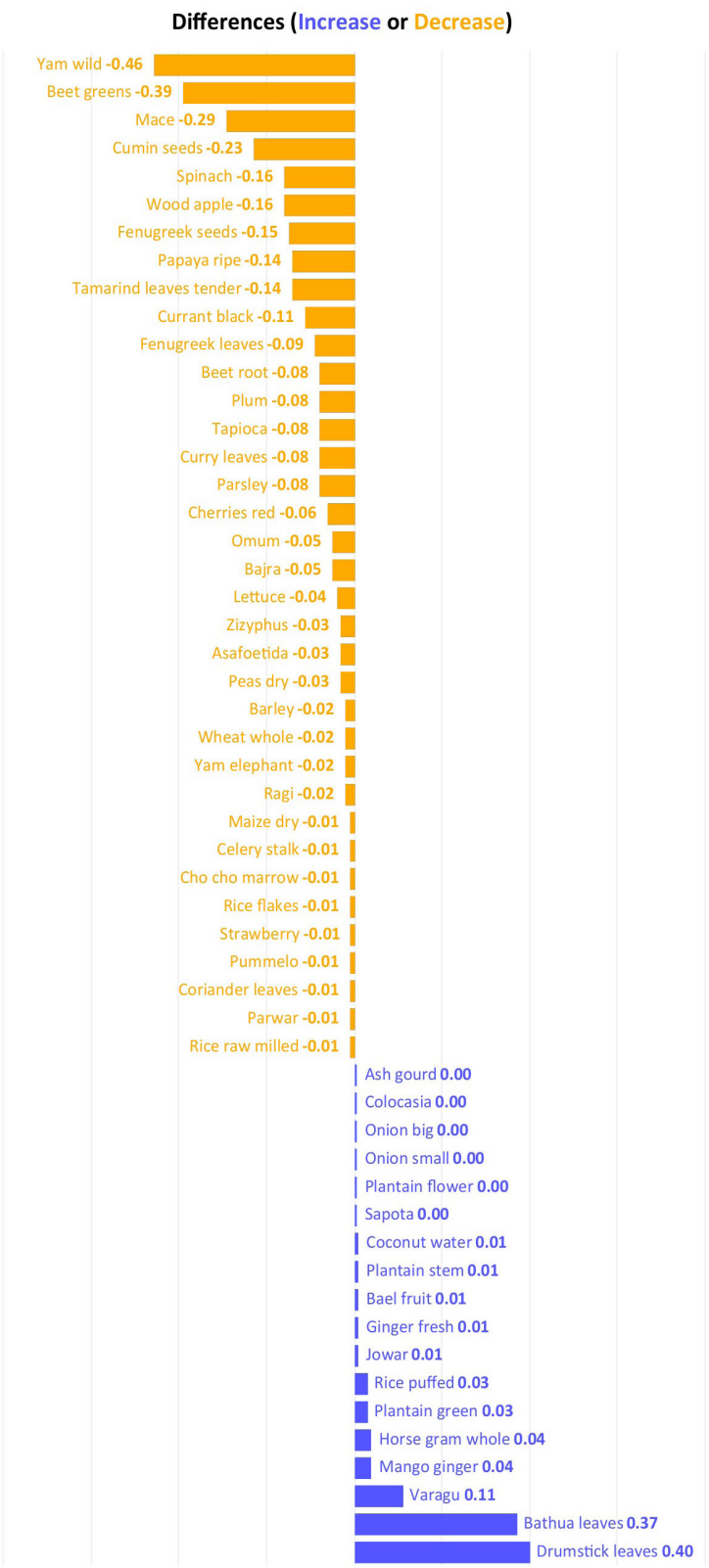
Annexture 3 Changes in Protein from 1987 to 2017

Food Items	1987	2017
Cumin seeds	18.70	13.91
Wood apple	7.10	3.14
Maize dry	11.10	8.80
Omum	17.10	15.89
Wheat whole	11.80	10.59
Bathua leaves	3.70	2.50
Currant black	2.70	1.51
Coconut water	1.40	0.26
Beet greens	3.40	2.38
Fenugreek seeds	26.20	25.41
Fenugreek leaves	4.40	3.68
Bajra	11.60	10.96
Parwar	2.00	1.40
Barley	11.50	10.94
Lettuce	2.10	1.54
Jowar	10.40	9.97
Parsley	5.90	5.55
Drumstick leaves	6.70	6.41
Horse gram whole	22.00	21.73
Mace	6.50	6.24
Plantain flower	1.70	1.47
Plantain green	1.40	1.18
Papaya ripe	0.60	0.42
Plantain stem	0.50	0.35
Ragi	7.30	7.16
Ginger fresh	2.30	2.22
Plum	0.70	0.64
Cho cho marrow	0.70	0.66
Rice puffed	7.50	7.47
Onion small	1.80	1.82
Tamarind leaves tender	5.80	5.84
Pummelo	0.60	0.68
Spinach	2.00	2.14
Celery stalk	0.80	0.98
Sapota	0.70	0.92
Coriander leaves	3.30	3.52
Beet root	1.70	1.95
Strawberry	0.70	0.97
Onion big	1.20	1.50
Colocasia	3.00	3.31
Tapioca	0.70	1.03
Mango ginger	1.10	1.45
Cherries red	1.10	1.49
Ash gourd	0.40	0.79
Zizyphus	0.80	1.34
Yam wild	2.50	3.07
Varagu	8.30	8.92
Peas dry	19.70	20.43
Bael fruit	1.80	2.63
Rice flakes	6.60	7.44
Rice raw milled	6.80	7.94
Curry leaves	6.10	7.41
Yam elephant	1.20	2.56
Asafoetida	4.00	6.34



Annexture 4 Changes in Riboflavin from 1987 to 2017

Food Items	1987	2017
Yam wild	0.47	0.02
Beet greens	0.56	0.17
Mace	0.42	0.13
Cumin seeds	0.36	0.13
Spinach	0.26	0.10
Wood apple	0.17	0.01
Fenugreek seeds	0.29	0.14
Papaya ripe	0.25	0.11
Tamarind leaves tender	0.17	0.03
Currant black	0.14	0.03
Fenugreek leaves	0.31	0.22
Beet root	0.09	0.01
Plum	0.10	0.02
Tapioca	0.10	0.02
Curry leaves	0.21	0.13
Parsley	0.18	0.10
Cherries red	0.08	0.02
Omum	0.28	0.23
Bajra	0.25	0.20
Lettuce	0.13	0.09
Zizyphus	0.05	0.02
Asafoetida	0.04	0.01
Peas dry	0.19	0.16
Barley	0.20	0.18
Wheat whole	0.17	0.15
Yam elephant	0.07	0.05
Ragi	0.19	0.17
Maize dry	0.10	0.09
Celery stalk	0.05	0.04
Cho cho marrow	0.04	0.03
Rice flakes	0.05	0.04
Strawberry	0.02	0.01
Pummelo	0.03	0.02
Coriander leaves	0.06	0.05
Parwar	0.06	0.05
Rice raw milled	0.06	0.05
Ash gourd	0.01	0.01
Colocasia	0.03	0.03
Onion big	0.01	0.01
Onion small	0.02	0.02
Plantain flower	0.02	0.02
Sapota	0.03	0.03
Coconut water	0.00	0.01
Plantain stem	0.01	0.02
Bael fruit	0.03	0.04
Ginger fresh	0.03	0.04
Jowar	0.13	0.14
Rice puffed	0.01	0.04
Plantain green	0.02	0.05
Horse gram whole	0.20	0.24
Mango ginger	0.03	0.07
Varagu	0.09	0.20
Bathua leaves	0.14	0.51
Drumstick leaves	0.05	0.45



Annexture 5 Changes in Thiamine from 1987 to 2017

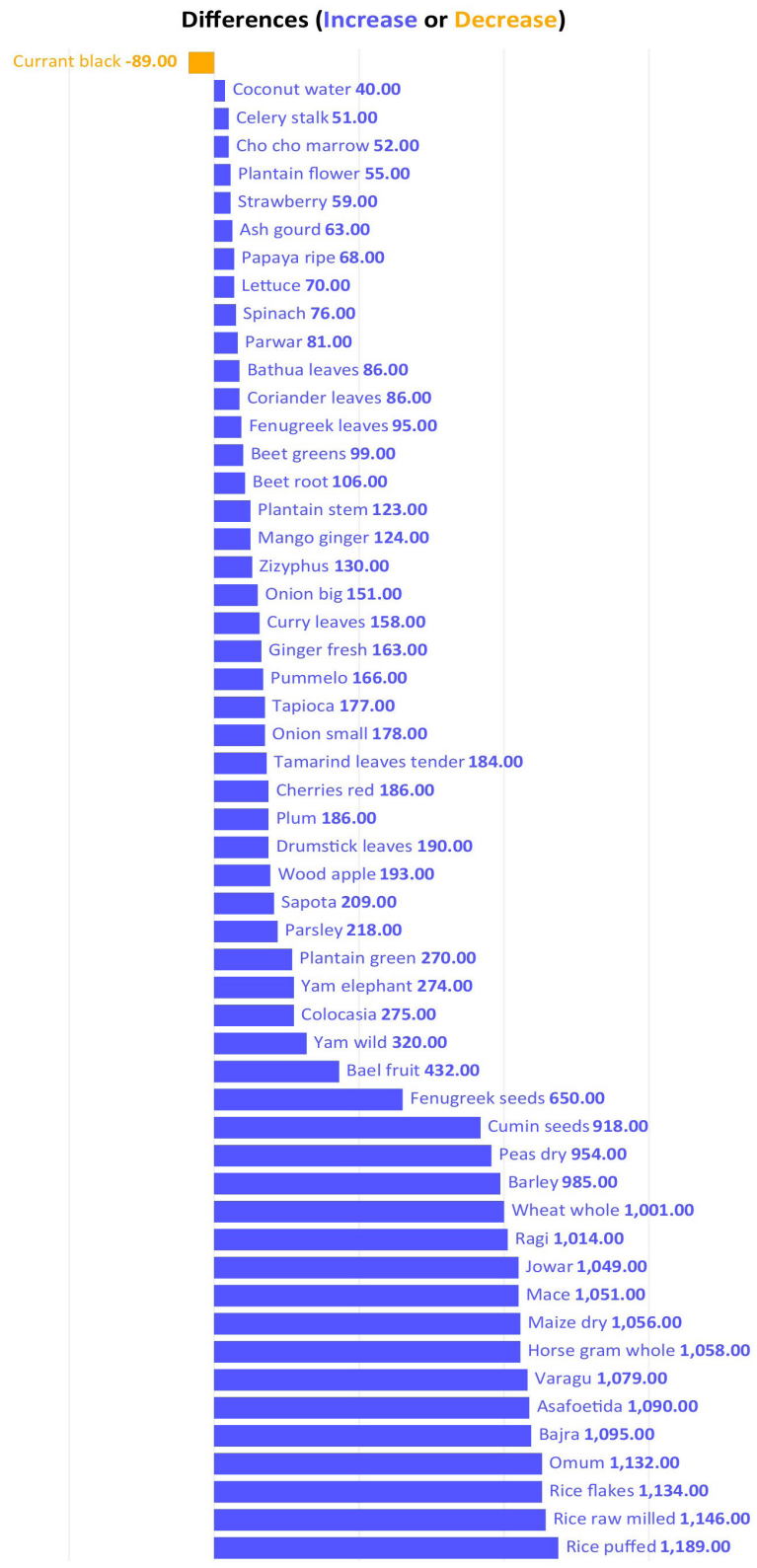
Food Items	1987	2017
Beet greens	0.26	0.02
Mace	0.25	0.13
Tamarind leaves tender	0.24	0.12
Barley	0.47	0.36
Bael fruit	0.13	0.03
Rice puffed	0.21	0.11
Horse gram whole	0.42	0.32
Celery stalk	0.12	0.03
Rice flakes	0.21	0.12
Maize dry	0.42	0.33
Bajra	0.33	0.25
Yam wild	0.19	0.12
Fenugreek seeds	0.34	0.28
Ragi	0.42	0.37
Varagu	0.33	0.29
Onion big	0.08	0.04
Plantain green	0.05	0.01
Lettuce	0.09	0.05
Cumin seeds	0.55	0.52
Plantain flower	0.05	0.02
Ash gourd	0.06	0.03
Beet root	0.04	0.01
Colocasia	0.09	0.06
Jowar	0.37	0.35
Plum	0.04	0.02
Ginger fresh	0.06	0.04
Yam elephant	0.06	0.04
Papaya ripe	0.04	0.03
Sapota	0.02	0.01
Zizyphus	0.02	0.01
Cherries red	0.08	0.07
Curry leaves	0.08	0.07
Onion small	0.08	0.07
Rice raw milled	0.06	0.05
Coconut water	0.01	0.01
Currant black	0.03	0.03
Drumstick leaves	0.06	0.06
Parwar	0.05	0.05
Plantain stem	0.02	0.02
Wood apple	0.04	0.04
Cho cho marrow	0.00	0.01
Mango ginger	0.01	0.02
Wheat whole	0.45	0.46
Tapioca	0.05	0.07
Pummelo	0.03	0.06
Strawberry	0.03	0.06
Coriander leaves	0.05	0.09
Bathua leaves	0.01	0.06
Fenugreek leaves	0.04	0.11
Omum	0.21	0.30
Peas dry	0.47	0.56
Spinach	0.03	0.16
Parsley	0.04	0.19
Asafoetida	0.00	0.82

Annexture 6 Changes in Calcium from 1987 to 2017

Food Items	1987	2017
Omum	1,525.00	1,034.00
Asafoetida	690.00	266.00
Beet greens	380.00	151.00
Cumin seeds	1,080.00	878.00
Curry leaves	830.00	659.00
Drumstick leaves	440.00	314.00
Cho cho marrow	140.00	18.64
Fenugreek leaves	395.00	274.00
Parsley	390.00	288.00
Currant black	130.00	40.32
Wood apple	130.00	55.71
Coriander leaves	184.00	146.00
Bael fruit	85.00	47.95
Tamarind leaves tender	101.00	66.93
Onion big	46.90	21.03
Fenugreek seeds	160.00	135.00
Tapioca	50.00	25.89
Onion small	40.00	19.92
Horse gram whole	287.00	269.00
Pummelo	30.00	14.03
Strawberry	30.00	15.28
Bajra	42.00	27.35
Varagu	27.00	15.27
Mango ginger	25.00	13.74
Rice flakes	20.00	9.19
Ash gourd	30.00	19.39
Sapota	28.00	17.87
Colocasia	40.00	30.18
Rice puffed	23.00	15.09
Mace	180.00	174.00
Yam elephant	50.00	46.91
Rice raw milled	10.00	7.49
Plum	10.00	7.61
Papaya ripe	17.00	15.02
Wheat whole	41.00	39.36
Ginger fresh	20.00	18.88
Maize dry	10.00	8.91
Beet root	18.30	17.28
Cherries red	24.00	23.88
Peas dry	75.00	75.11
Parwar	30.00	30.76
Plantain stem	10.00	11.24
Plantain flower	32.00	34.06
Jowar	25.00	27.60
Barley	26.00	28.64
Coconut water	24.00	27.47
Plantain green	10.00	13.80
Lettuce	50.00	56.71
Celery stalk	30.00	38.73
Spinach	73.00	82.29
Ragi	344.00	364.00
Yam wild	20.00	44.13
Zizyphus	4.00	46.55
Bathua leaves	150.00	211.00

Annexture 7 Changes in Calcium from 1987 to 2017

Food Items	1987	2017
Currant black	316.00	227.00
Coconut water	24.00	64.00
Celery stalk	18.00	69.00
Cho cho marrow	27.00	79.00
Plantain flower	34.00	89.00
Strawberry	44.00	103.00
Ash gourd	10.00	73.00
Papaya ripe	32.00	100.00
Lettuce	21.00	91.00
Spinach	26.00	102.00
Parwar	20.00	101.00
Bathua leaves	30.00	116.00
Coriander leaves	44.00	130.00
Fenugreek leaves	49.00	144.00
Beet greens	46.00	145.00
Beet root	43.00	149.00
Plantain stem	42.00	165.00
Mango ginger	53.00	177.00
Zizyphus	74.00	204.00
Onion big	50.00	201.00
Curry leaves	108.00	266.00
Ginger fresh	67.00	230.00
Pummelo	44.00	210.00
Tapioca	157.00	334.00
Onion small	59.00	237.00
Tamarind leaves tender	115.00	299.00
Cherries red	64.00	250.00
Plum	52.00	238.00
Drumstick leaves	92.00	282.00
Wood apple	134.00	327.00
Sapota	98.00	307.00
Parsley	87.00	305.00
Plantain green	64.00	334.00
Yam elephant	79.00	353.00
Colocasia	97.00	372.00
Yam wild	110.00	430.00
Bael fruit	137.00	569.00
Fenugreek seeds	333.00	983.00
Cumin seeds	356.00	1,274.00
Peas dry	315.00	1,269.00
Barley	336.00	1,321.00
Wheat whole	346.00	1,347.00
Ragi	328.00	1,342.00
Jowar	349.00	1,398.00
Mace	437.00	1,488.00
Maize dry	342.00	1,398.00
Horse gram whole	321.00	1,379.00
Varagu	309.00	1,388.00
Asafoetida	297.00	1,387.00
Bajra	361.00	1,456.00
Omum	363.00	1,495.00
Rice flakes	346.00	1,480.00
Rice raw milled	345.00	1,491.00
Rice puffed	325.00	1,514.00

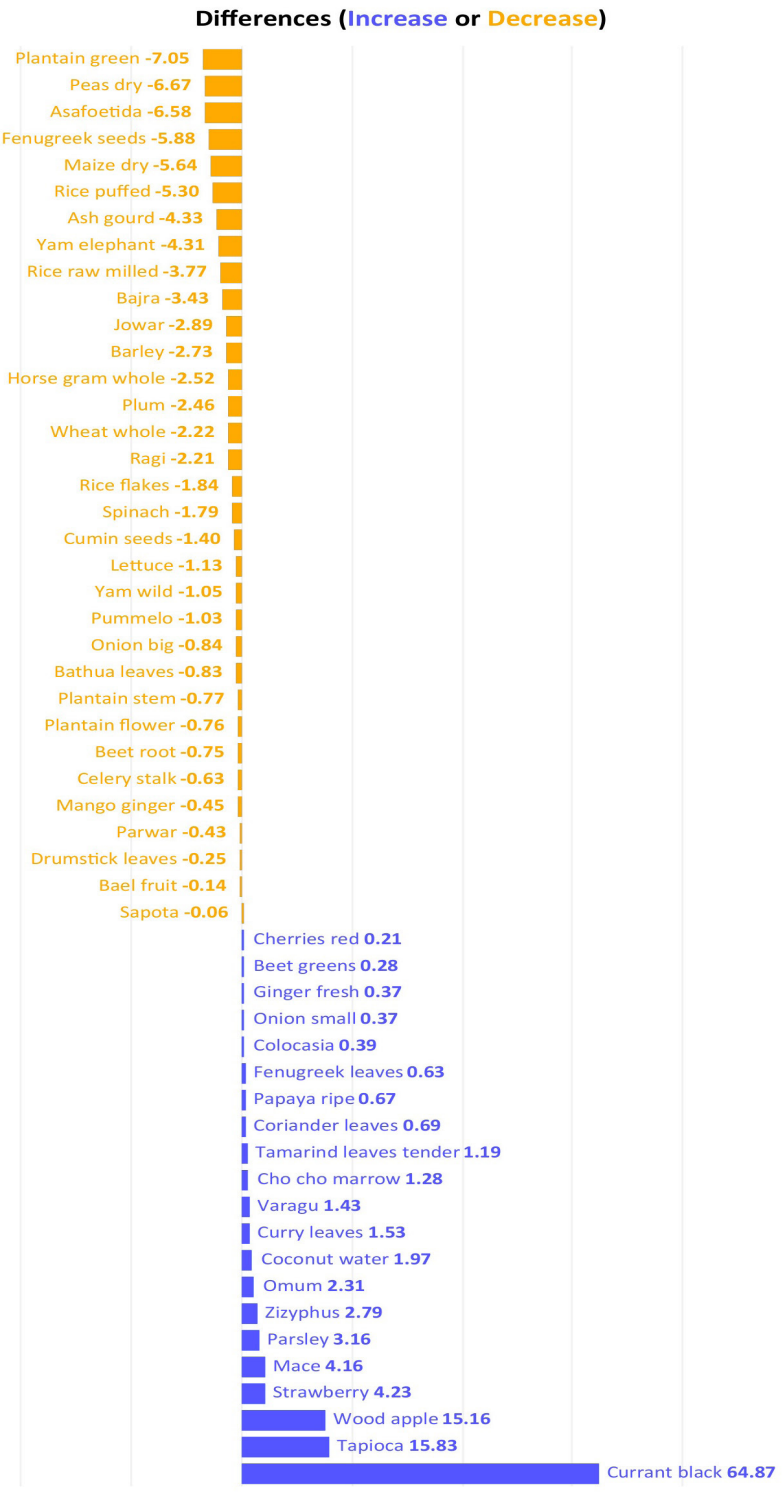


Annexture 8 Changes in Iron from 1987 to 2017

Food Items	1987	2017
Asafoetida	39.40	15.68
Rice flakes	20.00	4.46
Parsley	17.90	5.51
Beet greens	16.20	5.80
Currant black	8.50	1.36
Plantain green	6.27	0.34
Celery stalk	4.80	1.36
Rice puffed	6.60	4.55
Peas dry	7.05	5.09
Ginger fresh	3.50	1.90
Bajra	8.00	6.42
Bathua leaves	4.20	2.66
Strawberry	1.80	0.36
Wheat whole	5.30	3.97
Plantain flower	1.60	0.40
Parwar	1.70	0.50
Plantain stem	1.10	0.26
Sapota	1.25	0.49
Onion small	1.20	0.53
Beet root	1.19	0.76
Bael fruit	0.60	0.23
Plum	0.60	0.25
Ash gourd	0.80	0.47
Mango ginger	2.60	2.31
Papaya ripe	0.50	0.23
Pummelo	0.30	0.06
Cherries red	0.57	0.36
Onion big	0.60	0.43
Jowar	4.10	3.95
Cho cho marrow	0.60	0.48
Barley	1.67	1.56
Zizyphus	0.50	0.40
Tapioca	0.90	0.81
Rice raw milled	0.70	0.65
Coconut water	0.10	0.06
Wood apple	0.48	0.45
Yam wild	1.00	1.04
Maize dry	2.30	2.49
Colocasia	0.42	0.66
Lettuce	2.40	2.73
Yam elephant	0.60	1.22
Ragi	3.90	4.62
Omum	12.50	13.65
Spinach	1.14	2.95
Varagu	0.50	2.34
Fenugreek seeds	6.50	8.47
Horse gram whole	6.77	8.76
Tamarind leaves tender	0.30	2.84
Drumstick leaves	0.85	4.56
Fenugreek leaves	1.93	5.69
Coriander leaves	1.42	5.30
Curry leaves	0.93	8.67
Cumin seeds	11.70	20.58
Mace	12.30	22.69

Annexture 9 Changes in Moisture from 1987 to 2017

Food Items	1987	2017
Plantain green	83.20	76.15
Peas dry	16.00	9.33
Asafoetida	16.00	9.42
Fenugreek seeds	13.70	7.82
Maize dry	14.90	9.26
Rice puffed	14.70	9.40
Ash gourd	96.50	92.17
Yam elephant	78.70	74.39
Rice raw milled	13.70	9.93
Bajra	12.40	8.97
Jowar	11.90	9.01
Barley	12.50	9.77
Horse gram whole	11.80	9.28
Plum	86.90	84.44
Wheat whole	12.80	10.58
Ragi	13.10	10.89
Rice flakes	12.20	10.36
Spinach	92.10	90.31
Cumin seeds	11.90	10.50
Lettuce	93.40	92.27
Yam wild	70.40	69.35
Pummelo	88.00	86.97
Onion big	86.60	85.76
Bathua leaves	89.60	88.77
Plantain stem	88.30	87.53
Plantain flower	89.90	89.14
Beet root	87.70	86.95
Celery stalk	93.50	92.87
Mango ginger	85.00	84.55
Parwar	92.00	91.57
Drumstick leaves	75.90	75.65
Bael fruit	61.50	61.36
Sapota	73.70	73.64
Cherries red	83.40	83.61
Beet greens	86.40	86.68
Ginger fresh	80.90	81.27
Onion small	84.30	84.67
Colocasia	73.10	73.49
Fenugreek leaves	86.10	86.73
Papaya ripe	90.80	91.47
Coriander leaves	86.30	86.99
Tamarind leaves tender	70.50	71.69
Cho cho marrow	92.50	93.78
Varagu	12.80	14.23
Curry leaves	63.80	65.33
Coconut water	93.80	95.77
Omum	7.40	9.71
Zizyphus	81.60	84.39
Parsley	74.60	77.76
Mace	15.90	20.06
Strawberry	87.80	92.03
Wood apple	64.20	79.36
Tapioca	59.40	75.23
Currant black	18.40	83.27



5. References

1. Longvah T, et al. Indian Food Composition Tables. 2017; 96.
2. Mayer AM. Historical changes in the mineral content of fruits and vegetables. *British Food Journal.* 1997; 99:207–11. https://doi.org/10.1108/00070709710181540
3. Varshney V. Food basket in danger. 2017.
4. FAO FP. Food and Agricultural Organisation of the United Nations. Rome, Italy. 2009.
5. Gopalan C, et al. Nutritive value of Indian foods. 1989; 161.
6. Smil V. Nitrogen and food production: proteins for human diets. *AMBIO: A Journal of the Human Environment.* 2002; 31(2):126–31. PMid: 12078001. https://doi.org/10.1579/0044-7447-31.2.126
7. Shukla, et al. Micronutrients deficiencies vis-a-vis food and nutritional security of India. *Indian J Fert.* 2014; 10(12):94–112.
8. TiwariS.IndianFoodCompositionTable1939-2017.1963. https://doi.org/10.22214/ijraset.2017.10153
9. Gupta SM, et al. Finger millet: A "certain" crop for an "uncertain" future and a solution to food insecurity and hidden hunger under stressful environments. *Frontiers in Plant Science*. 2017; 8:643. PMid: 28487720 PMCid: PMC5404511. https://doi.org/10.3389/fpls.2017.00643
10. Shukla A, et al. Current status of micronutrient deficiencies in soils and crop-specific recommendations for different agro-climatic zones of Madhya Pradesh. *Indian J Fert.* 2016; 12:26–35.
11. Esther G. Dirt Poor: Have fruits and vegetables become less nutritious? Because of soil depletion, crops grown decades ago were much richer in vitamins and minerals than the varieties most of us get today. *Sci Am.* 2011.