The Available Iron in Some Tropical Foodstuffs[1]

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THE VALUE of various foods as sources of iron cannot be based entirely upon their total iron content. Nutritional studies have determined that each food contains a portion of iron that is readily utilized for hemoglobin formation and a portion that is unavailable and that may consist mainly of hematin compounds (organic iron). The first investigator to use the term "available iron" was Hill.[2] He applied this term to that portion of iron in food stuffs capable of combining with α, α'–dipyridine, thereby producing a colored solution the intensity of which varied according to the amount of inorganic or available iron present.

By feeding different vegetable sources of iron to anemic rats, Elvehjem, Hart, and Sherman[3] showed that the efficiency of a food in regenerating hemoglobin could be correlated quite closely with its available iron, as determined by the chemical method (α, α'–dipyridine method). They concluded that it is the available iron and not the total iron that has to be considered in evaluating a food as a source of iron in a diet.

EXPERIMENTAL DATA

The method used in this work was a modification of the dipyridine method for available iron, as proposed by Köhler, Elvehjem, and Hart.[4]

The foodstuffs to be analyzed were obtained in the local markets in as fresh a state as possible and brought to the laboratory, where they were washed and cut into small pieces with a hard horn spatula sharpened on one side. Five to ten gram samples of the fresh material were weighed and transferred to a glass mortar and ground with the aid of a small amount of iron-free silica sand and 5 cc. of a 10 percent acetic acid solution. The ground material, together with the sand, was transferred to a 50 cc. centrifuge tube. The adhering material left in the mortar and pestle was washed into the centrifuge tube with the aid of 10 additional cc. of 10 percent acetic acid solution. One cc. of a 0.2 percent solution of α, α'–dipyridine in 10 percent acetic acid solution was then added.

To reduce all the inorganic iron present to its ferrous condition, in which state alone it reacts with dipyridine, 0.25 gram of pure ironfree hydroquinone was added. The hydroquinone used was purified by repeated crystallization from dilute hydrochloric acid solution and the tube then tightly stoppered and vigorously shaken. It was then allowed to stand until the maximum color had developed, generally after two days at least. (Some samples required five days before the color developed.) Then 5 cc. of a 7.5 percent lead acetate solution were added and the tube again shaken and allowed to stand overnight. The next day the tube was centrifuged and the colored supernatant liquid transferred to a test tube of the same size as that in which the standards were kept, matching it against the corresponding standard in a wooden box comparator.

A series of standard solutions, ranging from 0.1000 mg. to 0.0025 mg. of iron, were prepared by adding the corresponding concentration of iron from a stock iron standard solution to 10 cc. of a 10 percent acetic acid solution and developing the color in exactly the same manner as with the food samples, that is, by adding 1 cc. of a 0.2 percent α, α'–dipyridine solution, 0.25 gram of iron-free hydroquinone, 5 cc. of the lead acetate solution, and finally diluting to 21 cc. volume with 10 percent acetic acid. In addition, a blank determination with the reagents used in the work was run and a very faint pink color developed, corresponding to a concentration of 0.0005 mg. of iron which was deducted from the readings for the different foodstuffs examined. Simultaneously with the determination of available iron, the total iron content of the foodstuffs was determined by the ferric thiocyanateamyl-alcohol method.[5] Moisture determinations were also performed. The results of the total and available iron determinations and the percentage of total iron available on the wet basis are given in the following table.

1. Received for publication August 6, 1943.
2. R. Hill, *Proc.Roy.Soc.*, 107:205, 1930.
3. C. A. Elvehjem, E. B. Hart, and W. C. Sherman, *J.Biol.Chem.*, 103:61, 1933.
4. G. O. Köhler, C. A. Elvehjem, and E. B. Hart, *J.Biol.Chem.*, 113:49, 1936.
5. R. P. Kennedy, *J.Biol.Chem.*, 74:385, 1927.

Total Iron, Available Iron, and the Percentage Availability of Iron in Some Common Tropical Foodstuffs

Name of Foodstuffs	*Total Iron Mg. Percent*	*Available Iron Mg. Percent*	*Percent of Total Iron Available*
Arracacha (*Apio*)	0.8385	0.3990	47.6
Rice (*Arroz*)	0.6050	0.3976	65.7
Sesame Seeds (*Ajonjolí*)	13.2917	0.6859	5.2
Water Cress (*Berros*)	6.7553	0.7886	11.7
Eggplant (*Berenjena*)	0.4440	0.0471	10.6
Pumpkin (*Calabaza*)	0.4945	0.1473	29.8
Peas (*Guisantes*)	4.9233	1.6589	33.7
Chayote (*Chayote*)	0.3543	0.1798	50.8
Cowpea (*Frijol*)	11.4912	1.1543	10.0
Giant Banana (*Guineo gigante*)	0.6299	0.1994	31.7
Apple Banana (*Guineo manzano*)	0.4907	0.1002	20.4
Fig Banana (*Guineo niño*)	0.7773	0.1978	25.5
Pigeon-pea (*Gandul*)	1.2792	0.5226	40.9
Chickpea (*Garbanzo*)	4.4433	1.3577	30.6
Stringbeans (*Habichuelas tiernas*)	5.2703	0.3345	6.3
Red Kidney Beans (*Habichuelas coloradas*)	11.9709	1.1919	10.0
White Beans (*Habichuelas blancas*)	8.5374	1.0086	11.8
Pink Beans (*Habichuelas rosadas*)	16.7068	0.9577	5.7
Lima Beans (*Habas*)	6.9556	1.5938	22.9
Sweet Corn Root (*Lerenes*)	0.9820	0.1714	17.5
Lettuce (*Lechuga*)	5.1423	0.0957	1.9
Corn (*Maíz*)	2.0296	0.2924	14.4
Dasheen (*Malanga*)	1.0799	0.3992	37.0
Yam, white (*Ñame blanco*)	0.6171	0.3301	53.5
Yam, yellow (*Ñame amarillo*)	0.7186	0.1356	18.9
Okra (*Quimbombó*)	0.7734	0.1886	24.3
Potato, native (*Papa del país*)	2.4960	1.2002	48.1
Pimento, green (*Pimiento verde*)	0.1947	0.1938	99.5
Sweet Potato (*Patata*)	1.3640	0.4007	29.4
Plantain, green (*Plátano verde*)	0.4151	0.0822	19.8
Breadfruit seeds (*Pana de pepita*)	1.0971	0.1463	13.3
Tomato, ripe (*Tomate maduro*)	0.2962	0.1238	41.8
Tanier, white (*Yautía blanca*)	0.6188	0.1999	32.3
Tanier, yellow (*Yautía amarilla*)	1.4887	0.3885	26.1
Carrots (*Zanahorias*)	3.8640	0.3648	9.4

SUMMARY

Thirty-five common tropical foodstuffs have been analyzed for their total iron and available iron. The percent of total iron available is herein reported.