



# Biodiversity food dataset: Centralizing chemical composition data to allow the promotion of nutrient-rich foods in Brazil

Fernanda Grande<sup>1,2</sup>  | Eliana Bistriche Giuntini<sup>2</sup> | Kristy Soraya Coelho<sup>1,2</sup> |  
Eduardo Purgatto<sup>2,3</sup> | Bernadette Dora Gombossy de Melo Franco<sup>2,3</sup> |  
Franco Maria Lajolo<sup>2,3,4</sup> | Elizabete Wenzel de Menezes<sup>2,4</sup> 

<sup>1</sup>Post Graduate Program in Applied Human Nutrition (PRONUT/USP), FCF/FEA/FSP, University of São Paulo (USP), São Paulo, Brazil

<sup>2</sup>Food Research Center (FoRC/CEPID/FAPESP), São Paulo, Brazil

<sup>3</sup>Department of Food and Experimental Nutrition, Faculty of Pharmaceutical Sciences, University of São Paulo (USP), São Paulo, Brazil

<sup>4</sup>Coordinators of BRASILFOODS, São Paulo, Brazil

## Correspondence

Elizabete Wenzel de Menezes, Food Research Center, Rua do Lago, 250, Ed. Semi Industrial, bloco C, Lab. De Engenharia de Alimentos, Cidade Universitária, São Paulo, SP 05508-080, Brazil.  
Email: wenzelde@usp.br

## Funding information

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior; Conselho Nacional de Desenvolvimento Científico e Tecnológico; Post Graduate Program in Applied Human Nutrition (PRONUT/USP); Food Research Center (FoRC/CEPID/FAPESP)

## Abstract

Centralizing chemical composition data for biodiverse foods is an important strategy in promoting their consumption. To support this strategy, a dataset of foods based on Brazilian biodiversity was created. The set was based on data for foods produced or commercialized in Brazil; these data were previously compiled for the Brazilian Food Composition Table (TBCA), according to international guidelines. Inclusion criteria were based on the following indicators: (i) foods with description below species level; (ii) wild foods; and (iii) underutilized foods. The dataset contains 1,305 food entries, and the majority correspond to raw plant foods. Nutrient content in foods identified below species level exhibited a wide range of values. Underutilized foods presented similar or higher selected nutrient contents than commonly consumed foods. For instance, depending on the cultivar of sweet potato (*Ipomoea batatas*), vitamin A content ranged from a negligible amount to high content (0.33- to 3,637- $\mu$ g retinol equivalents per 100-g edible portion on a fresh weight basis [EP]). Camu-camu (*Myrciaria dubia*), a fruit from Amazon, was identified as the richest source of vitamin C (2,300 mg of ascorbic acid per 100-g EP), corresponding to 48-fold the content of orange. The dataset provides evidence to promote nutrient-rich foods that may be integrated into more effective programmes and policies on nutrition and food security in Brazil. It can be accessed online, free of charge on the TBCA platform.

## KEYWORDS

biodiversity, cultivars, data compilation, food composition databases, underutilized foods, varieties

## 1 | INTRODUCTION

Total diversity of crops used for human nutrition has significantly decreased across countries in the past 50 years, resulting in the

relatively homogeneous composition of the world's food supply. In spite of the existing food biodiversity, approximately 90% of the worldwide dietary supply for energy, protein and fat is obtained from only 94 crop species (Khouri et al., 2014). At the same time,

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2020 The Authors. Maternal & Child Nutrition published by John Wiley & Sons Ltd

micronutrient deficiencies are widespread, especially those relating to iron, vitamin A, iodine, zinc and folate (Bailey, West, & Black, 2015). New approaches are required from the agriculture sector in order to increase not only the amount of food produced but also the amount of nutrient-dense foods that may help to improve food security (WHO/CBD, 2015). In this context, biodiversity can play an important role, because it may be linked to nutrition in different ways. On a dietary level, food biodiversity provides a natural wealth of macronutrients and micronutrients that can contribute to diverse and healthy diets (Bioversity International, 2013).

Biodiversity, also known as biological diversity, is 'the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (CBD, 2005). Thus, the concept of biodiversity is comprehensive, including variations based on genetics, habitats and ecosystems (WHO/CBD, 2015).

Genetic diversity represents an important factor that can significantly affect the nutrient content of foods (Burlingame, Charrondiere, & Mouille, 2009; Rodriguez-Amaya, Kimura, Godoy, & Amaya-Farfan, 2008). When evaluating food consumption data, differences in the nutrient content of a certain food across different cultivars can result in either deficient or adequate micronutrient intake (Burlingame et al., 2009). However, in order to promote the link between biodiversity and nutrition, it is necessary to address some knowledge gaps, including the need for more food composition data based on worldwide biodiversity (WHO/CBD, 2015).

Despite the importance of such information, there are limited data on the chemical composition of different food varieties, including underutilized and wild foods; this makes it difficult to evaluate their contribution to the nutrient intake (Charrondiere et al., 2013). The generation, compilation and dissemination of food composition data may raise awareness of biodiversity's relevance to improve diets (Burlingame et al., 2009; Charrondiere et al., 2013).

Recognizing the importance of food composition data, the Brazilian Network of Food Data Systems (BRASILFOODS) has been coordinating activities that aim to gather information on Brazilian food composition, through data compilation and analysis of new foods and specific compounds (de Menezes et al., 2011). As a result of these efforts, the TBCA was launched in 1998 and has been continuously updated. In 2017, it was restructured under the coordination of BRASILFOODS, the University of São Paulo (USP) and the Food Research Center (FoRC) (Coelho et al., 2019; Giuntini et al., 2019; Grande, Giuntini, Coelho, & Menezes, 2019). Current version 7.0 comprises two databases: the Nutrient Intake Evaluation Database, including data on the content levels of 34 components of commonly consumed foods in Brazil, and the Biodiversity and Regional Food Database, containing analytical data on Brazilian food biodiversity and typical dishes from different regions of the country (TBCA, 2019). The present article describes how the dataset of foods based on Brazilian biodiversity was elaborated for incorporation in the TBCA. Certain entries from the dataset will be used to illustrate differences in the levels of selected nutrients among these foods.

### Key messages

- A dataset on the composition of foods based on Brazilian biodiversity was elaborated.
- The dataset holds a total of 7,945 component values, comprising 1,305 food entries, mainly pertaining to raw plant foods.
- The nutrient content of foods exhibits a wide range below species level.
- Underutilized foods exhibited a higher content for selected nutrients than commonly consumed ones.
- The dataset provides evidence to identify nutrient-rich foods that may be included in national programmes and policies on nutrition and food security.

## 2 | METHODS

Data compiled for the TBCA over the past few years formed the basis for the dataset of foods based on Brazilian biodiversity. Data were compiled by researchers at the University of São Paulo, and the criteria adopted are described in the following sections.

### 2.1 | Data sources and compilation

Comprehensive literature searches were performed to collect data on foods that were produced and/or consumed in Brazil, in order to centralize national food composition data thus far dispersed in the literature. In-house data from several laboratories were also compiled.

Data compilation (collection, evaluation and calculation) followed the guidelines of the Food Agricultural Organization of the United Nations/International Network of Food Data Systems (FAO/INFOODS). Data were recorded using an updated version of the data compilation form proposed by BRASILFOODS (de Menezes et al., 2011). This form consists of independent Excel spreadsheets that display detailed food identification variables (e.g., species, variety, maturation degree, processing methods, part of the food and origin of the samples), nutrient content, data quality and other relevant information. Compiled data were evaluated according to mandatory information on description of part and state of analysed food, food origin and references of analytical methods. Exclusion criteria included use of not validated analytical methodologies, unclearly described adopted conversion factors, data presented in graphs without providing values and missing moisture value (for data presented on a dry weight basis). The INFOODS food component identifiers (tagnames) were used to standardize data compilation and to allow for data comparisons (Klensin, Feskanich, Lin, Truswell, & Southgate, 1989). Compilation encompassed the following components: energy, moisture, total fat, protein, dietary fibre, ash, minerals and trace elements, vitamin A,

retinol, carotenoids, vitamin C, ascorbic acid, dehydroascorbic acid, vitamin E, tocopherols and tocotrienols. Values expressed on a dry weight basis in original publications were converted to fresh weight basis, relying on moisture values provided by the authors. Data included in the final dataset were standardized to grams, milligrams or micrograms per 100-g 'edible portion on a fresh weight basis' (EP). All foods were classified in 17 groups, and each food entry was assigned a unique alphanumeric code.

## 2.2 | Selection of foods based on Brazilian biodiversity

Data previously compiled for the TBCA comprised a total of 3,358 food entries from 13 different food groups. Foods based on Brazilian biodiversity were selected to compose the dataset elaborated in this work. Inclusion criteria were derived from the indicators proposed by FAO (2017), including (i) foods with a detailed description below species level, including identification at the variety/cultivar/breed level or accession/genotype level; (ii) wild foods described at species level (or with a local name); and (iii) underutilized foods.

Wild foods were included based on the details compiled from original publications regarding sample collection procedures (e.g., collected in the wild). Foods classified as underutilized were taken from the INFOODS List of underutilized species contributing to the Nutritional Indicators for Biodiversity, version 1.2 (FAO/INFOODS, 2013b); from publications by Plants for the Future initiative (Brasil, 2011, 2016); and from the List of food species of the Brazilian sociobiodiversity (Brasil, 2018).

Food entries including details on different edible parts of the same food, maturity stages and processing methods were also included in the dataset because they met the inclusion criteria previously mentioned. However, no recipes (composite foods) were included.

## 2.3 | Calculated components

Some components in the dataset were calculated based on the compiled analytical data to standardize modes of expression and conversion factors, whenever possible. Calculated components included energy values, carbohydrate, protein and vitamins A, E and C. Further details on calculated components are presented in Table 1.

## 2.4 | Examples of foods included in the dataset

Two types of foods were selected from the dataset in order to illustrate the differences in the nutrient content among foods based on Brazilian biodiversity:

- *Fruits and vegetables with data available for different varieties/cultivars*: the range between the minimum and maximum values of

selected nutrients was presented per 100-g EP for foods including data on at least three different varieties/cultivars. The data were also compared taking into consideration the nutrient content per serving as a percentage of the dietary reference intake (DRI) used for labelling purposes in Brazil (Brasil, 2003). The amount of food considered for this calculation was based on the average servings reported by the National Dietary Survey (IBGE, 2011).

- *Underutilized fruits and leafy vegetables*: underutilized foods identified as nutrient rich for selected components were compared with the most consumed fruits and vegetables in Brazil. When more than one data point was available for a certain food, the average value was considered. The top three fruits (banana, orange and papaya) and leafy vegetables (lettuce, cabbage and kale) most commonly purchased by the Brazilian population according to the Household Budget Survey (Pesquisa de Orçamentos Familiares 2008–2009) were selected for comparison (IBGE, 2010). These nutrient values were obtained from the TBCA's Nutrient Intake Evaluation Database (TBCA, 2019).

Given the available information, only food entries with similar food descriptions especially regarding the part of the food and maturation degrees were compared. In addition, only components with the same definition (i.e., the same tagname) were considered, in order to avoid faulty comparisons.

## 3 | RESULTS AND DISCUSSION

### 3.1 | Description of the dataset of foods based on Brazilian biodiversity

The dataset of foods based on Brazilian biodiversity contains 1,305 food entries. The majority correspond to raw foods (958), followed by processed foods (336) and dried (11) foods (Table 2). The main processing methods applied included freezing and different types of cooking methods. Food descriptions were meticulously documented to provide details other than variety/cultivar/breed, which might interfere with the chemical composition of foods (e.g., part of the food, maturation degree, season and processing method) (Burlingame et al., 2009; Rodriguez-Amaya et al., 2008).

A total of 7,945 component values were included in the dataset. Proximate composition including energy, moisture, protein, fat, dietary fibre and ash represented 40% of the values, whereas minerals accounted for 25%. Vitamins A, C and E, as well as provitamins, accounted for 34% of the component values, but the majority corresponds to data on vitamin A and carotenoids. The inclusion of many data points for vitamins and minerals is crucial because their content varies significantly in plant-based foods (Greenfield & Southgate, 2003).

Component values correspond to analytical data reported in the original publication, but they were always expressed per 100-g EP. In addition, some components were calculated from original analytical data to allow for standardized data comparison. Therefore, no data

**TABLE 1** Description of calculated components included in the dataset of foods based on Brazilian biodiversity, expressed per 100-g edible portion on a fresh weight basis (EP)

Component	Unit	Tagname	Description
Energy	kJ	ENERC_kJ	Metabolizable energy (kJ/100-g EP) = $17 \times$ total protein (g/100-g EP) + $17 \times$ available carbohydrate (g/100-g EP) + $8 \times$ dietary fibre (g/100-g EP) + $37 \times$ total fat (g/100-g EP) + $29 \times$ alcohol (g/100-g EP)
Energy	kcal	ENERC_kcal	Metabolizable energy (kcal/100-g EP) = $4 \times$ protein (g/100-g EP) + $4 \times$ available carbohydrate (g/100-g EP) + $2 \times$ dietary fibre (g/100-g EP) + $9 \times$ total fat (g/100-g EP) + $7 \times$ alcohol (g/100-g EP)
Total carbohydrates	g	CHOCDF	Total carbohydrates by difference (g/100-g EP) = $100 -$ water (g/100-g EP) $-$ total fat (g/100-g EP) $-$ total protein (g/100-g EP) $-$ ash (g/100-g EP)
Available carbohydrates	g	CHOAVLDF	Available carbohydrates by difference (g/100-g EP) = $100 -$ water (g/100-g EP) $-$ total fat (g/100-g EP) $-$ total protein (g/100-g EP) $-$ total dietary fibre (g/100-g EP) $-$ ash (g/100-g EP)
Protein	g	PROCNT	Total protein (g/100-g EP) = total nitrogen (g/100-g EP) $\times$ nitrogen conversion factor  The nitrogen conversion factors of Jones were applied (FAO/WHO, 1973). When no specific factor is given, the general nitrogen conversion factor of 6.25 was used.
Vitamin A	$\mu$ g	VITA	Total vitamin A activity expressed as retinol equivalent (RE) ( $\mu$ g/100-g EP) = $\mu$ g retinol + $1/6 - \mu$ g $\beta$ -carotene + $1/12 - \mu$ g $\alpha$ -carotene + $1/12 - \mu$ g $\beta$ -cryptoxanthin (FAO/WHO, 2001)
Vitamin A	$\mu$ g	VITA_RAE	Total vitamin A activity expressed as retinol activity equivalent (RAE) ( $\mu$ g/100-g EP) = $\mu$ g retinol + $1/12 - \mu$ g $\beta$ -carotene + $1/24 - \mu$ g $\alpha$ -carotene + $1/24 - \mu$ g $\beta$ -cryptoxanthin (IOM, 2001)
Vitamin C	mg	VITC	Total vitamin C (mg/100-g EP) = L-ascorbic acid (mg/100-g EP) + L-dehydroascorbic acid (mg/100-g EP)
Vitamin E	mg	VITE	Alpha tocopherol equivalents (mg/100-g EP) = $\alpha$ -tocopherol (mg/100-g EP) + $0.4 \times$ $\beta$ -tocopherol (mg/100-g EP) + $0.1 \times$ $\gamma$ -tocopherol (mg/100-g EP) + $0.01 \times$ $\delta$ -tocopherol (mg/100-g EP) + $0.3 \times$ $\alpha$ -tocotrienol (mg/100-g EP) + $0.05 \times$ $\beta$ -tocotrienol (mg/100-g EP) + $0.01 \times$ $\gamma$ -tocotrienol (mg/100-g EP) (FAO/WHO, 2001)

were aggregated, estimated or borrowed from other sources in order to fill data gaps, meaning that values were presented according to availability. Moreover, some foods resulted in more than food entry in the dataset, because similar foods were not aggregated to result in a single average value.

Fruits and vegetables represented 55% and 23% of all food entries, respectively. The types of foods presented according to inclusion criteria are shown in Figure 1. Underutilized foods represented the majority of food entries (45%), followed by foods identified below species level (39%). A low number of food entries (7%), mainly from the fish and shellfish group, were classified as wild. Similar results

were recorded in the last Report on the Nutrition Indicators for Biodiversity prepared by FAO/INFOODS (2013a), which described the availability of data on food biodiversity. Only 9% of the total number of foods were identified as both underutilized and below species level. Although many underutilized fruits were not identified also as wild in the original source, it is known that some of these fruits are not cultivated at commercial scale and therefore are available only in their native habitats.

The new dataset centralizes analytical data on the chemical composition of biodiverse foods from Brazil, which is the most biodiverse country in the world (Brasil, 2016). Nevertheless, this type of data is

**TABLE 2** Number of food entries included in the dataset of foods based on Brazilian biodiversity, according to food group and state of the analysed food

Food group	Number of food entries			
	Raw	Processed	Dried	Total
Cereals	49	2		51
Vegetables	179	114	7	300
Fruits	563	159		722
Fat and oils		7		7
Fish and shellfish	56	3		59
Meat	52	1		53
Beverages			4	4
Sugars and sweets	1	1		2
Legumes	58	49		107
Total	958	336	11	1,305

not yet widely presented in food composition tables and databases disaggregating biodiversity, nutrition and agriculture. Compiled data can contribute to the identification of nutrient-rich foods in order to promote the production and consumption of selected varieties and local foods (Burlingame et al., 2009).

### 3.2 | Descriptive analysis of nutrient data for some foods included in the dataset

Many foods in the dataset were identified below species level, and in some cases, there was a wide range between the minimum and maximum values of certain components. Table 3 provides some examples of selected components for fruits and vegetables, including some staple foods. According to details specified in the food descriptions, only raw and mature foods without additional processing methods were selected. Inclusion of these variables could complicate comparison of nutrient values, because factors other than genetics (e.g., processing,

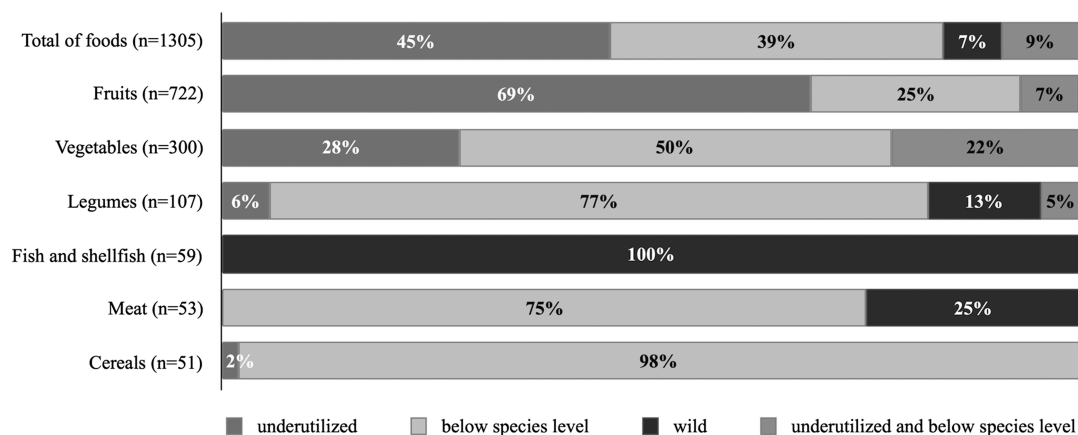
maturation degree and agricultural practices) may influence foods' nutrient content (Greenfield & Southgate, 2003; Rodriguez-Amaya et al., 2008). Nevertheless, based on available data, production sites varied in most cases; in addition, certain details such as foods' harvest seasons were unavailable, which may have influenced nutrient content values.

A wide range in vitamin A values was found for carrot, cassava, sweet potato, squash, lettuce, banana, papaya, mango, peach and loquat. Sweet potato exhibited the widest range in vitamin A content among varieties/cultivars. The highest content provides more than 10 times the DRI per serving, whereas the lowest value represents negligible amounts. Flesh colour gives evidence of the vitamin A content, because yellow- and orange-fleshed sweet potatoes present higher values for provitamin A carotenoids (Wang, Nie, & Zhu, 2016). Therefore, colour should be included in food descriptions when elaborating food composition tables and databases.

Mangoes also showed considerable variation in vitamin A levels: 100–417 µg of retinol equivalents (RE) per 100-g EP. Although all cultivars displayed a high vitamin A content (≥30% of the DRI per serving), they correspond to a minimum of 36% of the DRI to a maximum of 148% of the DRI per serving. Variation was likewise considerable for entries in the *Indian Food Composition Tables* (Longvah, Ananthan, Bhaskarachary, & Venkaiah, 2017), which include data for seven different mango cultivars: vitamin A content ranged from 101- to 215-µg RE per 100-g EP. As for ascorbic acid, in strawberry, the maximum value (112 mg per 100-g EP) more than tripled the minimum value (31.4 mg per 100-g EP).

Regarding minerals, different types of taro and banana ranged from small amounts to source of magnesium per serving (15%–29.9% of the DRI). The highest calcium content in taro was 10-fold the lowest one.

These results are consistent with previously published data, which show that different varieties and cultivars exhibit significantly different nutrient contents (Burlingame et al., 2009; Rodriguez-Amaya et al., 2008; Toledo & Burlingame, 2006). Therefore, in these cases, food composition tables and databases should



**FIGURE 1** Percentage distribution of total data (and main food groups) included in the dataset of foods based on Brazilian biodiversity according to inclusion criteria

**TABLE 3** Range of mineral and vitamin content in different varieties/cultivars in certain fruits and vegetables within the dataset of foods based on Brazilian biodiversity (values are expressed per 100-g edible portion on a fresh weight basis [EP])

	Serving size <sup>b</sup> (g)	n <sup>c</sup>	Nutrient content per 100-g EP <sup>a</sup>									
			Calcium (mg)		Magnesium (mg)		Vitamin A, RE <sup>d</sup> (μg)		α-Tocopherol <sup>e</sup> (μg)		Ascorbic acid <sup>f</sup> (mg)	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Rice, brown, raw ( <i>Oryza sativa</i> L.)	59	32							0.21	1.41		
Broccoli, flower, raw ( <i>Brassica oleracea</i> L., var. <i>italica</i> Plenk)	63	3					395	660				
Carrot, raw ( <i>Daucus carota</i> )	46	4					375	798				
Cassava, peeled, raw ( <i>Manihot esculenta</i> Crantz)	166	25					0	161				
Sweet potato, peeled, raw ( <i>Ipomoea batatas</i> Lam.)	207	10					0.33	3.637				
Squash, peeled, raw ( <i>Cucurbita moschata</i> )	108	3					1.143	4.302				
Taro, peeled, raw ( <i>Colocasia esculenta</i> L.)	97	5	8.48	74.8	19	46						
Kale, raw ( <i>Brassica oleracea</i> )	52	4					733	1,000				
Lettuce, raw ( <i>Lactuca sativa</i> )	36	9					165	410				
Banana, peeled, raw ( <i>Musa</i> spp.)	105	5	1.88	4.8	32.1	50.9	6.42	239				
Orange, juice ( <i>Citrus aurantium</i> L.)	265	10					0.25	4.75			42.3	80
Papaya, peeled, raw ( <i>Carica papaya</i> L.)	201	9					59	128				
Mango, peeled, raw ( <i>Mangifera indica</i> L.)	213	3 <sup>g</sup>	5.8	11	8.1	11.1	100	417				
Peach, raw ( <i>Prunus persica</i> L.)	139	5					1.17	107				
Strawberry, raw ( <i>Fragaria × ananassa</i> Duch.)	139	10									31.4 <sup>i</sup>	112 <sup>i</sup>
Loquat, raw ( <i>Eriobotrya japonica</i> Lindl.)	139	5 <sup>h</sup>					6.33	306			5.28	8.2
Dietary reference intake (DRI) <sup>j</sup>			1,000		260		600		10		45	

<sup>a</sup>Shaded cells were based on the serving size and on the dietary reference intake (DRI): black shaded cells contain values (per serving) >100% DRI; dark shaded cells contain values 60%–99.9% DRI; medium shaded cells contain values 30%–59.9% DRI; unshaded outlined cells contain values 15%–29.9% DRI; and unshaded cells contain values <14.9% DRI.

<sup>b</sup>Serving size was calculated for raw foods; amount of food was based on the average servings reported by the National Dietary Survey (IBGE, 2011).

<sup>c</sup>n is the number of data points considered for each food.

<sup>d</sup>Vitamin A expressed in retinol equivalents was calculated as μg retinol + 1/6-μg β-carotene + 1/12-μg α-carotene + 1/12-μg β-cryptoxanthin.

<sup>e</sup>α-Tocopherol only.

<sup>f</sup>Ascorbic acid only.

<sup>g</sup>n = 9 for vitamin A.

<sup>h</sup>n = 10 for vitamin A.

<sup>i</sup>Data refer to total vitamin C (L-ascorbic acid plus L-dehydroascorbic acid).

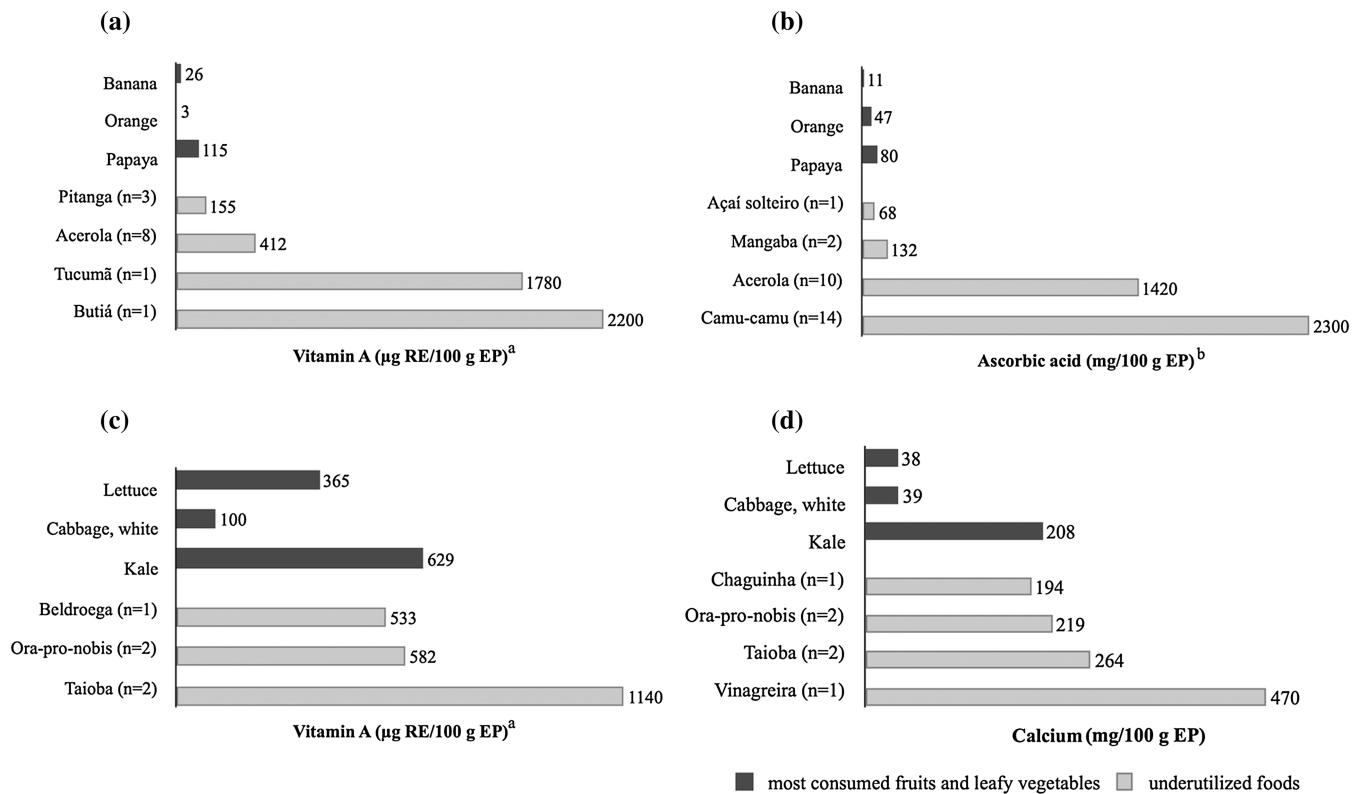
<sup>j</sup>Brazilian technical regulation on nutrition labelling of packaged foods (Brasil, 2003).

publish foods individually reporting their unique nutrient profile, instead of a singular entry with average nutrient values (Toledo & Burlingame, 2006).

In addition to foods identified at species level, many underutilized fruits and vegetables were included in the dataset; among them, some were identified as important sources of certain nutrients. Figure 2 provides some examples of underutilized foods included in the dataset. The most purchased fruits and leafy vegetables in Brazil were also included for reference. Underutilized foods presented a similar or

higher content per 100-g EP for the selected nutrients than the most consumed foods in Brazil (Figure 2).

Papaya is among the most consumed fruits in Brazil, and it is recognized as a source of vitamin A (FAO/WHO, 2001). However, Tucumã (*Astrocaryum aculeatum*) and Butiá (*Butia eriopatha*) showed a much higher vitamin A content, corresponding to 15 and 19 times that of papaya, respectively (Figure 2a). The consumption of small portions of these fruits (about 35 g) can cover the DRI of vitamin A (600-μg RE per day). Tucumã occurs naturally in the North and



**FIGURE 2** Content of selected nutrients in some underutilized foods included in the dataset, as well as in Brazil's most consumed fruits (a and b) and leafy vegetables (c and d) in Brazil. <sup>a</sup>Vitamin A values, expressed in retinol equivalents (RE), were calculated as  $\mu\text{g retinol} + 1/6\text{-}\mu\text{g } \beta\text{-carotene} + 1/12\text{-}\mu\text{g } \alpha\text{-carotene} + 1/12\text{-}\mu\text{g } \beta\text{-cryptoxanthin}$ . <sup>b</sup>L-ascorbic acid only. EP, edible portion on a fresh weight basis

Midwest regions of Brazil, whereas Butiá is found in the South region. Both fruits can be used *in natura* or to prepare juices, jams and other desserts (Brasil, 2018).

In Acerola (*Malpighia glabra* L.), vitamin A values were 3.5 times greater than those in papaya, whereas ascorbic acid values were almost 30 times greater than those in oranges. Due to the high ascorbic acid content of acerola, several studies have published data evaluating changes in vitamin C content according to maturation degree and storage conditions. This type of data was also included in the dataset because it can be useful when elaborating recommendations regarding processing methods for foods based on Brazilian biodiversity.

Camu-camu (*Myrciaria dubia*) is a fruit that occurs naturally in the Amazon basin and is almost unknown in Brazil (Yuyama, 2011). However, it was identified as the richest fruit in vitamin C. Based on the 14 data points available, the average content of ascorbic acid was found to be 2,300 mg per 100-g EP (Figure 2b), ranging from 1,530 to 4,840 mg per 100-g EP. Camu-camu may be consumed *in natura* or used to prepare juice, nectar, jams and ice cream, among others (Brasil, 2018). In addition, some genotypes of camu-camu may adapt and grow in other Brazilian states, which would widen the fruit's distribution (Yuyama, 2011).

Lettuce (*Lactuca sativa* L.), cabbage (*Brassica oleracea* var. *capitata*) and kale (*Brassica oleracea* var. *acephala*) are the most widely consumed leafy vegetables in Brazil. As for underutilized leaves,

beldroega (*Portulaca oleracea* L.) and ora-pro-nobis (*Pereskia aculeata*) presented a vitamin A content similar to that of kale, whereas the vitamin A content of taioba (*Xanthosoma taioba*) was almost twice that of kale (Figure 2c).

Calcium content was similar among underutilized leaves and kale, except for vinagreira (*Hibiscus sabdariffa* L.), which contained more than twice the amount found in kale (470 mg vs. 208 mg per 100-g EP, respectively) (Figure 2d). This difference may greatly impact mineral intake because the consumption of 100 g of raw leaf (which can be included in different recipes) covers almost 50% of the DRI for calcium (1,000 mg/day). It should be noted that when making calcium intake recommendations, milk and dairy products were considered as the mineral's main source (IOM, 2011); the bioavailability of calcium in plant foods may be comparatively due to the presence of components such as dietary fibre, phytate and oxalate, which may reduce the mineral's absorption; thus, a greater intake of plant-based foods may be required (Burckhardt, 2013).

Inadequate intake of vitamins A, E and C, as well as calcium and magnesium, was widely observed among Brazil's adult population in the last National Dietary Intake Survey (Araujo et al., 2013). Interestingly, foods included in the dataset showed that the consumption of certain cultivars/varieties or underutilized foods may have a significant impact on the nutrient intake, which could reduce micronutrient deficiency in the Brazilian population.

The examples provided reinforce the importance of including data on food biodiversity in food composition tables and databases for use in different areas of nutrition. The present dataset can be used as a tool to identify nutrient-rich foods based on Brazilian biodiversity, which may then be considered in the elaboration of national programmes and policies on nutrition and food security. Strategies may include stimulating the production of certain varieties/cultivars of commonly consumed foods or promoting consumption of underutilized foods, for example, through nutrition education or school feeding programmes.

In order to give visibility to this valuable information, the elaborated dataset on the Brazilian food biodiversity was incorporated into the Biodiversity and Regional Food Database in version 7.0 of the TBCA. The database centralizes analytical data on Brazilian food biodiversity and typical dishes from different regions of the country. It can be accessed online, free of charge on the TBCA platform ([www.fcf.usp.br/tbca](http://www.fcf.usp.br/tbca)).

## 4 | CONCLUSION

The dataset on Brazilian food biodiversity centralizes analytical data on the chemical composition of 1,305 food entries. The available information concerns mainly underutilized foods and foods identified below species level. Substantial differences were in the content values of selected nutrients, not only among different varieties of fruits and vegetables but also between underutilized and most widely consumed plant foods in the country. The dataset provides evidence to identify nutrient-rich foods, which can help address gaps in the current food composition data and allow the inclusion of these foods in national programmes and policies on nutrition and food security.

## ACKNOWLEDGMENTS

This work was supported by the Food Research Center (FoRC/CEPID/FAPESP) and by the Post Graduate Program in Applied Human Nutrition (PRONUT/USP). Scholarships were provided by the 'Conselho Nacional de Desenvolvimento Científico e Tecnológico' (CNPq) and the 'Coordenação de Aperfeiçoamento de Pessoal de Nível Superior' (CAPES).

## CONFLICTS OF INTEREST


There are no conflicts of interest to declare.

## CONTRIBUTIONS

FG, EBG, KSC and EWM contributed to the design of the research; all authors contributed to the implementation of the research; FG elaborated the dataset; FG wrote the manuscript with support from EWM; and all authors have reviewed the final manuscript.

## ORCID

Fernanda Grande  <https://orcid.org/0000-0002-2058-3683>

Elizabete Wenzel de Menezes  <https://orcid.org/0000-0002-5011-8205>

## REFERENCES

- Araujo, M. C., Bezerra, I. N., dos Barbosa, F. S., Junger, W. L., Yokoo, E. M., Pereira, R. A., & Sichieri, R. (2013). Macronutrient consumption and inadequate micronutrient intake in adults. *Revista de Saúde Pública*, 47 (SUPPL.1), 177–189. <https://doi.org/10.1590/S0034-89102013000700004>
- Bailey, R. L., West, K. P., & Black, R. E. (2015). The epidemiology of global micronutrient deficiencies. *Annals of Nutrition and Metabolism*, 66 (suppl 2), 22–33. <https://doi.org/10.1159/000371618>
- Bioversity International. (2013). *Diversifying food and diets*. New York: Routledge.
- Brasil. (2003). Resolução RDC nº 360. Regulamento Técnico sobre Rotulagem Nutricional de Alimentos Embalados. Agência Nacional de Vigilância Sanitária (ANVISA). <https://doi.org/10.1017/CBO9781107415324.004>
- Brasil. (2011). Ministério do Meio ambiente. *Espécies nativas da flora brasileira de valor econômico atual ou potencial: plantas pra o futuro - Região sul. Espécies Nativas da Flora Brasileira de Valor Econômico Atual ou Potencial Plantas para o Futuro - Região Sul*. Brasília: Ministério do Meio Ambiente. Secretaria de Biodiversidade. 978-85-7738-153-1
- Brasil (2016). Ministério do Meio Ambiente. *Espécies nativas da flora brasileira de valor econômico atual ou potencial: plantas para o future - Região centro-oeste*. Brasília: Ministério do Meio Ambiente. Secretaria de Biodiversidade. Retrieved from <http://www.b4fn.org/the-countries/brazil>
- Brasil. (2018). Ministério do Meio Ambiente. Ministério do Desenvolvimento Social. Portaria Interministerial n. 284 de 30 de maio de 2018. Lista as espécies da sociobiodiversidade brasileira de valor alimentício. *Diário Oficial Da União, seção, 1*, 92–94.
- Burkhardt, P. (2013). Calcium revisited: Part I. *BoneKey Reports*, 2(May), 1–6. <https://doi.org/10.1038/bonekey.2013.167>
- Burlingame, B., Charrodiere, U. R., & Mouille, B. (2009). Food composition is fundamental to the cross-cutting initiative on biodiversity for food and nutrition. *Journal of Food Composition and Analysis*, 22(5), 361–365. <https://doi.org/10.1016/j.jfca.2009.05.003>
- CBD. (2005). *Secretariat of the Convention on Biological Diversity. Handbook of the Convention on Biological Diversity including its Cartagena Protocol on Biosafety. Biological Conservation* (3rd ed., Vol. 114). Montreal. [https://doi.org/10.1016/S0006-3207\(03\)00053-3](https://doi.org/10.1016/S0006-3207(03)00053-3)
- Charrodiere, U. R., Stadlmayr, B., Rittenschober, D., Mouille, B., Nilsson, E., Medhammar, E., ... Burlingame, B. (2013). FAO/INFOODS food composition database for biodiversity. *Food Chemistry*, 140(3), 408–412. <https://doi.org/10.1016/j.foodchem.2012.08.049>
- Coelho, K. S., Bistrice Giuntini, E., Grande, F., da Silva Dias, J., Purgatto, E., de Melo Franco, B. D. G., ... de Menezes, E. W. (2019). 12th IFDC 2017 special issue—Brazilian Food Composition Table (TBCA): Development and functionalities of the online version. *Journal of Food Composition and Analysis*, 84(October). <https://doi.org/10.1016/j.jfca.2019.103287>
- de Menezes, E. W., Giuntini, E. B., Dan, M. C. T., Santos, N. C., de Melo, A. T., & Lajolo, F. M. (2011). Brazilian Network of Food Data Systems and LATINFOODS Regional Technical Compilation Committee: Food composition activities (2006–2009). *Journal of Food Composition and Analysis*, 24(4–5), 678–681. <https://doi.org/10.1016/j.jfca.2010.09.003>
- FAO. (Ed.) (2017). *FAO/INFOODS food composition database for biodiversity version 4.0—BioFoodComp4.0*. Rome: FAO. Retrieved from <http://www.fao.org/infoods/infoods/tables-and-databases/faoinfoods-databases/en/>
- FAO/INFOODS. (2013a). *FAO/INFOODS Report on the Nutrition Indicators for Biodiversity—Food composition and food consumption. Global Progress Report 2013*. Rome: FAO.
- FAO/INFOODS. (2013b). *INFOODS List of underutilized species contributing to the Nutritional Indicators for Biodiversity version 1.2*. Rome: FAO.



- Retrieved from <http://www.fao.org/infoods/infoods/food-biodiversity>
- FAO/WHO. (1973). Joint FAO/WHO Ad Hoc Expert Committee on Energy and Protein Requirements, World Health Organization & Food and Agriculture Organization of the United Nations. Energy and protein requirements: Report of a Joint FAO/WHO ad hoc expert committee. [meeting held in Rome from 22 March to 2 April 1971]. Geneva. Retrieved from [http://whqlibdoc.who.int/trs/WHO\\_TRS\\_522.pdf](http://whqlibdoc.who.int/trs/WHO_TRS_522.pdf)
- FAO/WHO. (2001). *Human vitamin and mineral requirements*. Bangkok: Food and Agriculture Organization of the United Nations. World Health Organization. Human vitamin and mineral requirements. 10.1016/B978-0-323-06619-8.10013-1
- Giuntini, E. B., Coelho, K. S., Grande, F., Marchioni, D. M. L., De Carli, E., Sichieri, R., ... Menezes, E. W. (2019). 12th IFDC 2017 special issue—Brazilian Nutrient Intake Evaluation Database: An essential tool for estimating nutrient intake data. *Journal of Food Composition and Analysis*, 83(October). <https://doi.org/10.1016/j.jfca.2019.103286>
- Grande, F., Giuntini, E. B., Coelho, K. S., & Menezes, E. W. (2019). Elaboration of a standardized dataset for foods fortified with iron and folic acid in Brazil. *Journal of Food Composition and Analysis*, 83(October). <https://doi.org/10.1016/j.jfca.2019.103285>
- Greenfield, H., & Southgate, D. A. T. (2003). In FAO. (Ed.), *Food composition data: Production, management and use* (2nd ed.). Rome: Springer US. <https://doi.org/10.1007/978-1-4615-3544-7>
- IBGE. (2010). *Instituto Brasileiro de Pesquisa. Pesquisa de Orçamentos Familiares (POF) 2008-2009. Aquisição alimentar domiciliar per capita*. Rio de Janeiro: IBGE. Retrieved from [http://www.ibge.gov.br/home/estatistica/populacao/condicaoodevida/pof/2008\\_2009\\_aquisicao/pof20082009\\_aquisicao.pdf](http://www.ibge.gov.br/home/estatistica/populacao/condicaoodevida/pof/2008_2009_aquisicao/pof20082009_aquisicao.pdf)
- IBGE. (2011). *Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009. Análise do Consumo Alimentar Pessoal no Brasil*. Rio de Janeiro: IBGE.
- IOM. (2001). Institute of Medicine. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington, DC.
- IOM. (2011). *Institute of Medicine. Dietary reference intakes for calcium and vitamin D*. Washington: National Academies. 10.17226/13050
- Khoury, C. K., Bjorkman, A. D., Dempewolf, H., Ramirez-Villegas, J., Guarino, L., Jarvis, A., ... Struik, P. C. (2014). Increasing homogeneity in global food supplies and the implications for food security. *Proceedings of the National Academy of Sciences*, 111(11), 4001–4006. <https://doi.org/10.1073/pnas.1313490111>
- Klensin, J. C., Feskanich, D., Lin, V., Truswell, S., & Southgate, D. A. T. (1989). *Identification of food components for INFOODS data interchange*. Tokyo: United Nations University Press. Retrieved from [http://www.fao.org/uploads/media/Klensin\\_et\\_al\\_1989\\_Identification\\_of\\_food\\_components\\_for\\_I\\_02.pdf](http://www.fao.org/uploads/media/Klensin_et_al_1989_Identification_of_food_components_for_I_02.pdf)
- Longvah, T., Ananthan, R., Bhaskarachary, K., & Venkaiah, K. (2017). *Indian food composition tables*. Hyderabad: National Institute of Nutrition. Indian Council of Medical Research.
- Rodriguez-Amaya, D. B., Kimura, M., Godoy, H., & Amaya-Farfan, J. (2008). Updated Brazilian database on food carotenoids: Factors affecting carotenoid composition. *Journal of Food Composition and Analysis*, 21(6), 445–463. <https://doi.org/10.1016/j.jfca.2008.04.001>
- TBCA. (2019). Tabela Brasileira de Composição de Alimentos. version 7.0. Retrieved August 20, 2019, from <http://www.fcf.usp.br/tbca/>
- Toledo, A., & Burlingame, B. (2006). Biodiversity and nutrition: A common path toward global food security and sustainable development. *Journal of Food Composition and Analysis*, 19(6–7), 477–483. <https://doi.org/10.1016/j.jfca.2006.05.001>
- Wang, S., Nie, S., & Zhu, F. (2016). Chemical constituents and health effects of sweet potato. *Food Research International*, 89, 90–116. <https://doi.org/10.1016/j.foodres.2016.08.032>
- WHO/CBD. (2015). Connecting global priorities: Biodiversity and human health, a state of knowledge review. World Health Organization and Secretariat for the Convention on Biological Diversity. Retrieved from [www.cbd.int/en/health/stateofknowledge%5Cnhttp://apps.who.int/iris/bitstream/10665/174012/1/9789241508537\\_eng.pdf](http://www.cbd.int/en/health/stateofknowledge%5Cnhttp://apps.who.int/iris/bitstream/10665/174012/1/9789241508537_eng.pdf)
- Yuyama, K. (2011). The camu-camu culture in Brazil. *Revista Brasileira de Fruticultura*, 33(2), 335–690. <https://doi.org/10.1590/S0100-29452011000200001>

**How to cite this article:** Grande F, Giuntini EB, Coelho KS, et al. Biodiversity food dataset: Centralizing chemical composition data to allow the promotion of nutrient-rich foods in Brazil. *Matern Child Nutr*. 2020;16(S3):e13005. <https://doi.org/10.1111/mcn.13005>