1. Introduction

Knowledge of the nutrient content of foods is fundamental for virtually all nutrition-related projects, programmes and policies. Information on food composition is important for nutrition and health programmes, the agricultural and environmental sector as well as for labelling and trade regulations (Burlingame, 2004; Greenfield & Southgate, 2003). In addition food composition data can aid the selection of cultivars and varieties that are beneficial for nutritional quality and yield of foods (Burlingame, Charrondière, & Mouillé, 2009; Toledo & Burlingame, 2006).

For all these purposes high quality food composition data are required. Low quality food composition data may misdirect research and lead to inappropriate policies and resource allocations (Harrison, 2004; Pennington, 2008). Moreover, food composition must always be considered a work in progress and it requires continuing inputs from government, researchers and donors. The importance of food composition data has long been appreciated in West Africa, both in the health and agricultural sectors, and various food composition tables (FCT) had been published in the 1960 and 1970s. However, these contained few foods, and components without documentation (INFOODS, 2012).

Low quality food composition data may misdirect research and lead to inappropriate policies and resource allocations. Existing food composition tables (FCT) for most West African countries date back to 1960 and 1970 and contain in general few foods and components without documentation. As a result of the recommendations by the Economic Community of West African States (ECOWAS) Nutrition forum and other high level meetings, FAO/INFOODS, WAHO/ECOWAS and Bioversity International developed the West African FCT. It contains 472 foods and 28 components. Emphasis was given to include data on food biodiversity by incorporating cultivars/varieties and underutilized foods. The West African FCT enables users to address diet-related health problems, strengthen local development, enhance trade and promote biodiversity. In addition it contributes to poverty alleviation in both rural and urban areas. The FCT needs to be updated regularly and it is the most recent example of INFOODS for regional food composition activities.

West Africa has a rich diversity of ecosystems, food systems, and agro ecological zones, yet food and nutrition insecurity still remains. The production and availability of nutrient-rich traditional foods in the sub-region as in other parts of Sub-Saharan Africa is important to address the region’s food insecurity, micronutrient malnutrition and diet-related chronic diseases (Smith, Atta-Krah, & Eyzaguirre, 2010). Although progress is being made in achieving the World Food Summit targets, it is estimated that 10% of the population of West Africa is undernourished (FAO, 2010). In addition, West Africa faces a great challenge in dealing with significant micronutrient malnutrition along with increasing prevalence of obesity and diet related chronic diseases (Thiam, Samba, & Lwanga, 2006).

WAHO/ECOWAS, FAO/INFOODS and Bioversity International opted for a food based approach for which data on food composition are needed. The development of the West African FCT was initiated by WAHO/ECOWAS and its partners and it is the culmination of a very effective and fruitful collaboration among countries in the region, involving government ministries, academia, and research. It also represents an effective collaboration between the health and agriculture sectors, at both regional (WAHO/ECOWAS) and international (FAO/INFOODS) levels.

2. Materials and methods

In April 2010, national consultants from different West African countries collected food compositional data from scientific papers, theses, university reports and food composition Tables (FCT) of traditional foods in Benin, Burkina Faso, Ghana, Guinea, Niger, Nigeria
and Senegal. These data were compiled using the FAO/INFOODS Compilation Tool, a simple food composition database management system in Excel (Charrondière & Burlingame, 2011a; FAO/INFOODS, 2009). Subsequently the data were transferred to FAO Rome, checked for consistency and completed with analytical data from the literature and from other FCTs, mostly from outside of Africa (U.S. Department of Agriculture, Agricultural Research, 2010; Saxholt et al., 2008; Food Standards Agency, 2002). The composition of cooked foods was calculated by applying yield and nutrient retention factors from Bergström (1994), Bognár (2002) and EuroFIR (Vásquez-Caicedo, Bell, & Hartmann, 2008). In 2011, FAO Rome added new compositional data, mainly from the Food Composition Table for Mali (Barikmo, Ouattara, & Oshaug, 2004), Nigeria and the scientific literature. Moreover more cooked foods were calculated. The West African FCT is documented and compiled according to international standards and guidelines, including INFOODS food component identifiers (Klensin, Feskanich, Lin, Truswell, & Southgate, 1989), the FAO/INFOODS Compilation Tool (Charrondière & Burlingame, 2011a; FAO/INFOODS, 2009), the Food Composition Study Guide (Charrondière, Burlingame, Berman, & Elmadfa, 2011b; Charrondière, Burlingame, Berman, & Elmadfa, 2011c) and the compilation process outlined by Greenfield and Southgate (2003).

3. Results and discussion

In 2010, the FCT, Composition of Selected Foods from West Africa’, was published by FAO/INFOODS, WAHO/ECOWAS and Bioversity International with 173 foods and 30 components (Stadlmayr et al., 2010). It represents the first edition of a regional FCT. In 2011, this table was revised and the West African FCT was published in 2012 (Stadlmayr et al., 2012). The published FCT is downloadable free of charge in PDF and Excel format at the INFOODS web site available at http://www.fao.org/infoods/infoods/tables-and-databases/africa/en/. The table contains 472 foods that are divided in 13 food groups (Table 1). Each food code is composed of the code of the food group and the food code within the group. Foods are reported with the English name and French name.

As shown in Table 1, most foods are available for the food group cereals and their products (76) followed by vegetables and their products (70) and meat, poultry and their products (63). Eggs and their products as well as fats and oils account for the food groups with the fewest entries.

In order to include more foods from the wide spectrum of the food supply in West Africa, information on frequently consumed foods was retrieved from Household Budget Surveys available at FAO. Compositional data of these foods was searched and borrowed mainly from the USDA and South African FCTs (U.S. Department of Agriculture, Agricultural Research Service, 2010; Wolmarans, Danster, Dalton, Rosouw, & Schönfeldt, 2010).

For each food, the sources of data are indicated in the bibliographic code. The foods reported in the West African FCT represent average values of the collected compositional data from different sources. A standard deviation (SD) was calculated for records when the number of data points was three or more. If two data points were available, the minimum (min) and the maximum (max) values were reported. For each value the number of data points (n) was indicated.

The majority of foods are usually not eaten raw; therefore, it was decided to calculate the compositional data for foods as actually eaten. Fig. 1 gives and overview of the proportion of raw versus cooked foods for general foods and foods on biodiversity (e.g. cultivar/variety, wild or underutilized foods) included in the table and it reflects the efforts that was given to include foods as actually eaten, as well as the importance of biodiversity. Most of the foods included in the table are ‘general foods, raw’ (43%), followed by ‘general foods, cooked’ (23%), ‘biodiversity foods, raw’ (24%) and ‘biodiversity foods, cooked’ (10%) The composition of cooked foods was calculated based on the corresponding raw food by applying appropriate yield and nutrient retention factors. Since no reliable data for yield and nutrient retention factors were available from Africa, sources from outside of Africa had to be taken. Yield factors were applied from Bergström (1994) and Bognár (2002) and nutrient retention factors were used from EuroFIR (Vásquez-Caicedo et al., 2008). In case no yield factor for a traditional African food was reported, a yield factor from the most similar food was taken. For example, to calculate ‘green leaves, boiled’, the yield factor for ‘spinach, boiled’ from Bognár (2002) was used, or to calculate ‘cassava or taro tubers, boiled’, the yield factor for ‘root and tuber vegetables, boiled’ from Bognár (2002) was applied. The compositional data from boiled foods are ‘without salt’, which was also indicated in the food name. In view of non-communicable diseases and the concern about salt content of foods, it is intended to calculate cooked foods ‘with salt’ for the next edition. Generally, it would be best to have analytical data of raw and cooked foods. However, this is time consuming and expensive. The calculated nutrient values are of acceptable quality if appropriate yield and nutrient retention factors are applied. The quality can be increased if the yield factor is measured for the given food or recipe.

Reliable data on retention factors for a large number of foods and nutrients are available for cooking methods like boiling, frying and baking, but they are mostly from Europe and other western countries. Retention factors exist for other processing/preparation methods, e.g., fermentation, sun-drying, extraction, earth-oven cooking, but these are limited to a few foods and nutrients. Therefore, some approximations were made for certain retention factors.

Table 1

<table>
<thead>
<tr>
<th>Classification of food groups and number of food entries within each food group.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Cereals and their products (76)</td>
</tr>
<tr>
<td>02 Starchy roots, tubers and their products (34)</td>
</tr>
<tr>
<td>03 Legumes and their products (40)</td>
</tr>
<tr>
<td>04 Vegetables and their products (70)</td>
</tr>
<tr>
<td>05 Fruits and their products (44)</td>
</tr>
<tr>
<td>06 Nuts, seeds and their products (26)</td>
</tr>
<tr>
<td>07 Meat, poultry and their products (63)</td>
</tr>
<tr>
<td>08 Eggs and their products (4)</td>
</tr>
<tr>
<td>09 Fish and their products (47)</td>
</tr>
<tr>
<td>10 Milk and their products (21)</td>
</tr>
<tr>
<td>11 Fat and oils (10)</td>
</tr>
<tr>
<td>12 Beverages (19)</td>
</tr>
<tr>
<td>13 Miscellaneous (18)</td>
</tr>
</tbody>
</table>

Fig. 1. Overview of proportion of foods (raw versus cooked; general foods versus foods on biodiversity).
It is desirable that more analytical data on different nutrient changes in a wide range of foods, and processing conditions are generated to develop more appropriate retention factors for calculating nutrient contents. FAO/INFOODS is currently gathering and compiling analytical data from the literature on the different cooking and processing methods for green leafy vegetables. The data will be published in the FAO/INFOODS Food Composition Database and it is hoped that this information will contribute to develop different retention factors for different regions in future.

Originally, it was planned to include traditional recipes in the West African FCT by borrowing recipes together with their component values from other sources in Africa. It was, however, not possible to copy these values or to recalculate them due to inconsistencies in ingredients and values and lack of data documentation. Examples are missing information on the yield factors for the single recipes as well as the quantity of water, fat and salt added to the recipe. It is therefore, necessary to investigate traditional recipes for West Africa, to develop a list of all their raw ingredients in gram (including water, fat and salt) while indicating also the yield factor of the individual recipes or ingredients.

When gathering and compiling food composition data for the West African FCT, emphasis was given to include data on biodiversity by incorporating cultivars/varieties, wild and underutilized foods. The identification of varieties/cultivars, wild and underutilized foods was based on the criteria of the Nutrition Indicator for Biodiversity on Food Composition (FAO, 2008). In total 160 foods are included in the West African FCT on biodiversity level (49 for cereals, 30 for legumes, 18 for starchy roots and tubers, 30 for vegetables, 17 for fruits, 11 for nuts and seeds, 5 for meat). For local varieties/cultivars, the country of origin is reported in addition to the food name, and missing values were supplemented with values from other sources and are marked in italics, to indicate that these borrowed values do not necessarily represent biodiversity.

The West African FCT contains 28 components with all values expressed per 100 g edible portion. All components together with their units are documented with the INFOODS component identifiers (Klensin et al., 1989) (Table 2). The values per nutrient have been standardized and are expressed in a fixed maximum number of decimal places, i.e. no decimal places were added but values with higher decimal places were truncated to the maximal number of decimal places as indicated in the COMPONENT sheet of the Compilation Tool (FAO/INFOODS, 2009).

Information on the expressions and definitions of all components are found in the introduction of the table, in English and in French. Energy values have been calculated by applying metabolized energy conversion factors (General Atwater factors including for dietary fibre) and are expressed in both kilojoules (kJ) and kilocalories (kcal). Protein values were calculated by multiplying the nitrogen values with the nitrogen conversion factors of Jones. If no specific factor was given, the general nitrogen conversion factor of 6.25 was applied. No data are included for fatty acids and amino acids due to lack of data for these components.

The documentation of the table includes definition and expression of nutrients, a list of INFOODS tagnames, information on the calculation procedure of cooked foods, information on quality and sources of data as well as a food index and a bibliographic reference. The scientific names are listed in the food index together with the food code, the bibliographic references, the page number and the English and French food name.

The table was compiled with the objective to contain as few missing values as possible, as this limits the use of the tables, e.g. for nutrition assessment. Missing values were imputed or estimated based on similar foods within the table or from other sources. The variation of data was evaluated for plausibility after assessing correspondence of food component description and data quality. Another approach to decrease the amount of missing values was to presume zero values for some food groups’ specific components e.g. retinol and vitamin B12 in plant foods (in their natural form), dietary fibre in fish and meat and poultry (in their natural form).

Values for proximates (water, protein, fat, available carbohydrate, dietary fibre, ash) are complete for all foods, as they are needed to calculate values for energy and available carbohydrate by difference. Missing values for minerals and vitamins were supplemented whenever possible with compositional data from other sources, mainly from outside of Africa and the scientific literature. Data for some micronutrients and vitamins are still missing, due to lack of reliable data. Iodine and selenium were not included as their values highly depend on soil and feed, although in the previous edition ‘Selected foods from West Africa’ they were included. Among minerals, wide variability was found, in particular for iron values in plant foods. Huge differences among multiple references were observed. The variation of iron values may be due to differences in geographical regions, analytical methods, or can result from contamination with soil or dust (Murphy, Weinberg-Andersson, Neumann, Mulligan, & Calloway, 1991). The variation in the iron values presented in the table is expressed in the standard deviations.

In the West African FCT, efforts were made to increase the quality of the data by including as many as possible analytical data from West African countries, but few data could be found and even less could be included, because of their low quality. Analytical data from West Africa were seldom publicly available and if existing,
analytical methods were obsolete (e.g. crude fibre), data were described or expressed insufficiently or quality assurance was missing (or where not described). Therefore, much of the data in the West African FCT was taken from older FCTs and supplemented with newer data from outside West Africa. Preparation of the West African FCT confirmed the need for West African food composition scientists to generate more high quality analytical data for local foods, including on biodiversity, in order to meet the information needs of many sectors and professional users in these countries.

4. Conclusion

The West Africa FCT is a best practise in terms of partnerships using comparative advantages of the different institutions involved in the process and respond to a real demand for users, for improving nutrition education regarding the challenges of the nutrition transition, critical issue for achieving the Millennium Development goals (MDGs). High quality compositional data are needed for many different areas such as treatment, prevention and research on non-communicable diseases, micro-nutrient deficiencies and obesity. The development of the West African FCT is an initial step to address these issues and it is one of the first tables to include a good proportion of cooked foods and food biodiversity. However, due to the general low quality of available data, activities must be carried out to further develop and improve the table. In future editions traditional recipes and more analytical data on foods, local varieties and cultivars and more components should be included.

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