FAO (1) recommended that protein in foods should be measured as the sum of individual amino acid residues plus free amino acids, that fats should be analysed as fatty acids and expressed as triacylglycerol equivalents, and that carbohydrate should be analysed to determine both available carbohydrate and dietary fibre: direct analysis of available carbohydrate by summation of individual carbohydrate and AOAC 985.29 or a similar method for dietary fibre analysis should be used. Two energy-yielding food components were introduced into the present version of the Japanese food composition tables (Standard Tables of Food Composition in Japan [STFCJ]) published in 2010 (STFCJ 2010) (2): namely protein calculated as the sum of the amino acid residues <PROTCAA> and fat expressed as the triacylglycerol equivalent of fatty acids <FATNLEA>. The new revised version of the STFCJ (STFCJ 2015) and its three supplements, i.e., amino acid tables, fatty acid tables, and available carbohydrate tables, will be available in this fiscal year. The STFCJ 2015 will be a major revision in the history of our tables, because the number of food items will be increased, for the first time in 15 y, to more than 2,100, and available carbohydrate <CHOA VLM> data determined by direct analysis will be included. The aim of the present paper is to share information on issues concerning the energy-yielding macronutrients encountered during the revision with colleagues in the nutrient table/database community. (Note: throughout this paper INFOODS’ tagnames, <TAGNAME>, are used as component identifiers and as abbreviations for components.)

**Protein Calculated as the Sum of Amino Acid Residues <PROTCAA>**

Amino acid composition was determined by the methods described in the STFCJ (3). New analytical data on amino acid composition will be provided for approximately 230 foods, fatty acid composition for approximately 140 foods, and available carbohydrate (starch, glucose, fructose, sucrose, maltose, and lactose) composition for approximately 340 foods. These data will be published separately as three supplements to the STFCJ 2015: amino acid tables, fatty acid tables, and available carbohydrate tables. Available carbohydrate tables will also provide polyol (sorbitol and mannitol) and organic acid (acetic acid, lactic acid, citric acid, etc.) data. In the supplements, amino acid content will be adjusted for protein content calculated as reference nitrogen multiplied by a nitrogen to protein conversion factor, and fatty acid content adjusted for extractable lipid content, as in previous revisions. Available carbohydrate content, however, will be adjusted for water content. Values of protein content calculated as the sum of amino acid residues <PROTCAA>, lipid content expressed as triacylglycerol equivalents of fatty acids <FATNLEA>, and available carbohydrate content <CHOA VLM> will appear in the main tables of the STFCJ 2015. Protein, fat and available carbohydrate contents were significantly decreased when the preferred analytical methods of FAO were applied instead of the acceptable methods. Online publication of Japanese and English versions of these tables, reference materials, and a retrievable food composition database is planned.

**Key Words** amino acid composition, available carbohydrate composition, fatty acid composition, food composition tables, Japan
showed an apparent divergence from the line of equality. The content of PROTCAA was significantly lower than that of PROTRN (Fig. 1); mean difference (d) was 2.27 g/100 g edible portion (EP) and standard deviation of the difference (sd) was 1.91; t-test was significant at the 5% level (t = 20.51, p = 0.000) (n = 299, data from 3). A considerable difference between PROTRN and PROTCAA was found in fish and shellfish because of the probable presence of amines, which are measured as PROTRN in the STFCJ 2010.

**Fat Expressed as Triacylglycerol Equivalent of Fatty Acids <FATNLEA>**

New fatty acid tables will be published as a supplement of the STFCJ 2015. New analytical data on fatty acid composition will be provided for approximately 140 foods in the supplement, and the same number of foods with FATNLEA will be added to the main tables of the STFCJ. In the supplement, fatty acid contents will be adjusted for total fat <FAT> content determined by the methods described in the STFCJ (4).

FATNLEA has an obvious advantage over the gravimetric method, because there is no contribution of non-fat materials in the extracts, which is usually of major concern when fat is measured by gravimetric methods. The following formula was used to convert all individual contents of fatty acid to FATNLEA:

\[
\text{FATNLEA (g)} = \sum \left( \frac{\text{fatty acid (g)} \times (\text{MW} + 12.68)}{\text{MW}} \right)
\]

where MW is the molecular weight of the fatty acid, and 12.68 is the additional formula weight per fatty acid when converting fatty acid to triacylglycerol equivalent. This value is calculated as molecular weight of glycerol (92.09) divided by three, because glycerol binds to three fatty acid in triacylglycerol, and then subtracting the molecular weight of water (18.02), which is lost by ester bond formation.

There was a highly significant correlation between FATNLEA and FAT (r = 0.9977, p < 0.001). FATNLEA was, however, significantly lower than FAT (Fig. 2); d was 1.12 g/100 g EP and sd was 1.47; t-test was significant at the 5% level (t = 26.38, p = 0.000) (n = 1,193, data from 2). This is reasonable because gravimetrically determined fat also contains non-fat components.

**Available Carbohydrate <CHOAVLM>**

Available carbohydrates basically consist of starch (including dextrin and glycogen), monosaccharides (glucose and fructose) and disaccharides (sucrose, maltose and lactose), and these data will be published as an available carbohydrate table, a supplement to the STFCJ 2015. Available carbohydrate composition will be provided for approximately 340 food items in the supplement, and the same number of foods with CHOAVLM will appear in the main tables of the STFCJ 2015.

Starch was determined in accordance with AOAC 996.11 (amyloglucosidase-α-amylase method) after 80% ethanol extraction to remove glucose, maltose, maltooligosaccharides and maltodextrins. Mono- and disaccharides were determined by the combination of several HPLC methods in accordance with the Nutrition Labelling Standards (2003). The available carbohydrate tables will also contain data on polyols (sorbitol and mannitol) and several organic acids. For starch and mono- and disaccharides, individual saccharide content will be tabulated by weight (g) in the supplement, and total available carbohydrate content by monosaccharide equivalent (MSE, g) in the main tables of the STFCJ 2015. Available carbohydrate content will not be adjusted by available carbohydrate content calculated by difference <CHOAVLDF> (total carbohydrate by difference <CHOCDF> minus dietary fibre), but by water content, because the Codex Alimentarius Commission defined dietary fibre (ALINORM 09/32/26 and ALINORM 10/33/26), and our current method for dietary fibre measurement (modified AOAC 985.29) was judged obsolete, and new data acquisition on dietary fibre only for adjustment was deemed inefficient.

Available carbohydrates will be expressed in mono-
saccharide equivalent <CHOAVLM> as in the British, Italian and Greek food composition tables, instead of being expressed in weight <CHOAVL>. This component was chosen because the expression, monosaccharide equivalent (MSE), is reasonable from the viewpoint of energy calculation for available carbohydrates: After ingestion, available di-, oligo- and polysaccharides will be hydrolysed into monosaccharides and metabolised, and so the same weight of di-, oligo- and polysaccharides will produce different amounts of energy. Thus, the content expressed as monosaccharide equivalent is more appropriate than content expressed as the total weight of saccharides. The conversion factor for monosaccharide equivalents of starch will be 1.10 because of international harmonisation (6), although the scientifically correct factor is 1.11.

Our preliminary study showed that the sum of available carbohydrate by direct analysis <CHOAVL> was highly correlated with available carbohydrate calculated by difference <CHOAVLDF> (Fig. 3): d was 2.09 g/100 g EP and sd was 2.25; t-test was significant at the 5% level (t = 5.89, p = 0.000) (n = 40, data from 5). Horizontal line indicates mean difference.

Conclusions

As mentioned, when the energy-yielding macronutrients are analysed by the preferred methods of FAO (1), i.e., PROTCAA, FATNLEA and CHOAVL, the amounts of the components would usually be less than those analysed by the acceptable methods, i.e., PROT, FAT and CHOAVLDF. This means that food energy based on the components determined by the preferred analytical methods tends to be less than that by the acceptable analytical method. This decrease might partly be compensated by the energy of dietary fibre determined by the (modified) AOAC 2009.01 or AOAC 2011.25 because the methods can determine total dietary fibre including resistant starch and non-digestible low-molecular-weight oligosaccharides, which cannot be determined by the modified AOAC 985.29, and by the energy of polyols and organic acids.

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Additional information

The Expert Committee on Food Components is the sole organisation responsible for compiling the STFCJ, and every effort has been made to follow the guidelines presented by FAO/INFOODS unless they were judged to be inappropriate for the circumstances in Japan or for the current scientific standards.


REFERENCES


