Journal of Food Composition and Analysis 25 (2012) 166–172

Contents lists available at SciVerse ScienceDirect

Journal of Food Composition and Analysis

journal homepage: www.elsevier.com/locate/jfca

Original Article

Carotenoid and retinol composition of South Asian foods commonly consumed in the UK

Santosh Khokhar [a,*], Mark Roe [b], Gillian Swan [c]

[a] School of Food Science & Nutrition, University of Leeds, Leeds, UK
[b] Institute of Food Research, Norwich, NR4 7UA, UK
[c] Diet and Nutrition Surveys Team, Nutrition Division, Food Standards Agency, London, UK

ARTICLE INFO

Article history:
Received 25 November 2011
Accepted 27 November 2011
Available online 14 December 2011

Keywords:
Retinol
Carotenoids
β-Carotene
Lutein
Lycopene
Zeaxanthin
Cryptoxanthin
South Asian foods and Indian foods
Food data management
Food composition databank
Food analysis
Food composition

ABSTRACT

The main aim of this study was to provide new and reliable food composition data on carotenoids and retinol in South Asian Foods for the United Kingdom's national database. A total of 38 commonly consumed foods were analysed using HPLC and accredited methods of analyses. *Palak paneer* (spinach and soft Indian cheese) contained the highest levels of β-carotene (4066 μg/100 g) followed by *gajjeralla* (carrot based sweet, 2324 μg/100 g) and *saag* (mixed green leafy vegetables), which contained 1514 μg/100 g, whilst retinol was present in only a few foods, with *ghee* being the major source (968 μg/100 g). Meat dishes contained higher amounts of lycopene (up to 1140 μg/100 g in chicken *balti*) than vegetable or dhal dishes (highest in *palak paneer* 317 μg/100 g), because of larger quantities of tomatoes used in meat curries. A variety of ethnic vegetables (green leafy vegetables and other coloured vegetables), namely legumes/dhal, tomatoes and coriander, were identified to be the major ingredients containing carotenoids. These new data can be used in future diet and nutrition surveys, as well as to identify carotenoid-rich foods for dietary programs.

1. Introduction

Over 600 carotenoids have been identified, of which 40–50 are typically consumed in the human diet (Rao and Rao, 2007). Of these, β-carotene, lutein, lycopene, zeaxanthin and retinol have been the subject of most studies (Johnson, 2002). Different carotenoids have been postulated to exhibit various beneficial effects on health. Several studies have reported carotenoids to exert protective effects against chronic diseases such as type 2 diabetes (Akbaraly et al., 2008; Martini et al., 2010), certain cancers, including lung cancer (Fairfield and Fletcher, 2002; Calvo, 2005), cardiovascular diseases (Krinsky and Johnson, 2005; Reddy et al., 2003; Voutilainen et al., 2006; Ribaya-Mercado and Blumberg, 2004; Gilgun-Sherki et al., 2004) and carotid atherosclerosis (Riccioni et al., 2010). Lutein, zeaxanthin and retinol, which also act as antioxidants, have been mainly associated with protection against age-related macular degeneration and eye diseases (Van der Berg et al., 2000; Marres-Perlman et al., 2002; Krinsky et al., 2003; Mozaffarieh et al., 2003).

However, the *Alpha-Tocopherol, β Carotene Cancer Prevention Study* (Heinonen and Albanes,1994) showed no beneficial effect of dietary supplementation of β-carotene (20 mg/day, with and without vitamin E) in the prevention of lung cancer in men living in Finland. Similarly, a large-scale, randomised trial among healthy men showed no benefit or harm due after 12 years of β-carotene supplementation for malignant neoplasms, cardiovascular diseases, or death. On the contrary, a recently published study (Larsson et al., 2010) on breast cancer (a population-based cohort, 36,664 women, questionnaire completed in 1997) suggested an inverse association between alpha- and β-carotene and the risk of breast cancer among smokers and among those who did use dietary supplements.

Reliable food composition data are essential for provision of dietary guidelines and advice, as well as for identification of sources of these nutrients. Consumption of both authentic and modified South Asian ethnic foods in the UK has increased considerably over the last decade. Indian foods accounted for about 25% of value sales in the UK food market in 2006 (Leatherhead Food International, 2007) and UK sales of Indian foods were worth £494 million in 2007 (Mintel, 2007) due to the growing number of

* Corresponding author at: School of Food Science & Nutrition, University of Leeds, LS2 9JT, UK. Tel.: +44 1133432975; fax: +44 1133432982.
E-mail address: s.khokhar@food.leeds.ac.uk (S. Khokhar).

0889-1575/$ – see front matter
doi:10.1016/j.jfca.2011.11.005

migrant population (a 30% increase between 1990 and 2000 (Office for National Statistics, 2004) and the popularity of these ethnic foods among mainstream consumers). Ethnic groups form a significant part of the population with South Asians (people from the Indian sub-continents) being the largest minority group in the United Kingdom, UK (representing 4% of the total UK population). Similarly, ethnic foods have become very popular in Europe over the last decade as a result of several factors including globalisation of food supply chain and an increasing taste for exotic foods. The ethnic food market in Western Europe was estimated to be around €4.12 billion during 2006 (Leatherhead Food International, 2007).

Therefore, the increased consumption of these ethnic foods will affect the dietary intake of nutrients, including carotenoids. Additionally, the heterogeneity of ethnic groups, differences in food preparation practices and lack of current compositional data severely inhibit effective interventions and limit the provision of dietary advice to such populations, which are frequently at higher risk of diet-related diseases (Field et al., 2001; Steinberger and Daniels, 2003; Forouhi et al., 2005; Gillies et al., 2007; Gilbert and Khokhar, 2008). In the absence of data on food composition of South Asian diets in the UK, including carotenoids, it has not been possible to generate accurate information on dietary intake of carotenoids from these foods. For the first time, the current study reports new analytical data on β-carotene, lutein, lycopene, zeaxanthin, cryptoxanthin and retinol in South Asian foods using accredited methods of analyses.

2. Materials and methods

Data presented in this paper were generated using harmonised procedures reported by Khokhar et al. (2009) including all the aspects of identification of representative foods and key nutrients, sampling, accredited methods of analysis and quality assurance.

2.1. Identification and prioritisation of foods

A total of 38 foods (27 authentic and 11 modified ethnic foods) selected for their importance as major food sources of carotenoids in the diet, were collected. A list of foods was prioritised according to the criteria defined by Khokhar et al. (2009). Commonly consumed authentic and modified South Asian foods were identified from national food consumption surveys (including National Diet and Nutrition Survey, NDNS), information from major food retailers, manufacturers (including ethnic food manufacturers), ethnic food shops, restaurants and data from existing literature (research papers and books) as well as market reports (Mintel, 2005, 2006). Foods that have already been analysed and reported in Immigrant Foods (Tan et al., 1985) or McCance and Widdowson's (2002) food composition table for the UK, were removed. The foods were then grouped into 12 categories and food descriptions (Table 1) were prepared from information available in the ingredients list on the packaging, and from the volunteers who provided the home-cooked food samples. Non-vegetarian dishes were also of interest because these generally contain tomatoes, peppers, other vegetables and coriander which are rich in carotenoids. Due to the nature of this study and the requirement for composite sampling, information on the exact quantities of individual ingredients including herbs and spices was not available for home-cooked foods but only a list of ingredients.

2.2. Food collection and sampling

Modified South Asian food samples were collected from supermarkets, restaurants and takeaways whilst the authentic foods were either home-made or purchased from ethnic food shops and South Asian cafés/restaurants. Once collected, samples were stored in cold food storage (−20 °C and or 4 °C as required), in the School of Food Science & Nutrition at the University of Leeds. Samples were stored up to 5 days to produce composite sample and were analysed for nutrients within a month of their collection. A total 45 nutrients were analysed in these foods including retinol and carotenoids. The macronutrient composition of UK ethnic foods has been published (Khokhar et al., 2010) and compositional data on other key nutrients will be published elsewhere.

Modified ethnic food. One sample of each food (retail brand) from a standard range (excluding "luxury" or "best value" brands) was collected from each of the supermarkets. Samples of manufacturers' brands, which are also sold at these outlets, were also obtained. The samples collected from supermarkets reflect the distribution of food products throughout the UK as well as variations in the composition of ingredients sourced from different countries and regions. The composite sample represented 10–12 different supermarkets and manufacturer brands for each food. Modified samples from popular restaurants and takeaways were also collected from 4 locations in the UK (Birmingham, Bradford, Leeds and London); 3–4 samples from each location were included in the composite sample to represent variations in recipe and minor ingredients used in these regions. Number and sources of samples are presented in Table 1.

Authentic ethnic foods. Composite samples were prepared from 5 primary samples reflecting variations in minor ingredients in household recipes from the different South Asian households (Punjabis, Gujaratis, Hindus and Pakistanis) in Leeds and London. Each homemade food sample was prepared in five different households (5 primary samples). Commonly consumed sweets and cakes were collected from 9 different ethnic food shops, sweet centres and corner shops in Leeds and London. Selected foods which are often consumed in South Asian restaurants and cafés were also collected and added to the respective composite sample.

2.3. Preparation of composite samples

To ensure that all the samples were in edible form, pre-prepared foods were cooked in the laboratory according to the instruction on the package. Such samples were generally chilled or frozen foods from supermarkets. Primary samples were homogenised (Food Homogeniser, model Silverson L4R) and equal weights of these were mixed together to produce one composite sample (2 kg). From the composite sample, two sub-samples (500 g) were taken; one for analysis and one stored frozen (−20 °C) at the School of Food Science & Nutrition at the University of Leeds for confirmation, if required. The composite samples were placed in polystyrene boxes in close proximity to dry ice to ensure that they remained frozen or chilled before being transported to the analytical laboratory in a refrigerated van. *Ghee* was transported in a cardboard box surrounded by bubble wrap. Prior to analysis, samples were thawed, homogenised and stored refrigerated.

2.4. Analysis and quality control

Retinol content was determined by HPLC using the reference method BS EN 12823-1:2000 "Foodstuffs – Determination of vitamin A by high performance liquid chromatography, Part 1: Measurement of all-*trans*-retinol and 13-*cis*-retinol". Carotenoids were determined by HPLC, reference method BS EN 12823-2:2000, "Foodstuffs – Determination of vitamin A by high performance liquid chromatography, Part 2: Measurement of beta-carotene".

For retinol analysis, all samples were saponified using ethanolic potassium hydroxide solution and extracted three times with hexane:ethylacetate (85:15 v/v). The determination was carried out by reverse phase HPLC (Vydac C18 column, 250 × 4.6 mm, 5 μm) with fluorescence detection (excitation wavelength 325/