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A mixed mushroom control material to facilitate inter-laboratory harmonization of mushroom composition analyses

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ABSTRACT

A wide range of nutrients and health-promoting non-nutrient components in mushrooms are a subject of international research, but specific reference materials to facilitate comparison of results among laboratories are lacking. Commercially available food matrix reference materials do not contain components unique to mushrooms (e.g., ergosterol, vitamin D_2, chitin, beta-glucans, agaritine, ergothioneine). A mixed mushroom control material (CM) (homogeneous mixture of 15 types of mushrooms) was prepared and characterized for selected components, including proximates (moisture, protein, ash), total folate, folate vitamers, ergosterol, ergosterol metabolites, vitamin D_2 (ergocalciferol), amino acids, total dietary fiber, agaritine, elements (sodium, potassium, phosphorous, magnesium, calcium, iron, copper, manganese, zinc), riboflavin, niacin, thiamin, vitamin B6, pantothenic acid. Subsamples of the CM are available to qualified laboratories from the Food Analysis Laboratory Control Center at Virginia Tech (Blacksburg, VA, USA), to be assayed concurrently with mushroom samples for which food composition data will be published along with results for the CM. Implementation of this CM should facilitate comparison of published data on mushroom composition and health benefit among species, and biodiversity within species by serving as common control sample that allows the separation of analytical variability from true differences in sample composition determined at different laboratories.

1. Introduction

Mushrooms are a rich source of nutrients and other health-promoting components, including (but not limited to) vitamin D_2 (ergocalciferol), ergosterol, beta-glucans, and chitin [Australian Mushroom Growers Association (AMGA), 2012; Chandra et al., 2011; Dikeman et al., 2005; Dubost et al., 2006, 2007; Koyyalamudi et al., 2009a,b; Mallavadhani et al., 2006; Roupas et al., 2012; Smiderle et al., 2011]. Numerous species of mushrooms are consumed worldwide, and the composition and health benefits of mushrooms and their isolated components are active areas of research (see, for example AMGA, 2012; Chang and Wasser, 2012;

Abbreviations: AMGA, Australian Mushroom Growers Association; CM, control material; DW, dry weight; FALCC, Food Analysis Laboratory Control Center; NFNAP, National Food and Nutrient Analysis Program; UV, ultraviolet light; RM, reference material; RSD, relative standard deviation; SD, standard deviation; USDA, United States Department of Agriculture.

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Griensven, 2011; Guillamón et al., 2010; Jeong et al., 2010; Peterson et al., 2011; Ren et al., 2012; Rop et al., 2009). A search of "mushroom composition analysis" revealed 909 publications in 2014 alone, in journals indexed by ScienceDirect (SciVerse, 2015). In the *Journal of Food Composition and Analysis*, 45 articles on mushrooms were published from 2010 through 2014.

As with other foods the potential for significant variability in composition of different samples of mushrooms exists, even within the same species, due to the effects of growing conditions, post-harvest handling, and other factors (Choi et al., 2006; Mattila et al., 1999; Roberts et al., 2008; Tiwari and Cummins, 2013). For example, intentional and incidental ultraviolet light (UV) exposure increases vitamin D_2 in mushrooms (Jasinghe and Perera, 2006; Phillips et al., 2011a; Roberts et al., 2008; Simon et al., 2011; Teichmann et al., 2007), as well as other potentially bioactive components (Kalaras et al., 2012; Phillips et al., 2012). UV is also used in some cases to reduce the microbial load and prolong the shelf life and food safety of mushrooms (Guan et al., 2012), further contributing to the possible sources of variability in the composition of specific samples of a given mushroom species in the retail market. Changes in composition or variation in results based on differences in analytical methods (e.g., recovery, detection methods, calibration) can also yield different results for the very same sample assayed at different laboratories. However, comparing diverse reports on the nutrient and non-nutrient content of mushroom species and biodiversity within and among species is challenging, because the reports come from different laboratories, without the ability to quantify the contribution of analytical variability.

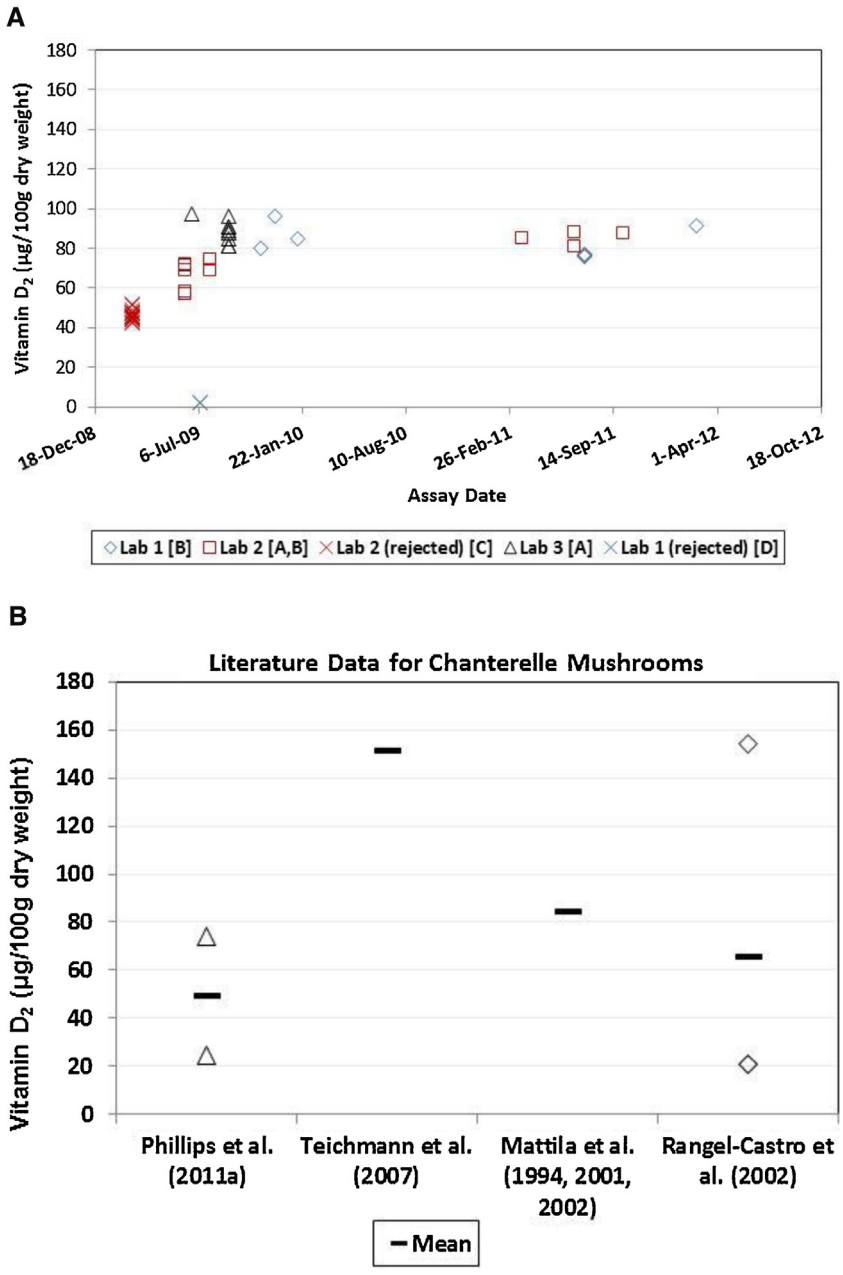

Fig. 1. Vitamin D_2 assayed in the same control sample (composite of ultraviolet light-treated and untreated portabella mushrooms) at three laboratories (A), and vitamin D_2 concentrations for different samples of chanterelle mushroom samples assayed in different laboratories, as reported in the literature (B). Labs for which the mean of all observations differ significantly ($\alpha < 0.05$) in panel A are indicated by different capital letters in the legend (Phillips et al., 2011a; Teichmann et al., 2007; Mattila et al., 1994, 2001, 2002; Rangel-Castro et al., 2002).