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Plant-Based Foods as a Source of Lipotropes for Human Nutrition: A Survey of In Vivo Studies

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Increased consumption of plant products is associated with lower chronic disease prevalence. This is attributed to the great diversity of healthy phytochemicals present in these foods. The most investigated physiological effects have been their antioxidant, anti-carcinogenic, hypolipidemic, and hypoglycemic properties. Although less studied in humans, some compounds were very early on shown to be lipotropic in animals, i.e., the capacity to hasten the removal of fat from liver and/or reduce hepatic lipid synthesis or deposits by mainly increasing phospholipid synthesis via the transmethylation pathway for triglyceride-rich lipoprotein exportation from the liver and enhanced fatty acid β-oxidation and/or down- and up-regulation of genes involved in lipogenic and fatty acid oxidation enzyme synthesis, respectively. The main plant lipotropes are choline, betaine, myo-inositol, methionine, and carnitine. Magnesium, niacin, pantothenate, and folates also indirectly support the overall lipotropic effect. The exhaustive review of rat studies investigating phytochemical effect on hepatic lipid metabolism suggests that some fatty acids, acetic acid, melatonin, phytic acid, some fiber compounds, oligofructose, resistant starch, some phenolic acids, flavonoids, lignans, stilbenes, curcumin, saponins, coumarin, some plant extracts, and some solid foods may be lipotropic. However, this remains to be confirmed in humans, for whom intervention studies are practically non-existent. Supplemental materials are available for this article. Go to the publisher's online edition of Critical Reviews in Food Science and Nutrition® to view the free supplemental file.

Keywords Phytochemicals, lipotropes, hepatic steatosis, humans, rats

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INTRODUCTION

Plant-based foods (PBF) are a rich source of bioactive compounds with various physiological effects, many of which remain unknown. The most well-known phytochemicals are fiber compounds, vitamins, minerals, trace elements, carotenoids, and polyphenolic compounds. Their health protective effects have been uncovered in both animal and humans, e.g., their ability to counteract increased oxidative stress, hyperlipidemia, hyperglycemia, carcinogen formation, and/or enhanced inflammation. All of these dysregulated metabolic mechanisms are generally found in major chronic illnesses.

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In addition to obesity, diabetes, cancer, and cardiovascular diseases (CVD), one major but less well-studied human health concern is liver steatosis, which can lead to more severe chronic liver diseases such as fibrosis, steatohepatitis, cirrhosis, and cancer. Stricto sensu, liver steatosis is characterized by excess triglyceride (TG) deposits. Liver steatosis may also be found in several chronic diseases or metabolic disorders, such as obesity (Riquelme et al., 2009), type 2 diabetes (Speliotes et al., 2010), and metabolic syndrome (York et al., 2009). It has been estimated that in 2000, more than 30 million Americans may have suffered from steatosis (Angulo, 2002). In 2003, Neuschwander-Tetri and Caldwell reported that "20 to 30% of adults in the USA and other western countries have excess fat accumulation in the liver" (2003, p. 1202), which is rather surprisingly high.

Therefore, the capacity of foods, notably PBFs, to prevent hepatic steatosis development is undoubtedly of the utmost interest within the context of preventive nutrition and public research. However, this issue has only been minimally studied in humans,