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Nutrition Research 25 (2005) 995–1003

NUTRITION RESEARCH

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Ground chia seed and chia oil effects on plasma lipids and fatty acids in the rat

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Received 5 May 2005; revised 17 August 2005; accepted 14 September 2005

Abstract

There is considerable evidence suggesting that regular consumption of ω-3 fatty acids prevents cardiovascular diseases, including atherosclerosis and thrombosis. Most studies, however, have been carried out with fish oils that are rich in eicosapentaenoic acid and docosahexaenoic acid fatty acids, but α–linolenic fatty acid, which is a precursor of eicosapentaenoic acid and docosahexaenoic acid, has received little attention. The purpose of the present study was to assess the effect chia seed, which is the highest known vegetative source of α–linolenic fatty acid, has on plasma total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein, triacylglycerol content, and fatty acid profile when fed to rats. Twenty-four male Wistar rats were fed ad libitum 3 diets containing equal energy levels derived from corn oil (T_1), chia seed (T_2), or chia oil (T_3) for 4 weeks. At the end of the feeding period, 6 rats from each treatment were used for blood analyses. Blood samples were analyzed for total cholesterol, HDL, low-density lipoprotein, triacylglycerol content, and fatty acid composition. Rats fed chia showed a significant decrease in serum triacylglycerol content, 3 and 2.5 times lower than the control for T_2 and T_3, respectively. There was a significant increase in serum HDL cholesterol content, 21.8% and 51% for T_2 and T_3, respectively, with the increase between chia diets being significant ($P < .05$). Total cholesterol was significantly lower for the T_2 diet compared with the T_3 diet. Serum fatty acid composition showed a significantly higher α–linolenic acid content and an improved ratio of ω-6/ω-3 fatty acids for T_2 and T_3 compared with T_1. In summary, the chia diets dramatically decreased triacylglycerol levels and increased HDL cholesterol and ω-3 fatty acid contents in rat serum. These findings suggest that α-linolenic–rich chia oil may be an alternative to ω-3 sources for vegetarians and people allergic to fish and fish products.

Keywords: Chia; Fatty acids; Linolenic; Rats; ω-3; Cholesterol

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doi:10.1016/j.nutres.2005.09.013

1. Introduction

Coronary heart disease (CHD) is the single most common cause of death in the United States, the United Kingdom, and other Western industrialized countries [1]. There is a consensus among scientists that dietary changes during the last century, which have included an increased intake of total lipids and saturated and polyunsaturated ω-6 fatty acids, have led to the high incidence of CHD [2,3].

There is increasing evidence from animal, epidemiological, and clinical studies that consuming lipids rich in ω-3 fatty acids is important in reducing CHD [4,5]. Early evidence of this appeared in the late 1970s from epidemiological studies conducted in populations consuming large quantities of fish that are rich in the very long polyunsaturated ω-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). At that time, it was generalized that the ω-3 α–linolenic acid was only a precursor of the long-chain fatty acids EPA and DHA, hence the reason for setting a low α-linolenic requirement [6]. Results from a number of recent epidemiological and controlled studies on α–linolenic acid in humans and animals suggest that this fatty acid has an important role for ω-3 status. These studies show that the consumption of α–linolenic acid is important, and it may reduce the risk for cardiovascular diseases [7-12].

Chia, along with corn, beans, and amaranth, was a core component in the diet of many pre-Columbian civilizations in America, including the Mayan and Aztec populations [13]. Chia contains the richest botanical source of α–linolenic acid known but does not contain any of the antinutritional compounds (total linamarin, linustatin, and neolinustatin) and vitamin B_6 antagonist factors [14-16], which are found in flax [17-19]. Flax is the most common source of α–linolenic acid commercially available; however, its antinutritional factors have significantly limited its use as a food or feed [20-24].

Chia seed was used successfully to increase the ω-3 content of eggs, poultry meat, and cow's milk; however, the effect of chia seed or its oil on serum lipids has not been reported. The objective of the present study was to compare the effect of equivalent dietary intakes of α–linolenic acid from chia seed and oil on serum total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), triacylglycerol content, and fatty acid composition when fed to rats.

2. Methods and materials

2.1. Animals

Male Wistar rats, 4 weeks of age, were obtained from the Department of Nutrition vivarium in the School of Pharmacy and Biochemistry at the University of Buenos Aires, Argentina. The rats weighed 35 to 48 g at the beginning of the trial and were randomized into 3 groups containing 6 rats each, such that mean body weight per group was approximately equal. The animals were housed individually in stainless steel cages and maintained at 21°C ± 1°C with a 12-hour light/dark cycle. Water and food were available ad libitum. Each group of rats was fed an assigned diet for 4 weeks; during that period, food consumption and body weights were recorded. At the end of the experimental period, after a 4-hour fast, body weights were recorded. Animals were anesthetized with ethyl ether and exsanguinated by