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ORIGINAL ARTICLE

Hypolipidemic effect of fat spreads containing flaxseed oil

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Abstract The hypolipidemic effect of fat spreads containing flaxseed oil (rich plant source of long-chain omega-3 polyunsaturated fatty acid) represents the aim of the present study. Such effect was biologically evaluated through assessment of four biochemical parameters that reflect the blood serum lipid profile, namely total cholesterol, low- and high-density lipoproteins and triglyceride levels during a feeding experiment for 8 successive weeks using male albino rats. Eight fat spreads containing 20%, 40%, 60% and 80% total fat were used; of these, four spreads were formulated using palm and flaxseed oils while the other four treatments were prepared by palm and soybean oils at the same concentrations. Results showed that fat spreads containing flaxseed oil exerted reducing effect on total cholesterol, LDL levels, TC/HDL and LDL/HDL ratios at higher rates compared with those containing soybean oil or pharmaceutical product especially after 8 weeks of feeding experiment. Levels of HDL in animals administered the studied fat spreads were lowered at significant to insignificant different rates. Flaxseed oil exerted its beneficial effect when it was incorporated into formulation at high amounts since G6 (FPB3, containing 29.5% flaxseed oil) and G8 (FPB4, containing 39% flaxseed oil) animal groups exerted higher/comparative levels of HDL after 8 weeks of feeding compared to the initial concentration. Concerning triglycerides levels, all studied groups (except G8, FPB4) and controls showed significant higher levels at the end of feeding experiment compared to initial concentration. On the other hand, animals received the highest% of flaxseed oil (G8, FPB4) exerted its healthy effect as triglycerides levels were decreased from 104.3 mg/dL at zero time to 92.7 mg/dL after 4 weeks of feeding with decreasing rate of 11.1%, another reducing effect was noted after 8 weeks as triglycerides levels were significantly decreased to 79.7 mg/dL (decreasing rate of 23.6%).

Introduction

Hyperlipidemia, also known as hyperlipoproteinemia or dyslipidemia, is an abnormal elevation of lipid levels in the blood stream. These lipids include cholesterol, cholesterol

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compounds, phospholipids and triglycerides, all carried in blood as large molecules called lipoproteins. There are three types of hyperlipidemia namely hyperlipoproteinemia (elevated levels of lipoprotein in blood), hypercholesterolemia (high cholesterol) and hypertriglyceridemia (high triglycerides level in blood). Hyperlipidemia affects lipid production, transportation in blood stream and/or deposition in body cell (Carrero et al., 2004; Sies et al., 2005).

Increased consumer awareness of diet and health has resulted in higher demand for functional foods. In fat spreads market, two trends are emerging, i.e. enrichment with omega-3 fatty acids and the reduction in trans fatty acids (TFAs). However, there are currently significant technical gaps in the effective delivery of both omega-3 fatty acids and spreads which are genuinely low in trans fatty acids (Timon, 2010). The spread fat industry is working diligently in creating new varieties of spread fats that will produce more healthful fat.

Intake of high amounts of TFAs has been positively correlated with increased risk of coronary heart disease, inflammation, and cancer (Pande and Akoh, 2013). The major dietary sources of TFAs are products formulated with partially hydrogenated fats such as margarines, shortenings, bakery products, and fast foods (Wahle and James, 1993; Willet et al., 1993). The oils rich in polyunsaturated fatty acids (PUFAs) cause a decrease in "bad" cholesterol and triglycerides concentrations. Also, the omega-3 (ω-3) fatty acids (such as linolenic acid) in oils can increase the level of circulating good cholesterol (Khan et al., 2010).

Ng et al. (1992) and Choudry et al. (1995) declared that palm olein and olive oil have similar beneficial cholesterol modulating effects in protecting humans against cardiovascular diseases. Palm olein (rich in both fatty acids $C_{16:0}$ and $C_{18:1}$ represents about 40% and 43% of total fatty acids, respectively) and olive oil (rich in $C_{18:1}$ fatty acids, about 77% of total fatty acids) have comparable effects on total cholesterol, low- and high-density lipoproteins cholesterol (LDL and HDL) as well as LDL/HDL ratio.

Omega 3-fatty acids have a high nutritional status, its consumption has been reported by Tou et al. (2011) to improve health by reducing the risk of cardiovascular disease, obesity, diabetes, inflammation, and several neurological diseases. But their use in food products is limited due to their susceptibility to lipid oxidation (Choo et al., 2007). Also, fish oil (as source of omega-3) incorporation into fat spreads (especially at high %) resulted in increasingly fishy flavor and decreased sensory quality (Kolanowski et al., 2004).

Lipid flaxseed composition makes it an important source of omega 3 fatty acids, especially α-linolenic acid (ALA) which may constitute up to 52% (Gutiérrez et al., 2010) and 59.02% (El-Waseif et al., 2013) of the total fatty acids. Morris (2006) stated that flaxseed oil is a potentially vegetable important source of omega-3 as it is relatively stable to oxidation compared to fish oils.

Consumption of food products (such as fat spreads) enriched with flaxseed oil as a source of omega-3 PUFA represents an easy delivery system of such fatty acids into the human body and significantly improves the level and profile of PUFA in the diet and in human body tissues. In addition, Grune et al. (2001) and Grundt et al. (2003) demonstrated that the bioavailability of omega-3 from enriched intake was comparable with the bioavailability of the acids from capsule supplements.

As recommended by the American Heart Association, beneficial health effects could be gained for people with high triglycerides (blood fat) when they were supplemented with 1.5–3 g of flaxseed oil per day, the increased use of omega ω-3 fatty acids is a powerful example of one such nutritional therapeutic strategy that may produce significant cardiovascular benefits (Kris-Etherton et al., 2003; Rodriguez et al., 2010).

The present study was designed to evaluate the effect of oral ingestion of edible spreadable fats containing flaxseed oil (at four different concentrations) on blood serum lipid profile. Four parameter levels, namely total cholesterol, HDL, LDL and triglycerides during feeding experiment for 8 weeks using albino rats, were measured.

Materials and methods

Materials

Refined, bleached and deodorized palm and soybean oils were obtained from Arma Food Industries, 10th of Ramadan City, Egypt. Flaxseeds (*Linum usitatissimum* L.), variety Sakha 1, free from garden cress and weed seeds were obtained from Fiber Crops Research Section, Field Crops Research Institute, Agriculture Research Center, Giza, Egypt. Other materials used as additives including stabilizers (corn starch, sodium alginate and whey protein powder); emulsifying agents (skimmed milk powder, soybean lecithin and glycerol monostearate); antioxidant (ascorbyl palmitate); preservative (potassium sorbate) and flavor (butter flavor) were used in formulation of fat spreads.

Methods

Extraction of flaxseed oil

Flaxseed oil was extracted from crushed seeds using a hydraulic press (10,000 Lb/inch^2 for 1 h at room temperature) as described by Ustun et al. (1990). The resultant oil was filtered through a fine cloth, filled in dark brown bottles and stored at deep freezing temperature (−18 °C) until use.

Preparation of fat spreads

Eight fat spreads (blends) containing 20%, 40%, 60% and 80% total fat were formulated, according to procedures of Cheng et al. (2008) and Lumor et al. (2010) with minor modifications. El-Waseif et al. (2013), in previous work, described the details of formulation procedure followed. Four treatments were formulated using palm and flaxseed oils, the other four treatments contained palm and soybean oils (as a control treatments).

Biochemical experiment

Animals and negative control treatment

Sixty-six adults male albino rats (body weight 120–140 g); obtained from the farm of National Organization for Drug Control and Research, Giza, Egypt; were housed in screen bottomed aluminum cages in rooms maintained at 25 ± 1 °C with alternating cycles of light and dark of 12 h duration. The rats were fed on the control diet basal diet (composed of; g/100 g diet; casein 10.0, cotton seed oil 5.0, salt mixture 4.0, vitamin mixture 1.0 and maize starch as carbohydrate source, 80.0).