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Acute differential effects of dietary protein quality on postprandial lipemia in obese non-diabetic subjects

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ARTICLE INFO

Article history:
Received 17 June 2012
Revised 28 October 2012
Accepted 2 November 2012

Keywords:
Obesity
Postprandial lipemia
Triglyceride
Atherosclerosis
Dietary protein
Cross-over

ABSTRACT

Non-fasting triglyceridemia is much closer associated to cardiovascular risk compared to fasting triglyceridemia. We hypothesized that there would be acute differential effects of four common dietary proteins (cod protein, whey isolate, gluten, and casein) on postprandial lipemia in obese non-diabetic subjects. To test the hypothesis we conducted a randomized, acute clinical intervention study with crossover design. We supplemented a fat rich mixed meal with one of four dietary proteins i.e. cod protein, whey protein, gluten or casein. Eleven obese non-diabetic subjects (age: 40-68, body mass index: 30.3-42.0 kg/m^2) participated and blood samples were drawn in the 8-h postprandial period. Supplementation of a fat rich mixed meal with whey protein caused lower postprandial lipemia (P = .048) compared to supplementation with cod protein and gluten. This was primarily due to lower triglyceride concentration in the chylomicron rich fraction (P = .0293). Thus, we have demonstrated acute differential effects on postprandial metabolism of four dietary proteins supplemented to a fat rich mixed meal in obese non-diabetic subjects. Supplementation with whey protein caused lower postprandial lipemia compared to supplementation with cod and gluten. As postprandial lipemia is closely correlated to cardiovascular disease, long-term dietary supplementation with whey protein may prove beneficial in preventing cardiovascular disease in obese non-diabetic subjects.

1. Introduction

Obesity is escalating at epidemic proportions worldwide [1]. The consequences of obesity are substantial. Obesity amplifies the risks of cardiovascular disease (CVD) [2,3] and type 2 diabetes and is associated with reduced average life expectancy [4].

Obesity-related comorbidities include silent risk factors such as insulin resistance, hypertension and dyslipidemia [5]. Dyslipidemia related to obesity is characterized by low levels of high density lipoprotein (HDL) particles, small and dense

Abbreviations: BMI, Body mass index; Cas-meal, Casein meal; CVD, Cardiovascular disease; iAUC, Incremental area under the curve; GIP, Glucose-dependent insulinotropic peptide; GLP-1, Glucagon-like peptide 1; Glu-meal, Gluten meal; HDL, High density lipoproteins; I-tg, Infranatant triglycerides; LDL, Low density lipoproteins; NEFA, Non-esterified free fatty acids; PPL, Postprandial lipemia; P-tg, Plasma triglycerides; RP, Retinyl palmitate; S-tg, Supernatant triglycerides; T2DM, Type-2 diabetes mellitus.

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0271-5317/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.nutres.2012.11.004

low-density lipoprotein particles and hypertriglyceridemia [5]. Traditionally, the presence of hypertriglyceridemia has been evaluated based on blood samples drawn in the fasting state. However, recently it has been demonstrated that CVD is much stronger associated to non-fasting triglyceridemia–postprandial lipemia (PPL) [6–8]. An exaggerated PPL response in both increment and duration is observed in obese subjects compared to lean subjects [9–11].

The magnitude of PPL is primarily correlated to the diet in general and fat content of meals in particular [12]. The addition of refined carbohydrates to a fat rich meal increases PPL in type-2 diabetic subjects (T2DM) [13]. However, a similar increase is not observed in healthy subjects [14,15]. Addition of casein to the meal appears to reduce the unfavorable influence of carbohydrate on PPL in T2DM [13,15], while casein added to a fat rich meal without carbohydrate do not further reduce PPL compared to the fat rich meal per se in T2DM [13].

Nilsson [16] showed that different types of dietary protein have divergent insulinotropic effects in healthy subjects. It appears that dietary proteins have differential impact on postprandial lipid and carbohydrate metabolism, probably in part due to different insulinotropic effects. Thus, Mortensen [17] recently demonstrated that whey protein reduces PPL in T2DM compared to casein, gluten and cod protein. Furthermore, Akhaven [18] found lower postprandial glycaemia in young, healthy adults following premeal consumption of whey protein. Frid [19] showed similar postprandial glucose lowering effects of whey supplementation in T2DM. Regarding PPL in obese non-diabetic subjects van Wijk [10] demonstrated that daylong triglyceridemia is comparable between T2DM and obese non-diabetics but higher than in lean subjects. It is noteworthy that Halkes [20] found that lean men have higher daylong triglyceridemia than lean women while no gender differences were found in overweight subjects. While high dietary protein intake impairs glucose metabolism mainly by changing the utilization of gluconeogenic precursors [21,22] we do not know how dietary protein influences PPL in obese non-diabetic subjects.

We hypothesize that there are acute differential effects of four common dietary proteins (cod protein, whey isolate, gluten and casein) on postprandial plasma triglyceride load in obese non-diabetic subjects. As whey protein is particularly insulinotropic we expect to find reduced postprandial plasma triglyceride load following a fat rich meal supplemented with whey isolate compared to the three other dietary proteins. To test this hypothesis we performed primary analyses of a randomized crossover design in which 8 postmenopausal women and 3 men consumed each of the four fat rich protein supplemented meals. Reduction of postprandial triglyceride concentrations by dietary means may serve as a convenient lifestyle measure for reducing CVD risk.

2. Methods and materials

2.1. Subjects

Eleven obese white subjects (8 postmenopausal women and 3 men) were recruited after advertising in local newspapers. All subjects had a body mass index (BMI) above 30 and all subjects were non-diabetics according to fasting plasma glucose <7.0 mmol/L. Subjects with impaired fasting glucose were subjected to an oral glucose tolerance test and were excluded if the 2-hour plasma glucose level was ≥11.1 mmol/L. Hyperlipidemic subjects were allowed in the study. No participant took lipid lowering drugs and all participants were non-smokers. No change in concomitant medication was allowed during the trial. Subject characteristics are shown in Table 1. All subjects gave written informed consent and the study was approved by The Committees on Biomedical Research Ethics for the Central Region of Denmark. Clinicaltrials.gov (ID: NCT00863564).

2.2. Study design

We performed a randomized acute clinical intervention study. All subjects ingested four different meals on four different days with a washout period of 2 weeks between meals. Each subject was randomized to 1 of 4 meal sequences obtained according to a Latin square. Before each test day the subjects were given and consumed a standard diet with the following energy distribution: 56 E% carbohydrate, 24 E% fat and 20 E% protein. The energy content was 7000 kJ for women and 9000 kJ for men. All subjects were asked to refrain from alcohol consumption and exercise in the 24 hours preceding the test day. In the morning after a 12-hour fasting period the test meal was served and ingested within 20 min. During the 8-hour postprandial period the subjects were allowed to drink tap water ad libitum. Blood samples were drawn in the 8-hour postprandial period. Insulin, glucagon like peptide 1 (GLP-1), glucose-dependent insulinotropic peptide (GIP) and glucose were measured at 0, 15, 30, 45, 60, 120, 240, 360, and 480 minutes. Glucagon was measured at 0, 30, 60, 120, 240, 360, and 480 minutes. Nonesterified free fatty acids (NEFA) were measured at 0, 60, 120, 240, 360, and 480 minutes. Triglycerides and retinyl palmitate (RP) were measured at 0, 120, 240, 360, 420, and 480 minutes. Plasma was separated immediately by centrifugation at 2000*g* for 20 min at 4°C. Plasma samples were stored at –80°C until analyzed.

Table 1 – Clinical characteristics of the 11 (8 women and 3 men) obese non-diabetic subjects [1]

Age (y)	55.2 ± 9.4 (40-68)
Weight (kg)	100.9 ± 13.8 (79.0-120.9)
BMI (kg/m^2)	33.9 ± 3.4 (30.3-42.0)
Waist (cm)	111.4 ± 6.8 (102-121)
♂	118.7 ± 2.1 (117-121)
♀	108.6 ± 5.7 (102-117)
Waist-to-hip ratio	0.92 ± 0.07 (0.83-1.08)
♂	1.01 ± 0.06 (0.98-1.08)
♀	0.89 ± 0.03 (0.83-0.92)
HbA_{1c} (%)	5.8 ± 0.4 (5.3-6.5)
HOMA2 (IR)	1.3 ± 0.5 (0.3-2.0)
Fasting plasma glucose (mmol/L)	5.9 ± 0.4 (5.3-6.6)
Fasting plasma triglyceride (mmol/L)	2.0 ± 0.8 (0.7-3.1)

[1] All values are means ± SD; range in parentheses.