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Postprandial Bioactivity of Spread Cheese, Enhanced with Mountain Tea and Orange Peel Extract, in Healthy Volunteers. A Pilot Study †

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Abstract: Postprandial lipemia, glycemia and oxidative stress may affect the outcome of cardiovascular disease. It has been investigated that the enhancement of spread cheese with mountain tea *(Sideritis sp.)* and orange peel extract, may reduce postprandial metabolic biomarkers in healthy volunteers. The purpose of the present pilot study was the investigation of possible postprandial bioactivity of such a spread cheese. In the framework of cross-over design, 9 healthy volunteers 20–30 years old, consumed a meal, rich in fat and carbohydrates (80 g white bread, 40 g butter and 30 g full fat spread cheese). After a week washout period the same volunteers consumed the same meal with the spread cheese, enhanced with 6% mountain tea-dried orange peel extract. Blood sampling took place before, 1.5, 3 and 5 h after meal consumption. Total plasma antioxidant capacity, serum lipids, glucose, uric acid and anticoagulant activity were measured for each instant. There was a statistically significant increase in the antioxidant capacity of plasma, 3h after the meal consumption in the presence of cheese enhanced with extract, compared to the consumption of conventional cheese ($p < 0.05$). There was a tendency to decrease the rise rate of glucose and triglycerides, 1.5h after eating the meal with extract. The remaining biomarkers did not show statistically significant differences ($p > 0.05$). More studies in a larger sample are needed to draw safer conclusions about the effect of extract on metabolic biomarkers, such as oxidative stress, lipemia and glycemia.

Keywords: postprandial bioactivity; bioactive compounds enhanced cheese; orange peel extract; mountain tea extract; metabolic biomarkers

1. Introduction

The dynamic period, which includes metabolic processes after a digestion and absorption, is described as the postprandial state. Prolonged and excessive metabolic (lipemia, glycemia) and oxidative imbalance that can occur after a meal is called "Postprandial oxidative stress" [1]. Scientific evidence suggests that postprandial lipemia, glycemia and oxidative stress may promote cell dysfunction and affect the outcome of cardiovascular disease (CVD) [2,3]. The sudden increase in plasma glucose and triglycerides, after meals, are reported as activators of endothelial cell inflammation. Furthermore, oxidative stress is a promotive factor in the effect of metabolic stress on

vascular dysfunction and the formation of inflammation. Macronutrients in the consumed meal influence postprandial responses [4].

The term "functional foods" first appeared in Japan when, in 1984, the country's scientific community defined functional foods as performing three basic functions: meeting nutritional needs, sensing satisfaction and having a beneficial effect on the human body. By "functional" we mean foods, processed or not, which have been proven, based on scientific studies, that due to their bioactive constituents they contribute to the achievement of specific functional goals within the body, contributing to health promotion. Examples of functional ingredients in foods are carotenoids, probiotics and polyphenols [5]. It has been reported that mountain tea (*Sideritis sp.*) and orange peel (fruit by-product), as natural functional foods, contain bioactive compounds with possible beneficial effects on serum lipids and glucose levels, as well as on plasma total antioxidant activity [6,7].

Given the fact that the consumption of a meal, rich in fat and carbohydrates, could promote oxidative stress and postprandial lipemia and glycaemia, it has been investigated that the enhancement of a spread cheese with natural bio-functional foods, such as mountain tea (*Sideritis sp.*) and orange peel extract, may reduce postprandial metabolic biomarkers in healthy volunteers [8].

The purpose of this study was the investigation of possible postprandial bioactivity of a spread cheese, enhanced with mountain tea-orange peel extract.

2. Materials and Methods

In this randomized, cross-over design study, pilot, intervention study, 9 healthy volunteers 20-30 years old, were consumed a meal rich in fat and carbohydrates, (2 slices-80 g of white bread, spread with 40 g of butter and 30 g of full fat spread cheese (control meal). After a week washout period, the same volunteers consumed the same meal contained instead of the control cheese, a novel spread cheese enhanced with 6% mountain tea and dried orange peel extract (intervention meal). Blood sampling was performed, before and 1.5, 3 and 5 h after meal. The total antioxidant capacity (FRAP assay) [3], serum lipids [Total, HDL-, LDL- cholesterol and triglycerides], glucose and uric acid were measured using a Roche Cobas c111 biochemical analyzer, while anticoagulant activity were also determined for each instant [7].

The study protocol was approved by the Ethics committee of University of the Aegean and the study performed in accordance with the Declaration of Helsinki. All the participants signed an informed consent form and informed about the prime target of this study, the confidentiality of data and the voluntary nature of participation. All participants were initially screened by using a medical history questionnaire that also included demographic characteristics, level of physical activity and consumption of foods rich in polyphenols the last period. Furthermore, anthropometric measurements took place.

Preparation of the novel spread cheese

The extract prepared adding 3 g of mountain tea and 3 g of dried orange peel to 100 ml of boiling water, and then remaining for 5 min for the extractions of the bioactive compounds. Filtration of the extract was followed by filter paper. The mountain tea-orange peel extract contained 49.9 μg gallic acid/ml total phenolics (Folin-ciocalteu method) and appeared total antioxidant capacity 34.67 μmol Fe_2SO_4/ml (FRAP method). The functional spread cheese was prepared adding 6ml of mountain tea-orange peel extract to 94 g cheese, followed by mixture homogenization.

3. Results and Discussion

The basic result os the study was that a statistically significant increase was observed in the total antioxidant capacity of plasma 3h after the consumption of the intrevention meal (enhanced cheese with mountain tea-orange peel extract), compared to the consumption of the control meal (control cheese) ($p < 0.05$). Furthermore, there was a decrease tendency of glucose increase rate and triglycerides 1.5 h after the consumption of the intervention meal. The remaining biomarkers did not show statistically significant differences ($p > 0.05$).

These findings suggest that the enhancement of a spread cheese with mountain tea and orange peel extract may be beneficial on plasma antioxidant capacity, attenuating possible postprandial oxidative stress. The phenolic compounds metabolites may also affect the postpradial levels of serum triglycerides and glucose levels. Nevertheless, this was a pilot study; thus the extention of the study with more participants could lead to safer conclusions.

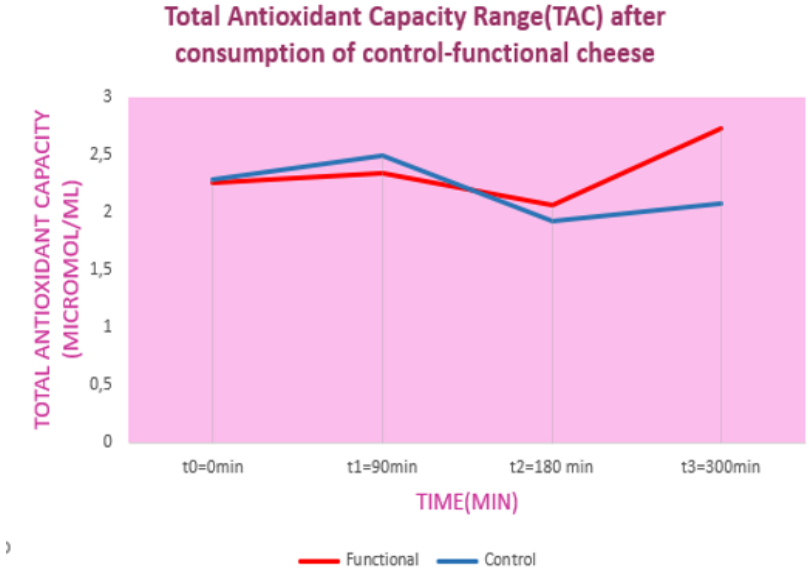

Figure 1. Value range curves for total antioxidant capacity of volunteer plasma, after consuming control and functional, spreadable cheese, respectively.

4. Conclusions

The present study showed a possible effect of natural bioactive compounds on postprantial plasma antioxidant capacity. Clinical trials are continuing and expanding in a larger sample of the population, in order to draw safer conclusions about the effect of extracton postprandial biomarkers of oxidative stress, lipemia and glycemia, factors that significantly affect the risk of cardiovascular disease(CVD).

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "conceptualization, X.X. and Y.Y.; methodology, X.X.; software, X.X.; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing—original draft preparation, X.X.; writing—review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y.", please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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