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File: ■ Cocoa (*Theobroma cacao*, Malvaceae)

■ Lycopene
■ Blood Pressure
■ Lipids

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RE: Lycopene-containing Dark Chocolate Lowers Blood Pressure and Some Lipid Levels in Subjects with Prehypertension

Petyaev IM, Dovgalevsky PY, Chalyk NE, Klochkov V, Kyle NH. Reduction in blood pressure and serum lipids by lycosome formulation of dark chocolate and lycopene in prehypertension. *Food Sci Nutr.* 2014;2(6):744-750.

Oxidative stress, with the subsequent accumulation of reactive oxygen species, is one of the known causes of the development of atherosclerosis and why antioxidants are often used to prevent and treat cardiovascular disease. Epidemiological and clinical studies suggest that the antioxidants, specifically flavanols and alkaloids, found in cocoa (*Theobroma cacao*, Malvaceae) may be used to prevent and treat cardiovascular disease. The goal of this randomized, controlled, blinded study was to determine the effects of a lycopene-containing formulation of dark chocolate on blood pressure and serum lipids in clinically healthy subjects with prehypertension.

The study was conducted by Lycotec Ltd at the Institute of Cardiology, the Ministry of Health of the Russian Federation in Saratov, Russia. Thirty-four Caucasian male and female subjects were chosen, having met the following inclusion criteria: 45-70 years old, a sustained resting systolic blood pressure (SBP) of 130-139 mmHg and diastolic blood pressure (DBP) of 80-90 mmHg, and elevated total serum cholesterol (200-250 mg/dL). The subjects were not taking any antihypertensive, lipid-lowering, or other cardiovascular drugs and had no other serious medical conditions. Smokers were allowed. Five subjects did not complete the trial because of dark chocolate intolerance or for non-health-related reasons.

The subjects were randomly assigned into 1 of the following 3 groups: the dark chocolate group (DC; n=10), consuming regular dark chocolate; the dark chocolate plus lycopene group (DC+LC; n=10), consuming regular dark chocolate bars and lycopene capsules; and the L-tug™ (Lycotec Ltd; Cambridge, United Kingdom) group (n=9), consuming L-tug composite chocolate bars containing lycopene.

All groups used dark chocolate bars (30 g) with 85% cocoa (Green & Black's Organic; East Hanover, New Jersey). L-tug is a proprietary lycosome formulation of dark chocolate with enhanced bioavailability of cocoa flavanols. Each 30 g L-tug chocolate bar contains 7 mg lycopene. The lycopene used in the capsules and in the L-tug chocolate (Lycocred Inc;

Orange, New Jersey) was derived from tomato (*Lycopersicon esculentum*, Solanaceae) oleoresin and contained 97% of *trans*-isomers and 3% of *cis*-isomers. Each lycopene capsule used by the DC+LC group contained 7 mg lycopene.

All subjects were asked to refrain from consuming cocoa- and tomato-based products for 10 days leading up to the start of the study. Subjects ingested 1 chocolate bar daily after the main meal for 4 weeks. Those in the DC+LC group also ingested 1 lycopene capsule at the same time. Clinical examinations and blood draws were done at baseline, day 14, and end of study. No statistically significant differences were seen in age, gender, body mass index, smoking status, blood pressure, pulse rate, lipid profile, or blood glucose levels of the subjects. At the end of 28 days, all subjects in all groups had a statistically significant reduction in systemic blood pressure ($P < 0.05$). A more significant reduction in DBP was seen in the L-tug group compared with the DC group (-6.22 mmHg, $P < 0.05$) and the DC+LC group (-3.00 mmHg, $P < 0.05$). As for SBP, all groups experienced a statistically significant reduction when comparing posttreatment measures with baseline measures ($P < 0.05$). Between-group differences at the end of 28 days were not significant.

Total cholesterol levels decreased after 2 weeks in the L-tug group and remained lower at the end of the study (-41 mg/dL). In the DC and DC+LC groups, total cholesterol levels remained unchanged. Compared with baseline low-density lipoprotein cholesterol (LDL-C) levels, post-trial levels were not significantly changed in the DC and DC+LC groups. Those in the L-tug group, however, experienced a significant reduction in LDL-C at the end of 28 days compared with baseline values, and a reduction in triglyceride levels at 14 and 28 days compared with baseline ($P < 0.05$ for all reductions). No changes in triglyceride levels were seen in the DC or DC+LC group. High-density lipoprotein cholesterol, C-reactive protein, and glucose concentration levels did not change in any group throughout the trial.

While all groups consumed a similar amount of dark chocolate, the L-tug formulation of dark chocolate caused the greatest decrease in systemic blood pressure. But this lipid-lowering effect occurred in a time-dependent manner, first appearing after 2 weeks of daily consumption. Consuming dark chocolate and lycopene as 2 separate nutraceuticals was not sufficient in producing any positive changes in serum lipid levels. The authors attribute the observed lipid-lowering ability of L-tug dark chocolate to an improved bioavailability of cocoa-derived bioactive compounds.

The authors note several limitations of the study, including the small sample size and lack of understanding of the dose-dependent nature of L-tug, and suggest that further *in vivo* and *in vitro* studies are needed. Despite this, the authors feel their findings show "that daily intake of lycopene-containing (L-tug) lycosome formulation of dark chocolate by healthy prehypertensive individuals ... reduces the systemic blood pressure, as well as the total cholesterol and triglycerides"

Two authors are employees of Lycotec Ltd, the manufacturer of L-tug; Petyaev is the CEO, and Kyle is a senior scientist.

—*Shari Henson*

Referenced article can be accessed at <http://onlinelibrary.wiley.com/doi/10.1002/fsn3.169/epdf>.

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