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# Metabolic effects of amino acid mixtures and whey protein in healthy subjects: studies using glucose-equivalent drinks<sup>1, 2, 3</sup>

Mikael Nilsson, Jens J Holst and Inger ME Björck

<sup>1</sup> From the Division of Applied Nutrition and Food Chemistry, Lund University, Lund, Sweden (MN and IMEB), and the Department of Medical Physiology, The Panum Institute, University of Copenhagen, Copenhagen, Denmark (JJH)

**Background:** Milk protein, in particular the whey fraction, has been shown to display insulinotropic properties in healthy persons and persons with type 2 diabetes. In parallel to the hyperinsulinemia, a pronounced postprandial rise of certain amino acids and of glucose-dependent insulinotropic polypeptide (GIP) was observed in plasma.

**Objective:** The objective of the study was to determine to what extent the insulinotropic properties of whey could be simulated by specific amino acid mixtures.

**Design:** Twelve healthy volunteers were served drinks consisting of pure glucose (reference drink) or glucose supplemented with free amino acids or whey proteins (test drinks).

**Results:** A test drink with the branched-chain amino acids isoleucine, leucine, and valine resulted in significantly higher insulin responses than did the glucose reference. A drink containing glucose and leucine, isoleucine, valine, lysine, and threonine mimicked the glycemic and insulinemic responses seen after whey ingestion. With consumption of this drink, the glucose area under the curve (AUC) was 44% smaller ( $P < 0.05$ ) and the insulin AUC was 31% larger (NS) than with consumption of the reference drink. With consumption of the whey drink, the AUCs were 56% smaller (glucose;  $P < 0.05$ ) and 60% larger (insulin;  $P < 0.05$ ), respectively, than with the reference drink. The whey drink was accompanied by an 80% greater GIP response ( $P < 0.05$ ), whereas the drinks containing free amino acids did not significantly affect GIP secretion.

**Conclusion:** A mixture of leucine, isoleucine, valine, lysine, and threonine resulted in glycemic and insulinemic responses closely mimicking those seen after whey ingestion in the absence of an additional effect of GIP and glucagon-like peptide 1.

**Key Words:** Milk • whey • blood glucose • serum insulin • hyperinsulinemia • amino acids • incretin hormones

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