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Acute Consumption of Very Low Carbohydrate Meals Lowers Postprandial Concentrations of Glucose, Insulin, Leptin, and Ghrelin

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Introduction

Low carbohydrate (LC) diets are popular because they produce quick and often greater weight loss than more traditional low fat, high complex carbohydrate (HC) diets. Persons following LC diets also report "food disinterest" that may contribute to reduced food intake and greater weight loss. Changes in neuroendocrine hormones involved in weight regulation could help explain this heightened response compared to other weight reduction diets.

This study used a random-order crossover design to test the hypothesis that acute consumption of LC meals leads to lower postprandial concentrations and total area under the curve (AUC) for glucose, insulin, leptin, and total ghrelin, and different patterns of change in concentration over time for all analytes than HC meals.

Methods

10 healthy, normal weight adults completed two 4-day controlled dietary phases with at least a 3-day washout period between visits. Subjects consumed a standard diet for 3 days (51% carbohydrate, 35% fat, 14% protein) and LC or HC meals providing 10 kcal/kg body weight on day 4. All study related procedures were performed at the Oregon Clinical & Translational Research Institute at OHSU.

Glucose concentrations were measured in plasma using a colormetric assay. Insulin concentrations were measured in serum using a chemiluminescent immunoassay on an automated immulite system. Leptin concentrations were measured in serum using an immunoradiometric assay (IRMA). Total ghrelin concentrations were measured in plasma using a radioimmunoassay (RIA).

Total AUC as well as AUC for the period after each meal was calculated for each analyte using the trapezoidal method. Differences in AUC between the two meals were compared using one sided paired t-tests. Pattern of postprandial change in concentrations over time were analyzed using orthogonal polynomials (up to order 4). Components of the polynomials were compared between meals using a Wilcoxon signed-rank test. Repeated measures analysis of variance (ANOVA) was used to test for differences between meals at selected time points. A p-value of <0.05 was considered statistically significant and data analyses were performed using STATA (version 10.0; StataCorp LP, College Station, Texas).

Results

Table 1. Subject Characteristics*

Sex	**4 male 6 Female**
Age (yr)	**25 3**
BMI (kg/m²)	**23 2**
% Body Fat	**24 5**

*Mean SD

Figure 1. Nutrient Composition of Test Meals

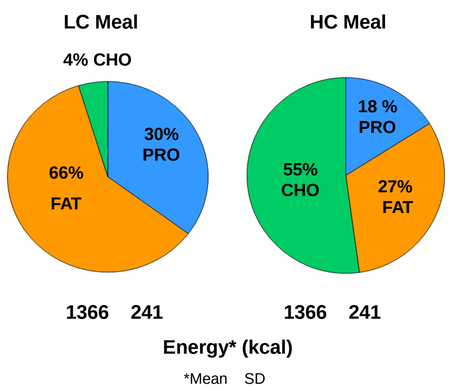

Figure 2. Postprandial Change in Glucose Concentration

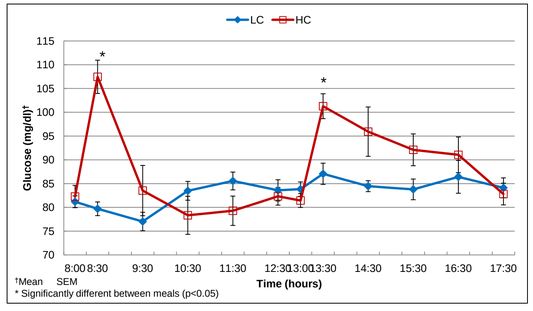

Figure 3. Postprandial Change in Insulin Concentration

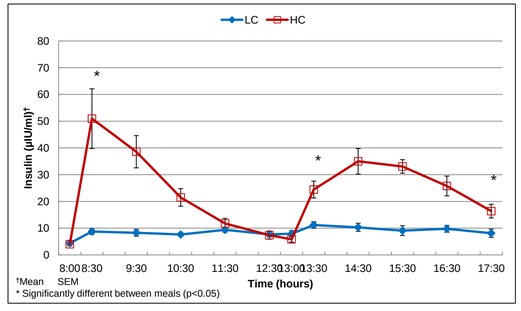

Figure 4. Postprandial Change in Leptin Concentration

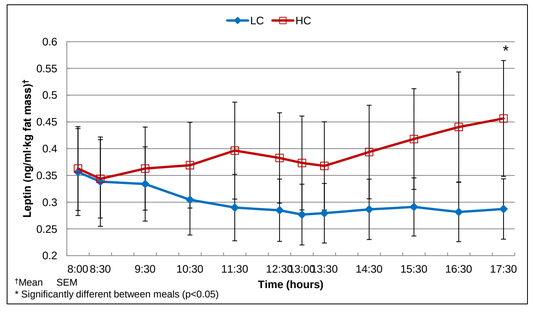

Figure 5. Postprandial Change in Total Ghrelin Concentration

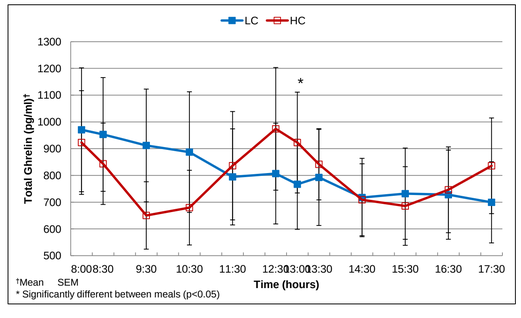

Table 2. Area Under the Curve

Analyte	AUC 1 (0800-1300)			AUC 2 (1300-1730)			Total AUC		
	LC	HC	Δ	LC	HC	Δ	LC	HC	Δ
Glucose (mg·h/dl)	410 ± 7	425 ± 13	-15 ± 14	425 ± 8	457 ± 12	-32 ± 16*	793 ± 13	841 ± 20	-48 ± 26*
Insulin (μIU·h/ml)	41 ± 4	118 ± 12	-77 ± 11†	47 ± 7	125 ± 13	-78 ± 8†	84 ± 10	240 ± 23	-156 ± 16†
Leptin (ng·h/ml·kg fat mass)	1.6 ± 0.33	1.9 ± 0.41	-0.30 ± 0.16*	1.4 ± 0.28	2.0 ± 0.46	-0.62 ± 0.23†	2.8 ± 0.58	3.7 ± 0.83	-0.87 ± 0.36*
Total Ghrelin (pg·h/ml)	4739 ± 1101	4422 ± 921	-317 ± 228	3313 ± 734	3409 ± 677	-96 ± 124	7662 ± 1746	7391 ± 1517	-270 ± 333

Mean ± SEM; LC (low carbohydrate); HC (high carbohydrate); Δ (AUC_{LC} – AUC_{HC})
*Significantly different between meals (p<0.05); †Significantly different between meals (p<0.01)

Table 3. Polynomial Analysis

Component	Glucose		Insulin		Leptin		Total Ghrelin	
	LC	HC	LC	HC	LC	HC	LC	HC
Linear (x)	6 ± 7*	1 ± 11	3 ± 4	-3 ± 16	-0.7 ± 0.1*	0.1 ± 0.1*	-300 ± 73*	-48 ± 82
Quadratic (x^2)	-3 ± 7	3 ± 8	-2 ± 2†	8 ± 11	0.05 ± 0.05†	0.03 ± 0.04†	68 ± 99	-18 ± 52
Cubic (x^3)	-1 ± 4	-16 ± 14†	-0.14 ± 2	-5 ± 8	-0.01 ± 0.03	0.02 ± 0.03	5 ± 83	-35 ± 96
Quartic (x^4)	3 ± 6	-7 ± 8*	-2 ± 2*	-35 ± 13†	-0.01 ± 0.03	-0.004 ± 0.03	-16 ± 51	297 ± 208*

Mean ± SD; LC (low carbohydrate); HC (high carbohydrate)
*Significant contribution to the curve (p<0.05)
†Significant contribution to the curve (p<0.01)

Conclusions

- AUCs were significantly lower for insulin, leptin, and glucose after LC compared to HC meals
- Postprandial patterns of change were significantly different across all analytes after LC compared to HC meals

Significance

- Consumption of LC meals decreased concentrations of neuroendocrine hormones associated with weight regulation.
- These findings are consistent with the previously reported food disinterest, decrease in energy intake, and greater weight loss associated with LC diets
- Further research is needed to determine the long term effects of consumption of LC diets on markers of weight regulation.

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