SLENDESTA® POTATO EXTRACT PROMOTES SATIETY IN HEALTHY HUMAN SUBJECTS: IOWA STATE UNIVERSITY STUDY

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KEY CONCLUSIONS

Ingestion of Slendesta® Potato Extract 60 minutes prior to a meal:

- *Induced a greater degree of fullness and decreased motivation to eat.*
- *Lowered post-meal plasma glucose levels.*
- *Raised pre-meal CCK levels and sustained a higher post-meal CCK level for a longer period of time.*
- *Elevated CCK levels could contribute to the earlier onset of satiety and lowering of post-meal glucose levels.*

INTRODUCTION

Excessive calorie intake and insufficient physical activities have been identified as key factors causing overweight and obesity. Reduction of calorie intake via appetite control is a key element for effective weight management. One means of controlling appetite is to maintain a feeling of satiety, or the absence of hunger. An enhanced level of satiety can produce a feeling of fullness for a longer period of time between meals and limit the amount of food consumed within individual meals, thereby promoting weight loss.

Cholecystokinin (CCK) is one of several known peptide hormones involved in satiety and food intake regulation in humans. Increased CCK levels have been shown to inhibit gastric emptying, suppress appetite and reduce food intake (1,2). Unfortunately, CCK cannot be administered orally because it is a protein molecule and can be rapidly broken down by proteinases in the digestive tract.

Slendesta® Potato Extract (Slendesta) is a satiety aid ingredient introduced by Kemin Foods that has been shown capable of inducing satiety, the feeling of fullness, in humans. Slendesta is standardized to contain 5% potato proteinase inhibitors (PI2). PI2 has been shown to enhance the release of intestinal CCK and delay gastric emptying in type 2 diabetic patients (3) and to reduce energy intake in healthy subjects (4), when used at high doses (gram levels). More importantly, Slendesta can be orally administered to humans. This report summarizes results of a clinical study that supports PI2 at a dose of 15 to 30 mg, supplied by Slendesta (300 to 600 mg Slendesta Potato Extract 5% Powder*), as effective in promoting satiety in healthy humans. These results are consistent with the conclusion that ingestion of PI2 supplied by Slendesta 60 minutes before a meal induces satiety by affecting post-prandial CCK.

STUDY DESIGN

This study was a randomized, placebo-controlled, double-blind study carried out at Iowa State University, Ames, Iowa. Healthy female subjects between 18-55 years of age and with a BMI of 19-29 kg/m^2 were scheduled for a total of three visits. Subjects were exclusively female to reduce inter-gender variability. There is no scientific evidence that CCK release stimulated by PI2 is different in men and women and there is little reason to believe that results in females would not be applicable to men. Upon arrival at the test center after overnight fasting, blood was drawn from each subject for measuring fasting blood glucose and CCK levels. The subjects randomly consumed placebo,

* 300 to 600 mg Slendesta Potato Extract 5% Powder in capsule form (Satise®) provided 15 to 30 mg PI2.

15 mg or 30 mg PI2 (0, 300, or 600 mg Slendesta Potato Extract 5% Powder) 60 minutes before eating a 390 Kcal breakfast. Blood samples were taken from each subject right before the breakfast meal (Time 0), and at 30, 60, 90, 120 and 180 minutes after the meal. Post-meal appetite and satiety were rated using the Visual Analogue Scale (VAS), a reproducible method to assess sensations of appetite and motivation to eat (5).

RESULTS

Satiety and hunger ratings

The first satiety measure was "How Strong is Your Desire to Eat?" (**Figure 1A**). At 120 minutes post-meal, PI2 treatments significantly decreased the subjects' desire to eat (p = 0.0258 for 15 mg and p = 0.0335 for 30 mg). In response to the question, "How hungry do you feel?" hunger appeared to be more intense with placebo than PI2 treatments (**Figure 1B**, p = 0.0669 with 30 mg PI2 treatment at 180 minutes post-meal). When asked, "How full do you feel?" (**Figure 1C**), a significantly greater fullness was rated with PI2 treatments in a dose-dependent manner over the 3-hour post-meal period (p = 0.0367). Statistically significant improvements in fullness were observed for 15 mg at 120 minutes (p =0.0338), and for 30 mg at both 120 and 180 minutes (p = 0.0065 and 0.0107, respectively). The last satiety measure, "How much food do you think you could eat?" (**Figure 1D**), evaluating prospective food consumption (PFC) showed a decrease across placebo, 15 mg, and 30 mg treatments with differences between PI2 and placebo treatments being greatest at 120 minutes post- meal (p = 0.0563 for 15 mg; p = 0.0102 for 30 mg). In summary, a low dose of PI2 (15 to 30 mg) consumed 60 minutes prior to a meal was capable of promoting a greater extent of fullness, attenuating the feeling of hunger and desire to eat, and reducing estimated prospective food consumption in healthy humans. This effect appears to be dose-dependent and most prominent at 120 minutes post-meal.

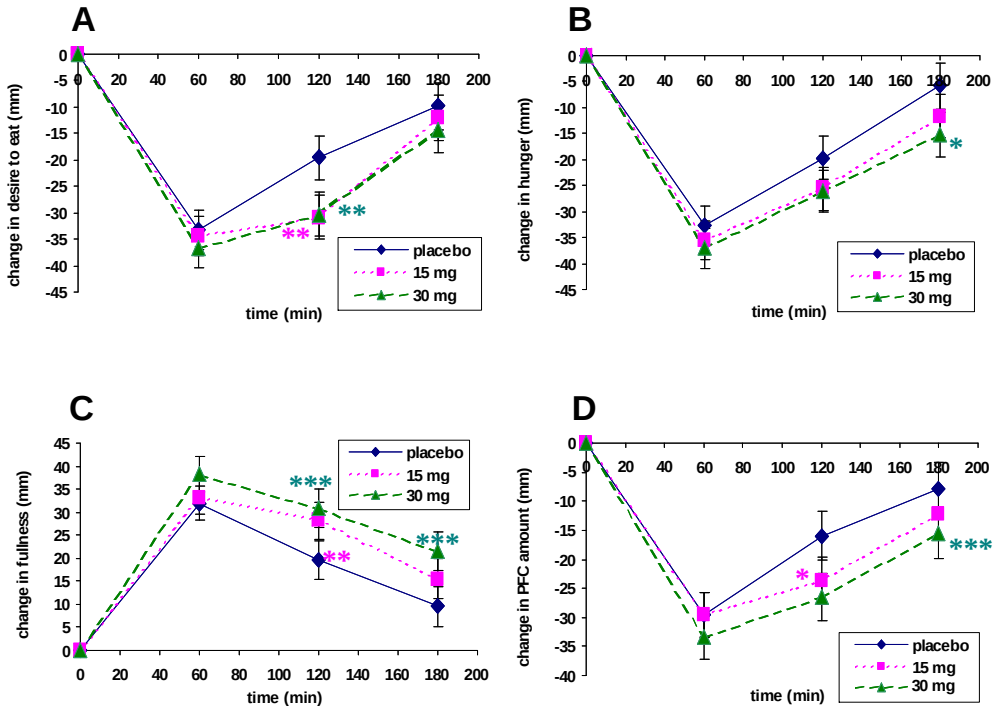

Figure 1. Mean changes in post-prandial satiety from pre-meal baseline with consumption of placebo, 15 or 30 mg PI2 (0, 300, or 600 mg Slendesta Potato Extract 5% Powder*). **(A)** Desire to eat (0 = very strong, -100 = very weak); **(B)** Hunger (0 = as hungry as ever felt, -100 = not at all hungry); **(C)** Fullness (0 = not at all full, 100 = very full); **(D)** Prospective food consumption (0 = large amount, -100 = nothing at all). Significant difference between PI2 treatments vs. placebo: * P<0.1; ** P<0.05; ***P<0.01.

Cholecystokinin (CCK)

Ingestion of PI2 before a meal led to a moderate elevation in plasma CCK levels. The average fasting CCK level was 0.45 ± 0.87 pM in the subjects. Pre-meal CCK levels measured 60 minutes after treatment but before the meal were 0.41 ± 0.13 and 0.59 ± 0.18 pM for placebo and 30 mg PI2, respectively ($p = 0.0825$). This moderate elevation in pre-meal CCK level may contribute to the earlier onset of satiety sensed by the subjects as small changes in CCK can significantly affect subjective satiety (6).

The effect of PI2 on post-prandial concentrations of CCK is illustrated in **Figure 2**. CCK increased within 90 min after the meal and then decreased at 120 to 180 min. Post-prandial CCK levels were higher with PI2 treatments than the placebo. Fifteen mg PI2 treatment raised post-prandial CCK by 34% at 60 minutes ($p = 0.0159$) and by 20% at 120 minutes ($p = 0.0933$).

The data demonstrate for the first time that 15 to 30 mg of PI2 can sustain a higher post-prandial CCK level for a longer period of time. Relatively high doses of PI2 were shown to increase post-prandial CCK in humans in previous studies (3,7). The 20 to 34% increase in CCK associated with 15 mg PI2 treatment was physiologically significant in promoting satiety since every 1% increase in CCK level has previously been correlated to a 0.45-mm decline in the VAS ratings of hunger and desire to eat, and a 0.5-mm increase in the rating of fullness (3). The observed increase in CCK was in agreement with the increase of VAS scores by 10 mm for desire to eat, fullness, and prospective food consumption (**Figure 1**).

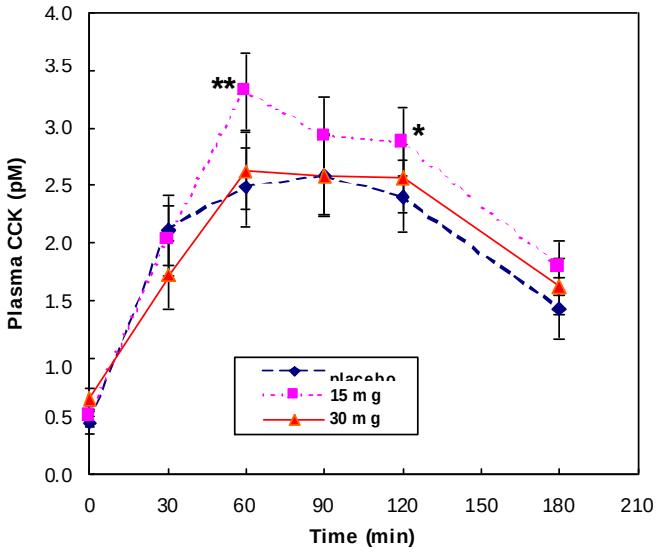

Figure 2. Post-prandial plasma CCK over 3 hours in 45 subjects who consumed placebo, 15 mg or 30 mg PI2 (0, 300, or 600 mg Slendesta Potato Extract 5% Powder*) 60 min before the meal. CCK levels at the 15 mg dose were significantly different from the placebo (* $P<0.1$; ** $P<0.05$).

Glucose

No difference was detected between the overnight fasting glucose levels and the pre-meal glucose level (T = 0 minute), indicating that PI2 ingestion had no apparent impact on fasting glucose level. Thirty mg PI2 treatment resulted in a 28% decrease ($p = 0.0277$) in the area under the curve (AUC) for post-prandial glucose from 0-90 min (**Figure 3**). Glucose $AUC_{0\text{-}120}$ and $AU_{C0\text{-}180}$ for both 15 and 30 mg PI2 were also lower than the corresponding AUC values for placebo although the differences did not reach statistical significance. The glucose lowering effect of PI2 was observed in a dose-

dependent manner. These data suggest that PI2 was effective in lowering overall glucose spikes post meal particularly for the first 90 minutes. Post-prandial glucose levels can be influenced by both insulin response to a meal and the rate of gastric emptying (8). The PI2-induced elevation of CCK levels at 60 and 120 minutes post-meal (**Figure 2**) could result in a delayed gastric emptying effect and reduced post-prandial glucose levels.

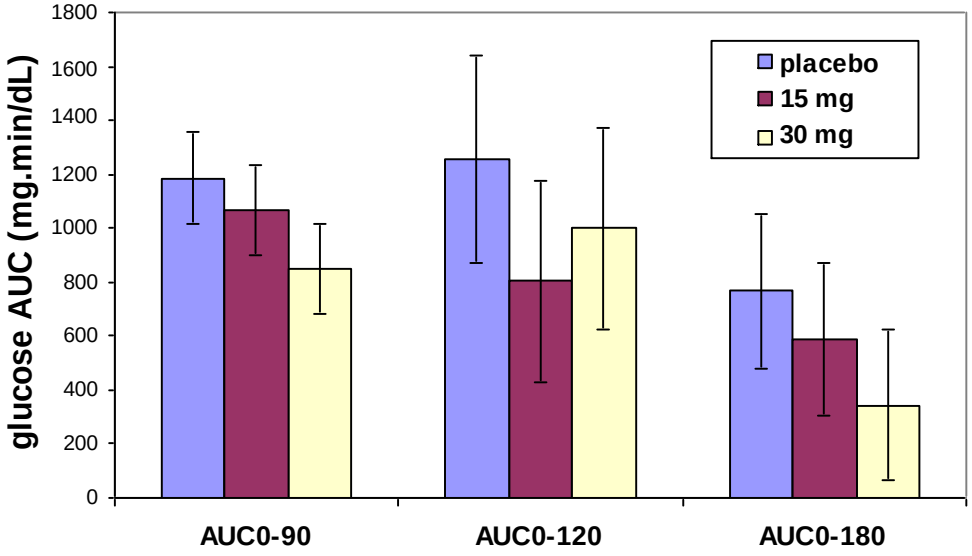

Figure 3. Post-prandial plasma glucose AUC at 0-90min, 0-120min and 0-180 min. AUC was significantly different from the placebo ($P<0.05$).

CONCLUSION

Consumption of 15 or 30 mg PI2 (300 or 600 mg Slendesta Potato Extract 5% Powder) prior to a meal induced a significantly greater degree of fullness and decreased the motivation to eat. PI2, supplied by Slendesta, significantly lowered post-meal glucose levels and a dose-response effect of PI2 was present. These effects of PI2 are consistent with its ability to affect circulating plasma CCK, as observed in the elevated CCK levels at 60 and 120 minutes post-meal. Therefore, Slendesta Potato Extract can be considered an effective agent to promote weight loss and weight effective adjunct to diet and exercise programs.