SUN-LB028

Effect of bread containing high level of resistant starch on glucose and insulin responses

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1. INTRODUCTION

Resistant starch (RS) is defined as the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals. RS appears to confer considerable health benefits related of inflammatory bowel disease and bowel cancer, reduction of postprandial glycaemia/insulinemia, improvement of insulin sensitivity and fat oxidation, increase satiety as well as play a prebiotic role.

The aim of this study was to evaluate the postprandial glucose and insulin responses *in vivo* to bread with high amount of RS. Common bread with lower RS level was used as control. We also determined the glycaemic index (GI) of the bread containing high level of RS.

2. METHODOLOGY

37 nondiabetic adults were recruited (26 females and 11 males; 16 with BMI ≤ 24.9 and 21 with BMI > 24.9 kg/m^2; aged 22-59 years). This was a single-blind, single-ingestion crossover study.

Two breads were tested:
REF (reference bread) – 88g conventionally baked bread from white wheat flour (RS=1.18% dwb*);
HRS (bread with high level of RS) - 102g bread with 80% white wheat flour and 20% maize flour baked at long time/low temperature conditions (RS=4.33% dwb*). This bread was developed in previous studies.
Broth breads were provided corresponding to 50g of available carbohydrates and served with 250ml of water.

The tested breads were given after an overnight fast on different days. Test meals were finished in 12-15 mins. **Postprandial glucose** was measured by finger prick capillary blood sampling, prior to intake (**0**) and **15**, **30**, **45**, **60**, **90** and **120** min. after the bread intake. Glucose values were measured directly using a glucose oxidase method (LifeScan One Touch Verio, Johnson & Johnson). The **insulin response** was measured in capillary-blood samples taken immediately before (**0**) and **30** mins. after the meal. Blood samples for insulin analysis were centrifuged and serum was separated and frozen. The insulin level was determined in serum with an enzyme immunoassay kit (Insulin ELISA ME E-0900, LDN Labor Diagnostika Nord GmbH, Germany).

The procedures for the determination of the **Glycaemic Index** (GI) in breads were based on the ISO/DIS 26642:2010. Two more sessions were considered to the volunteers with BMI ≤ 24.9, in order to obtain the IAUC (Incremental Area Under the Curve) for the reference food (50g of anhydrous glucose).

Statistical analyses were carried out using SPSS 23.0 for Windows. Significant differences ($p<0.05$) were evaluated by paired Student's t test. Incremental AUC was calculated using the trapezoid rule for 0-120 min. Any area under the baseline (fasting point) was ignored (Brouns *et al*, 2005).

*dry weight basis

3. RESULTS

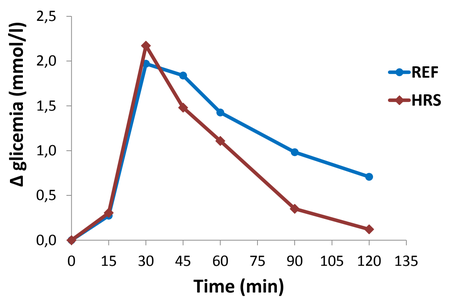

Figure 1 – Mean incremental change (Δ) in plasma glucose, group with BMI ≤ 24.9, n = 16

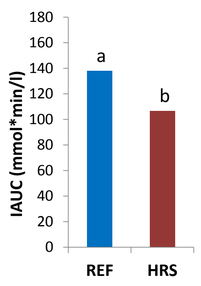

Figure 2 – Mean IAUC at 120 min, group with BMI ≤ 24.9, n = 16
Data with different letter are significantly different at p<0.05

These results suggest a lower postprandial glucose response after ingestion of **HRS** relative to **REF**. **HRS** showed significantly lower IAUC (106.6mmol*min/l) compared to **REF** (137.9 mmol*min/l) ($p<0.05$).

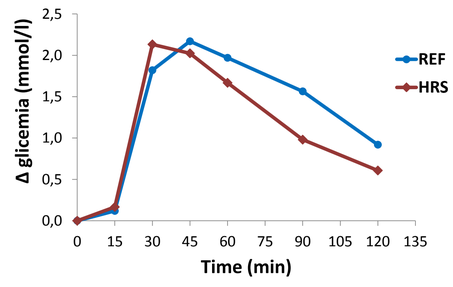

Figure 3 – Mean incremental change (Δ) in plasma glucose, group with BMI > 24.9, n = 21

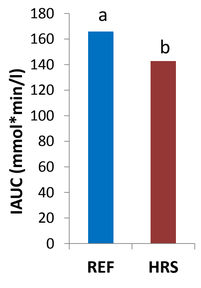

Figure 4 – Mean IAUC at 120 min, group with BMI > 24.9, n = 21
Data with different letter are significantly different at p<0.05

Similar data where observed for this group. It is evident that the mean IAUC for the **REF** (165.9 mmol*min/l) is significantly higher ($p<0,05$) than the mean IAUC for the **HRS** (142.8 mmol*min/l).

The statistical comparison of blood glucose and incremental AUC data across the two groups, showed no significant differences between them ($p<0.05$).

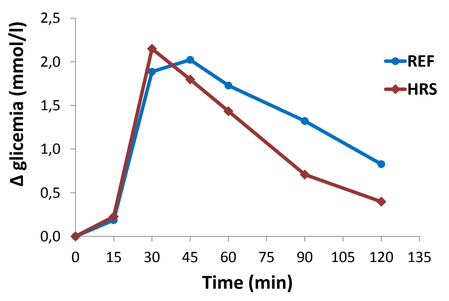

Figure 5 – Mean incremental change (Δ) in plasma glucose, all subjects, n = 37

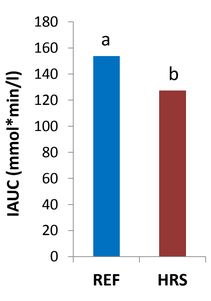

Figure 6 – Mean IAUC at 120 min, all subjects, n = 37
Data with different letter are significantly different at p<0.05

HRS induced lower postprandial glucose response then **REF**. **HRS** also showed significantly lower mean IAUC (127.1 mmol*min/l) compared to **REF** (153.8 mmol*min/l).

Our results seem to confirm that production of RS can also influence the rate of digestion of the available starch fraction. These results are in good agreement with those reported by Hallstrom *et al.* (2011) and Klosterbuer *et al*. (2012) for research studies with the same type of RS (RS3).

The insulin response was not significantly different ($p<0.05$) between two groups, whereby the data were handled together.

Table 1 – Fasting values and postprandial insulin response after ingestion of HRS and REF (mIU/l)

	REF	HRS
Fasting concentrations	12.6[a]	12.9[a]
30 min after ingestion	51.4[a]	54.4[a]
Δ insulin	38.8[a]	41.5[a]

Values are mean, n = 26
Values in each row not sharing the same letters were significantly different, p>0.05

30 min after ingestion of the meal, mean insulin response did not differ significantly ($p<0.05$) between the **REF** and the **HRS** and also there were no significant differences ($p<0.05$) in the mean incremental insulin response .

According to ISO/DIS 26642:2010 the **HRS** has a GI of 60 whereas the **REF** has a GI of 82. The correlation between increased RS content and reduced GI suggests that presence of RS can influence the glycaemic response to the available carbohydrates.

4. CONCLUSIONS

HRS bread seems to elicit a significantly lower postprandial glucose response than **REF** bread.

Insulin response up to 30 min. appears to have the same behaviour in both breads.

The decrease of the glycaemic response is expressed on the Glycaemic Index of the **HRS** bread which is lower than the **REF** bread.

HRS bread has a Glycaemic Index of 60, considered a medium GI food and, because of this, it can be a good choice in the context of a healthy diet.

HRS - BREAD WITH HIGH LEVEL OF RESISTANT STARCH

Moisture – 43.7%
[RS] – 4.33% (dwb)

REF - REFERENCE BREAD

Moisture – 35.4%
[RS] – 1.18% (dwb)

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Hallstrom, E., Sestili, F., Lafiandra, D., Bjorck, I., & Ostman, E. (2011). A novel wheat variety with elevated content of amylose increases resistant starch formation and may beneficially influence glycaemia in healthy subjects. *Food & Nutrition Research, 55*.

Klosterbuer, A. S., Thomas, W., & Slavin, J. L. (2012). Resistant Starch and Pullulan Reduce Postprandial Glucose, Insulin, and GLP-1, but Have No Effect on Satiety in Healthy Humans. *Journal of Agricultural and Food Chemistry, 60*(48), 11928-11934.