Making Fiber Irresistible:
Resistant Starch is a Natural

The Rediscovery of Resistant Starch

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OLDWAYS
THE FOOD ISSUES THINK TANK

Natural Hi-maize
The 5-in-1 Fiber

The Rediscovery of Resistant Starch

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Resistant Starch

Resistant starch escapes digestion in the small intestine to be digested or fermented in the large intestine.

Resistant starch is particularly rich in legumes and whole grains, particularly those with high amylose content.

What starches did we eat in the past?

Prehistoric hunter gatherers ate

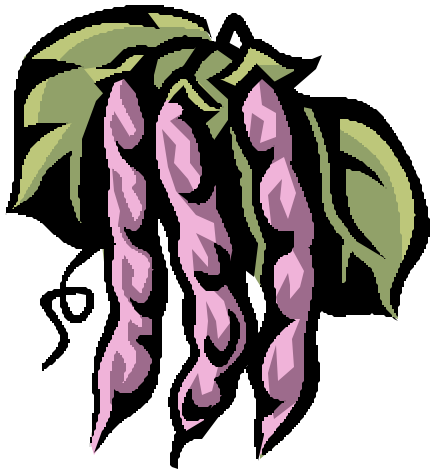
nuts and seeds

wild fruits, tubers and other vegetables

They ate only moderate amounts of starchy foods, many of them raw with high resistant starch content.

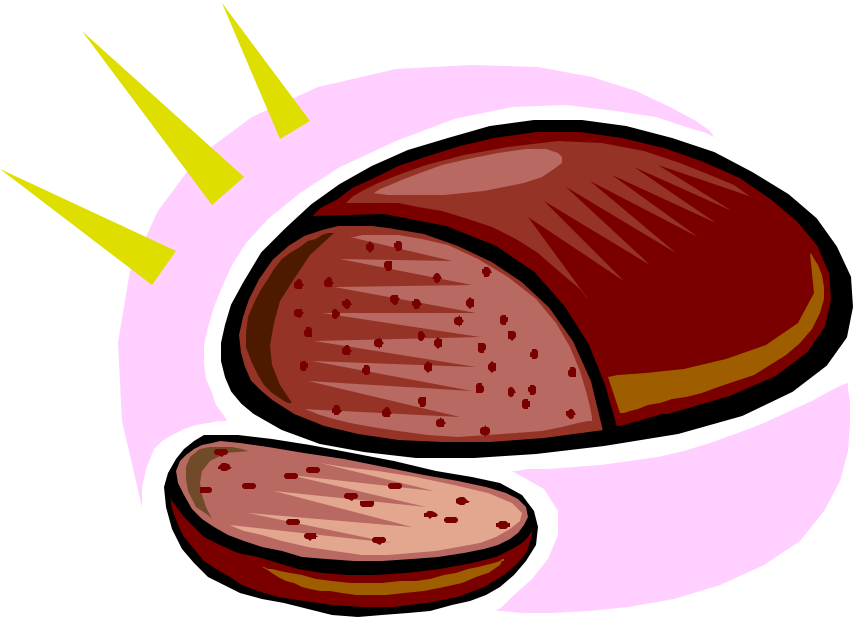
After the agricultural revolution, people ate

whole or coarsely ground cereals and grains
legumes
fruits and vegetables



After the agricultural revolution, people had

High intakes of both digestible and resistant starch



After the industrial revolution people ate processed cereal and grain products since milling procedures for flour and food preparation improved making starch more digestible.

People had high intakes of digestible starches but much lower intakes of resistant starch.

As our intake of whole grains and legumes has decreased over the last 200 years,

we have “lost”

resistant starch

from our diets.

For the last 20 years scientists have been

rediscovering resistant starch and its importance in the diet.

In 1982 Englyst et al described a starch that resisted enzymatic hydrolysis *in vitro*.

His group confirmed that this same type of starch also resisted enzymatic hydrolysis *in vivo* using health ileostomy subjects.

This lead to an upsurge in dietary fiber and resistant starch research in Europe, Australia, Asia (particularly Japan), and the USA.

In 1992 EURESTA defined resistant starch as:

The total amount of starch and the products of starch degradation that resists digestion in the small intestine of healthy people.

What makes a starch resistant?

Starch resists digestion for a variety of reasons related to the starch structure, physical location in a food, and food processing conditions.

Factors that influence starch digestibility

- Amount of starch eaten
  - diet composition and mass
- Nature of the Starch
  - amylose content
  - granularity
  - conformation

Factors that influence starch digestibility

- **Food processing**
  - processing conditions
  - extent of gelatinization
  - cellular structure
  - particle size
  - other food components – anti-nutrients
  - customs of food preparation & consumption
  - retrogradation

Factors that influence starch digestibility

- Physiology
  - health status
  - individual physiological differences
  - extent of chewing
  - gastric emptying
  - intestinal transit
  - fiber impact

- RS1 – physically inaccessible to digestion be entrapment in a non-digestible matrix (whole grains, legumes)
- RS2 – ungelatinized starch granules (raw potato starch, green banana, high amylose cornstarch)
- RS3 – retrograded starch (cooked, cooled, and re-crystallized)
- RS4 – chemically modified starch

Englyst et al. 1992, Brown et al 1995

Resistant Starch in Raw Foods, %

Kidney beans	25
Split peas	25
Barley	18
Barley flour	1
Whole wheat kernels	15
White wheat flour	2

Bednar et al. 2001

Resistant Starch in Cooked Foods, %

Wheat bran	0.42
Rye crispbread	1.2
Kidney beans	5.3
Cornflakes	4.0
Canned beans	16.5

McCleary & Rossiter, 2004

Physiologically, resistant starch behaves a lot like soluble fiber, but it also has some characteristics of an insoluble fiber.

Different types of resistant starch have different physiologic effects.

Physiological effects of resistant starch (RS), soluble (SF) and insoluble fiber (IF)

Property	RS	SF	IF
Water solubility	-	++	-
Fermentability	+++	+++	-
SCFA production	+++	+++	+
Increased butyrate	+++	++	-
Reduced fecal pH	+++	+++	-
Reduced plasma lipids	++	++	+

Physiological effects of resistant starch (RS), soluble (SF) and insoluble fiber (IF)

Property	RS	SF	IF
Increased fecal			
moisture	++	++	+
dry mass	++	+	+++
Reduced fecal			
transit time	++	-	+++

Resistant Starch

Has less energy.

~ 4 kcal/g for regular starches

~ 2 kcal/g for resistant starches

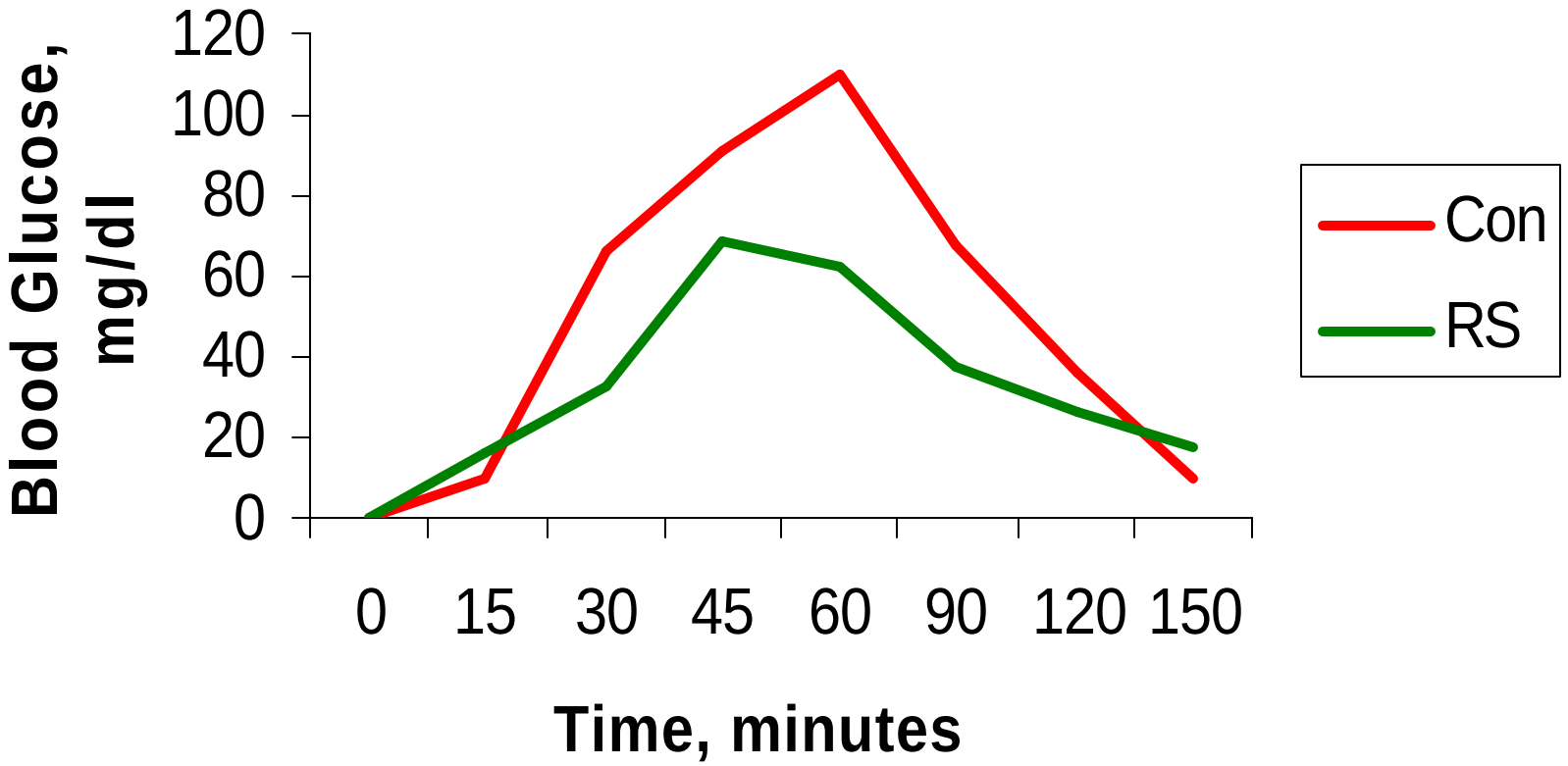
Can be used to dilute the energy content of foods and help reduce obesity.

Resistant starch

Results in a lower glycemic response to a meal. This may be important to people with insulin resistance or Type 2 diabetes.

Could contribute to better blood glucose regulation and reduced complications of diabetes.

Glycemic Response to RS



Hegsted

How does resistant starch decrease post-prandial blood glucose?

Through reduced release of glucose from resistant starch.

Through increased the release of GLP-1 (glucacon like peptide 1).

GLP-1stimulates the release of insulin.

Increased insulin sensitivity.

Subjects fed resistant starch had lower post-prandial glucose responses to a control meal the next day.

So the effect of resistant starch may carry over into non-resistant starch meals.

Robertson et al, 2004

Resistant starch

May increase satiety and subsequently reduce energy intake.

Could provide one more dietary tool to reduce food intake and obesity.

How does resistant starch increase satiety?

Resistant starch causes a more relaxed glycemic response to a meal, i.e. no great highs or lows to stimulate appetite.

Resistant starch increases the release of gut satiety peptides, GLP-1 and PYY.

Resistant starch

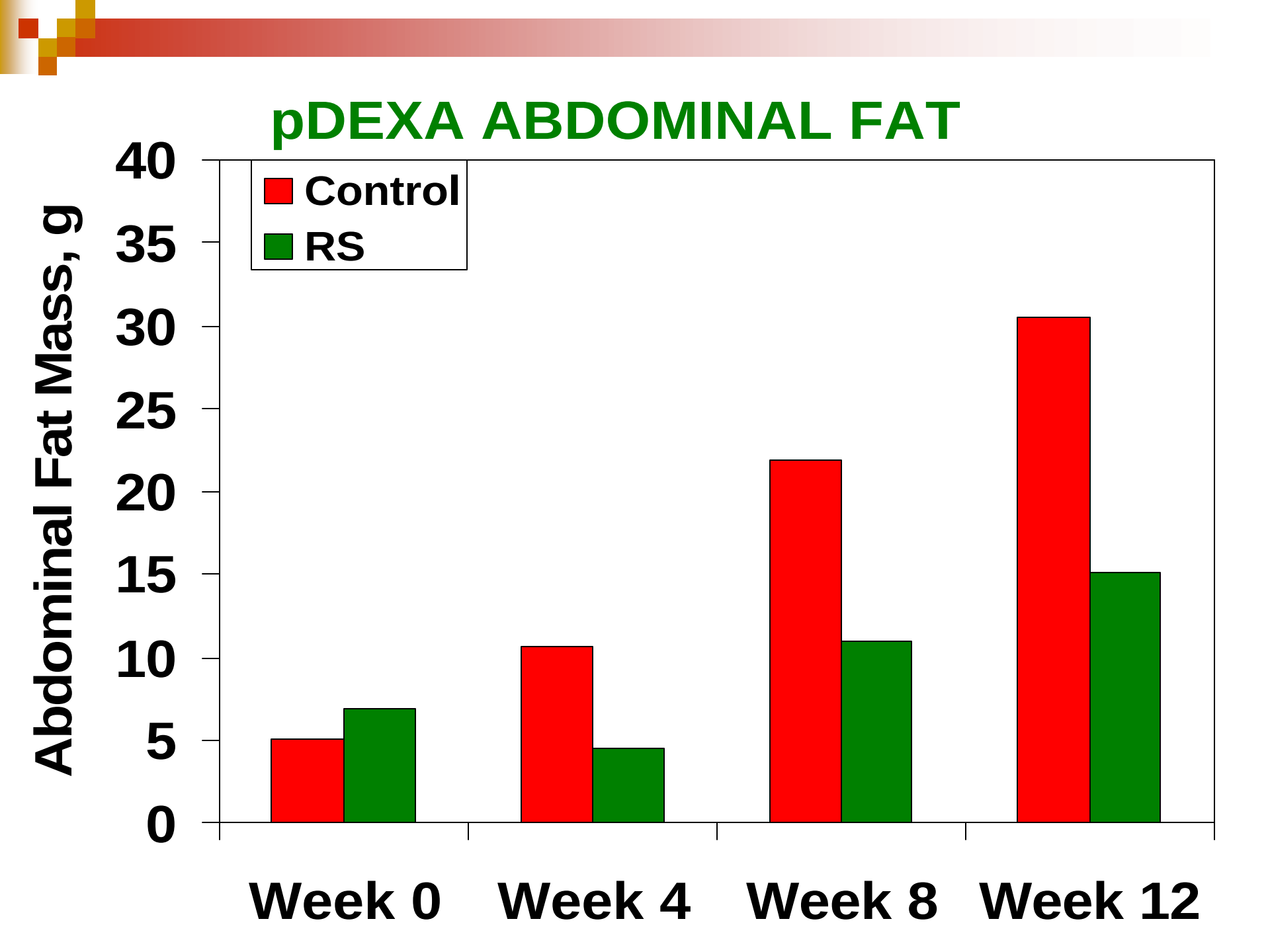
Increases fermentation in the colon producing butyrate and other short chain fatty acids.

Could improve colon health and potentially reduce colon cancer.

Resistant starch

Reduces body fat in animal studies.

Could help with weight maintenance and reduction of obesity.


pDEXA ABDOMINAL FAT
Abdominal Fat Mass, g
40
35
30
25
20
15
10
5
0
Control
RS
Week 0
Week 4
Week 8
Week 12

How does resistant starch reduce body fat?

Possible mechanisms:

- Increased levels of satiety signals PYY and GLP-1.
- Decreased fatty acid synthase activity.
- Decreased blood glucose levels for storage as fat.
- Increased insulin sensitivity(?) so less insulin to push lipogenesis.

Resistant Starch

Provides health benefits.

Is analyzed as “dietary fiber” for labeling purposes.

Can be used to increase the fiber content of commonly consumed foods.

Now is the time to rediscover resistant starch!