How much nutrition can humans obtain from wild plant foods and to what extent is cooking necessary in making these nutrients available during digestion?

Resource acquisition strategies of hunter gatherers involve obtaining sufficient calories that satisfy requirements of essential nutrition. Many models of human dietary ecology in evolution speculate on whether these needs could be met by human foragers in East Africa from meat, plant foods or both (1). A reliance on plant foods implies the need for cooking to breakdown physical and chemical barriers in the plant so a human consumer can access the nutrition commensurate to what was expended in acquisition (2). The Hadza hunter-gatherers of East Africa offer a unique opportunity to test the bioavailability of nutrition in the wild tubers they consume year round (3).

**Introduction and Background**

**Hadza ecology (4):**
- The Hadza hunter-gatherers are modern foragers living in northern Tanzania along the eastern side of the Rift Valley.
- Maintain a foraging subsistence lifestyle for >90% of diet.
- Hadza women target tubers.
- Available year round.
- Consumed both raw and roasted.

**Questions:**
- What is the bioavailability of nutrition?
- What is the relevance of brief roasting?

**Tuber properties (5):**
- High fiber.
- Moderate to low starch by fresh weight.
- High moisture (70-90%).

**Roasting practices (6):**
- 3-30 mins, average 5-7 mins.
- Open high-flame fire.
- Larger tubers roasted in sections.

**Consumption (5):**
- Peeled and bite-size sections cut.
- Chewed up to 3 mins.
- Wat or “quid” of fiber expectorated.

**4 tuber species collected for this study:**
- Mat’aitako
- Shabu shabu
- Tonga
- Panjuko

Starch images give an impression of relative density of easily digestible carbohydrates in the form of starch grains (light microscopy, 400x magnification).

**Methods**

**Procedure:**
1. Simulate roasting: 5 mins on open fire.
2. Peel and remove quids to extract edible fraction.
3. Submit to in-vitro digestion.
4. Dialyse analyzed for glucose.

**Amino acids (protein) below detection**

**Results**

**Conclusion:**
- Full replica of the stomach and small intestine (7).
- The meal is inserted directly into the stomach and digested for 6 hours over a preset rate. Absorption of metabolic products (sugars and amino acids) through semi-permeable hollow-fiber membranes (5 kDa) are measured in the “dialysate”.

**Summary:**
The results indicate high intra-species variation in nutrition availability with low impact from brief roasting.

**Two strategies emerge:**
1. the forager must select the highest quality tuber.
2. Roasting gains a slight improvement but is not essential, raw consumption is reasonable in certain settings.

We posit that roasting is a key communal activity, reinforces social bonding and distributes resource cost and therefore should be prioritized in mixed group settings. We also stress the importance of activating the whole gut in digestion. The upper gut digests and absorbs simple sugars and starch while the lower gut receives fermentable polysaccharides and provides further metabolic products to the host (SCFAs).

**References**

1. Step 1: Rehydration by dissolution followed by gelatinization in water.
2. Step 2: Starch molecules undergo glycogenation to form amyllopectin.
4. Step 4: Amylose is further converted to amylopectin.
5. Step 5: Amylopectin is finally converted to starch.
6. Step 6: Starch is finally digested to glucose.

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**Notable observations:**
- Low starch by wet volume.
- High simple sugars make raw consumption feasible and cooking unnecessary.
- High fiber and pectin.
- Fiber increases gut passage time.
- Both upper and lower-gut digestion enabled.

**Alternative reasons for brief roasting:**
- Softens food, faster peeling.
- Ease of consumption for children.
- Slower gut passage, longer satiation.
- Preserve moisture in tubers.
- Brief roasting may preserve vitamins (TBD).

**Conclusions**

**Terminology:**
- Bioavailable: fraction of nutrition reaching circulation.
- Gelatinizes: loss of semi-crystalline structure in starch granules as water is absorbed during heating.
- Quid: wat or fibers expectorated after chewing, inedible fraction.
- How cooking alters food:
  - Gelatinizes starch.
  - Denatures protein.
  - Softens structural polysaccharides.

**Figures:**
- Starch images give an impression of relative density of easily digestible carbohydrates in the form of starch grains (light microscopy, 400x magnification).

**Figures:**
- TNO gastro-intestinal model (TIM) showing stomach and small intestine.

**Figures:**
- Glucose absorption: individual tubers.
- Glucose absorption: pooled tubers.

**Figures:**
- Starch images showing the effect of roasting on starch digestion.

**Figures:**
- Tuber properties showing the impact of roasting on starch digestion.

**Figures:**
- Consumption patterns showing the impact of roasting on starch digestion.

**Figures:**
- Methods showing the impact of roasting on starch digestion.