Understanding the properties of millet couscous related to its slow gastric emptying for translation to other carbohydrate-based foods

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ABSTRACT

Gastric emptying rates of traditional West African millet-based foods were previously measured in a human study conducted in Mali. It was found that the millet couscous and thick porridge foods have significantly slower gastric (stomach) emptying rates compared to non-traditional urban carbohydrate foods, such as rice, potato and pasta. While slow gastric emptying was seen with the thick porridge form of millet, it was also found with millet couscous which is a non-viscous food. The slow gastric emptying properties of millet couscous seem independent of viscosity and may be related to slow disintegration of the couscous particles within the stomach, causing it to empty later. Slow gastric emptying of millet couscous may also be caused by slow starch digestion. We have found that slowly digestible starch can trigger the ileal brake in the rat, a system in the body that delays disintegration of the couscous particles within the stomach, causing it to empty later. Slow gastric emptying of millet couscous may also be caused by slow starch digestion. We have found that slowly digestible starch can trigger the ileal brake in the rat, a system in the body that delays disintegration of the couscous particles within the stomach, causing it to empty later. Slow gastric emptying of millet couscous may also be caused by slow starch digestion.

MATERIALS AND METHODS

- Millet couscous will be used for in vitro and in vivo work.
- A [13C]-labeled octanoic acid breath test will be used to measure gastric emptying rates of millet couscous in human studies.

OVERVIEW

FACTORS THAT AFFECT GASTRIC EMPTYING RATE:
- Viscosity
- Food form
- Particle size reduction time (disintegration rate)
- Starch digestion rate (to elicit ileal brake mechanism)
- Starch structure
- Phenolic compounds

POSSIBLE MECHANISMS

PHYSICAL DISINTEGRATION
Increased time to reduce in particle size in the stomach

SLOW RATE OF STARCH DIGESTION
Delivery of glucose to distal small intestine to trigger ileal brake

REFERENCES


SLOWEST GASTRIC EMPTYING

Figure 1. Half emptying times and lag phases of different solid carbohydrate-based test meals (mean ± SEM). Different letters indicate statistically significant differences between treatments (Cisse dissertation, 2014)

Figure 2. Relationships between gastric emptying, glycemic response and gut hormone secretion (Marathe et al., 2013)

Figure 3. Millet: a traditional and locally grown crop in West Africa (FAO)

Figure 4. Breath test mechanism for [13C] recovery (Sanaka and Nakada, 2010)

Figure 5. Food disintegration patterns during digestion: a) food surface degrades faster than tendarization front, exponential decay in mass retention; b) food surface degrades slower than tendarization front, sigmoidal decay of mass retention (Singh, 2009)

Figure 6. Concept of ileal and colonic brake mechanism related to slowly digestible or resistant starches caused by ileal glucose (Glc) release and short-chain fatty acids (SCFA) from fermentation. GLP1 = glucagon-like peptide 1; and PYY = peptide YY (Lee et al., 2013)

It is known that viscosity can delay gastric emptying and increase the satiating property of food. However, there are other physical properties related to non-viscous foods, such as millet couscous, like particle size and density that may contribute to a slow disintegration rate in the stomach compared to other carbohydrate foods.

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