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Opinion

Type 2 diabetes: Towards the Identification of Distinct Starch Digestion Products of Importance in the Regulation of Glucose Homeostasis

Nantanga KKM*

Department of Food Science and Technology, Faculty of Agriculture and Natural Resources, Namibia

***Corresponding author:** Nantanga KKM, Department of Food Science and Technology, Faculty of Agriculture and Natural Resources, Private Bag 133301, Pioneerspark, Mandume Ndemufao Ave, Windhoek, Namibia.

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Abstract

It is trite that glucose is an energy source for humans and is exclusively used by the brain for energy. Glucose is typically concentrated in the form of starch, organised in yet not well understood architectural and molecular structures. The molecular structures range from relatively highly branched amylopectins, moderately branched intermediate materials and relatively linear amyloses. The digestion, over time, of these diverse and complex molecules to release glucose has been linked to the increasing rates of degenerative conditions such as type 2 diabetes, cardiovascular diseases and obesity. Unlike in the case of for instance oils and proteins which comprise known essential fatty acids and essential amino acids respectively, the essential structure(s) and/or molecule(s) in the nutrition of carbohydrates remains elusive. Hints from research findings exist that it is not simply the amount of starch in a diet that influences the rate of glucose production during digestion. But different starch digestion structures can also inhibit or amplify the rate of glucose release or sensing and concomitant insulin response. To improve the understanding of carbohydrate digestion, the nutritional quality of starchy foods warrants ingenious probing focusing on identifying the nature and identity of what can be regarded essential hydrolysate(s) from the gastrointestinal starch digestion process. The hydrolysate structures that can be beneficial to the human long-term health by optimally modulating glucose homeostasis. Such structures can then be intelligently incorporated in the diet via starch food products and reduce the rate of lifetime degenerative conditions such as type 2 diabetes.

Introduction

Glucose is important to the human body [1]. It is the primary digestion product that our body use as an energy source for our brain. While some food products may contain soluble sugars such as glucose, maltose, fructose and various oligosaccharides, starch is the main source of glucose to most of the human population. The rate and extent of release of glucose into the blood from starch digestion in the gut and its subsequent control can result in metabolic degenerative disorders such as type 2 diabetes, cardiovascular diseases and obesity in adults [2]. So, is there a starch of best or optimal quality to prevent or manage these disorders and for normal glucose homeostasis? Is there a characteristic essential "starch or starch digestion product" for inclusion in the diet? It appears, unlike for the proteins and fats, whose nutritional quality are known based on their respective characteristic essential monomeric structures, the nutritional quality of starch is not well understood. Due to this lack of known and distinct starch molecules or remnants of starch molecules that are structure-functionally important for normal glucose homeostasis, scientists are globally sifting starch food matrices hoping to net what is conceptually termed slowly digestible starch [3,4]. For improved control and management of type 2 diabetes and other sugar-related metabolic disorders, this piece argues for research focus on the identification and characterisation of starch digestion intermediate products that influence glucogenesis and/or incretin hormones and insulin release for the control of blood glucose.

Luminal Starch Digestion Products: Influence on Glucose and Incretin Hormones Release

The availability of glucose from starch digestion in humans is brought about by a consortium of enzymes [5-7]. The digestion is almost sequential from the oral cavity to the mucosa of the small

intestine. It is started by salivary α-amylase in the mouth. The action of this enzyme can continue all the way in the gastrointestinal tract. This is because the salivary α-amylase can be protected in the food boluses. In the small intestine, pancreatic α-amylase joins in the digestion of starch and/or salivary α-amylase starch digestion products. At the mucosal level, sucrase-isomaltase and maltase-glucoamylase completes the digestion of starch and the products of luminal (salivary and pancreatic) α-amylases. Key observations can be made:

1. Among the luminal starch digestion products, some can synergistically amplify or inhibit further steps [7,8] in the hydrolysis of starch into glucose in the lower gut.

2. Among the luminal starch digestion products, some can influence the production of incretin hormones [9-12]. The produced incretin hormones in turn contribute to the release of insulin to concomitantly deal with the expected glucose release into the blood.

These observations offer an opportunity for a strategy and techniques to investigate the nature and identity of the luminal starch digestion products of importance to the regulation of glucose homeostasis, which have not been elucidated. Currently, there is broad information on the size distribution of the starch hydrolysis products [13,14]. These include high molecular weight starch polymers and various ranges of linear and branched dextrins and oligosaccharides. The high molecular components can comprise raw granular starch to completely gelatinised and/or retrograded starch molecules in the matrix of other food constituents. The degree of gelatinisation and/or retrogradation of starch during processing and the nature of the food matrix, duration of digestion among others can affect the proportions and structures of the luminal starch digestion products [15].

Concluding Remarks

Current knowledge on the digestion of starch and glucose homeostasis paves the way for revisiting and intensification of studies aimed toward the identification and/or quantification of the specific molecular and/or structures of starch polymers or digestion products responsible for the optimal regulation of glucose and/or insulin release by inducing incretin hormones secretion. The identity and quantity of starch digestion products of "metabolic quality" can allow for their intelligent inclusion in the human diet to manage and control metabolic disorders such as diabetes, obesity and cardiovascular diseases.

References

1. Gray GM. (1992). Starch digestion and absorption in nonruminants. Journal of Nutrition 122: 172-177.
2. Ludwig DS. (2002). The glycemic index: physiological mechanisms relating to obesity, diabetes, and cardiovascular disease. Journal of the American Medical Association 287: 2414-2423.
3. (2011). European Food Safety Authority (EFSA). Scientific Opinion on the Substantiation of a Health Claim Related to "Slowly Digestible Starch in Starch-containing Foods" and "Reduction of Post-prandial Glycaemic Responses" Pursuant to Article 13 (5) of Regulation (EC) No 1924/2006 9: 2292.
4. Zhang GY, Hamaker BR. (2009). Slowly digestible starch: concept, mechanism, and proposed extended glycemic index. Crit Rev Food Sci 49: 852-867.
5. Butterworth PJ, Warren FJ, Ellis PR, (2011) Human α-amylase and starch digestion: An interesting marriage. Starch-Stärke 63: 395-405.
6. Hoebler C, Karinthi A, Devaux MF, Guillon F, Gallant DJG, et al., (1998). Physical and chemical transformations of cereal food during oral digestion in human subjects. British Journal of Nutrition 80: 429-436.
7. Dhital S, Lin AHM, Hamaker BR, Gidley MJ, Muniandy A. (2013) Mammalian mucosal α-glucosidases coordinate with α-amylase in the initial starch hydrolysis stage to have a role in starch digestion beyond glucogenesis. PLoS One 8: 1-13.
8. Quezada Calvillo R, Robayo Torres CC, Ao Z, Hamaker BR, Quaroni A, et al., (2007). Luminal substrate ''brake'' on mucosal maltase-glucoamylase activity regulates total rate of starch digestion to glucose. Journal of Pediatric Gastroenterology and Nutrition 45: 32-43.
9. Ells LJ, Seal CJ, Kettlitz B, Bal W, Mathers JC. (2005). Postprandial glycaemic, lipaemic and haemostatic responses to ingestion of rapidly and slowly digested starches in healthy young women. Br J Nutr 94: 948-955.
10. Wachters Hagedoorn RE, Priebe MG, Heimweg JAJ, Heiner AM, Englyst KN, et al., (2006). The rate of intestinal glucose absorption is correlated with plasma glucose-dependent insulinotropic polypeptide concentrations in healthy men. Journal of Nutrition 136: 1511-1516.
11. Crapo PA, Reaven G, Olefsky J. (1977). Postprandial plasma-glucose and insulin responses to different complex carbohydrates. Diabetes 26: 1178-1183.
12. Holst JJ, Gromada J. (2004). Role of incretin hormones in the regulation of insulin secretion in diabetic and nondiabetic humans. American Journal of Physiology Endocrinology and Metabolism 287: E199-E206.
13. Pérez S, Bertoft E. (2010). The molecular structures of starch components and their contribution to the architecture of starch granules: A comprehensive review. Starch/Starke 62: 389-420.
14. Nantanga KKM, Bertoft E, Seetharaman K. (2013). Structures of human salivary amylase hydrolysates from starch processed at two water concentrations. Starch 65: 637-644.
15. Holm J, Lundquist I, Björck I, Eliasson AC. Asp NG. (1988). Degree of starch gelatinization, digestion rate of starch *in vitro*, and metabolic response in rats. American Journal of Clinical Nutrition 47: 1010-1016.