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Resistant starch: Importance, categories, food sources and physiological effects

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Abstract

The present day resistant starch consumption has become popular as it proved to improve insulin sensitivity, lower blood sugar levels, reduces appetite and has beneficial effects on colon. Resistant starch has various benefits for metabolic health. It also has a "second meal effect" - meaning that if you eat resistant starch with breakfast, it will also lower the blood sugar spike at lunch. The aim of present study is ascertain the importance of consumption of resistance starch and to understand its effects.

Keywords: resistance starch, insulin sensitive, food sources, physiological effects

Introduction

Resistant starch has been defined as “the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals” (Muir *et al*., 1993). In other words, starch not hydrolyzed in the small intestine is considered resistant starch (RS), in the sense that it has resisted hydrolysis by the amylolytic enzymes secreted by the healthy human (Champ *et al*., 1999) [3]. The rate and extent of hydrolysis in the small intestine are both important nutritionally. An altered rate of hydrolysis in the colon may lead to the desired resistant starch fermentation occurring in the different portion of the colon, with any physiological effects of the fermentation products accruing to the specific colonic region.

RS directly passes into the colon where it can be fermented by natural microflora to short-chain fatty acids such as butyric acid (Baghurst *et al*., 1996) [1]. RS is a non-caloric ingredient and does not contribute to increase in blood glucose. In this, it has physiological effects in the human body that are similar to that of dietary fiber, which has been shown to reduce risks for some diseases, including colon cancer, coronary heart disease and glycemia (Champ *et al*., 1999; Ranhotra *et al*., 1996) [3, 16]. In addition, RS does not hold much water and, thus, may be a preferred fiber source for use in low-moisture products such as cookies and crackers. Unlike traditional fiber sources, RS is free of gritty mouth feel and also does not alter flavor and textural properties of foods. These characteristics make RS a food ingredient of increasing interest.

Resistant starch classification

Physically inaccessible starch (RS1): RS granules (RS2): retrograded starch (RS3): Chemically modified fragments (RS4) (Englyst *et al*., 1992; Tovar, 1992) [5, 23]. In most cases, processing raw food materials would destroy RS1 and RS2, but it can produce RS3. RS3 is widely welcomed, because it can retain its functional characteristics when RS is used as a nutritional ingredient in cooked foods (Rosin *et al*., 2002) [14].

Resistant starch type 1 (RS1)

is composed of physically trapped starch.These starch granules are physically trapped within the food matrix so that the digestive enzymes are prevented or delayed from having access to them. This can occur in whole or partly ground grains, seeds, cereals, and legumes (Lineback, 1999) [11]

Resistant starch type 2 (RS2)

refers to native resistant starch granules such as those typically found in bananas, raw potatoes and amylose maize starch. These native starch granules are known to resist attack by α-amylase. Berry first showed that the amylose level in maize starches generally correlates with resistant starch levels (Berry, 1986). Additionally, it was also reported that the granular size of high amylose starch influences the digestibility. Smaller granules have lower digestibility (Knutson *et al*., 1982) [10].

Resistant starch type 3 (RS3)

is comprised of retrograded starch. The starch components (amylose and amylopectin) undergo the process of retrogradation in a time dependant process after the starch has been cooked or gelatinized. Although, RS3 is often attributed to amylose retrogradation (Sievert and Pomeranz, 1989; Eerlingen *et al*., 1993) [18, 6], retrograded amylopectin has also been shown to contribute to type 3 resistant starch (Eerlingen *et al*., 1994; Russell *et al*., 1989) [7]. Most amylose-containing starches can be processed by heat and moisture to produce some type 3 resistant starch. For example, wheat starch will produce low levels of resistant starch as a result of gelatinization and cooling in bread baking (Rabe and Sievert, 1992; Bjorck *et al*., 1986) [15]. In one recent review focusing on resistant starch type 3 (Eerlingen and Delcour, 1995) [8] the authors stated that RS3 was shown to be "thermally very stable", and was isolated by the TDF method (Total dietary fiber). These authors subsequently noted that "highly resistant" fractions are those that resist hydrolysis at 100°C. Sievert and Pomeranz (1989) [18] described the use of autoclave/cooling cycles to produce resistant starch. They studied the autoclaved starches and resistant starch isolated by the TDF method, and showed that the high temperature Differential Scanning Calorimetry (DSC) endotherm of the intact starches correlated with a similar endotherm from the RS. Based on polymer crystallization theory, it is (Eerlingen *et al*., 1993) [6] hypothesized that the formation of type 3 resistant starch can be considered as a crystallization process of amylose in a partially crystalline system. Multi-cycle autoclaving of starch-based products results in retrogradation, and consequently increased levels of RS3, particularly in high amylose foods (Skrabanja and Kreft, 1998) [20].

Resistant starch type 4 (RS4)

It is defined as chemically modified starch. This is a relatively newer classification of resistant starch that refers to- a chemically modified or re polymerised starch. (Croghan, 1994). Chemical modification facilitates the generation of distarch phosphodiester cross-linkages which could be modulated to produce products of 40 % - 80 % resistant starch by the total dietary fiber method (Seib and Woo, 1999) [19].

Food sources of resistant starch

Food sources of resistant starch and factors affecting their resistance are given table 2.1

Table 1: Food sources of resistant starch and factors effecting resistance

Type of RS	Food Sources	Resistance reduced by
RS1	Whole or partly milled grains and seeds, legumes, pasta.	Milling, Chewing.
RS2	Raw potatoes, green bananas, some legumes, high amylase starches.	Food processing and cooking.
RS3	Cooked and cooled potatoes, bread, cornflakes, food products with prolonged and/or repeated moist heat treatment.	Processing conditions.
RS4	Some fibre- drinks, foods in which modified starches have been used (e.g. certain breads and cakes)	Less susceptible to digestibility *in vitro.*

Resistant starch consumption

Within the framework of EUREST A, the per capita availability of RS was evaluated from data on the intake of starchy foods from ten European countries during the period 1992 to 1994. The RS content of the foods used in the calculations was determined by the method of Englyst *et al.* (1992) [5] or by Berry's method as modified by Champ (1992). Different food consumption methods and balance sheets or disappearance statistics were used. The data from some countries were incomplete. The mean RS intake in Europe is estimated to be 4.1 g dry matter/d (Dysseler and Hoffem, 1995) [4]. RS intake ranges from 3.2 g/d in Norway to 5.7 g/d in Spain. In the Netherlands mean RS intake is estimated to be 5.3 g/d. Bread and potatoes are the major sources of RS in most countries, providing together 60% to 90% of the total RS intake. The contribution of other sources of RS fluctuates considerably between the countries. The differences between the countries may be due to differences in dietary habits, but also to under- or over estimation in the analysis of some starchy foods. These data should be regarded as indicative only, because they differ with respect to their origin and completeness and because different analytical methods were used. In any case, the current RS intake in Europe seems low.

Reasons for Resistant starch in digestion

1. The compact molecular structure limits the accessibility of digestive enzymes, various amylases, and explains the resistant nature of raw starch granules (Haralampu, 2000) [9]. The starch may not be physically bio accessible to the digestive enzymes such as in grains, seeds or tubers.
2. The starch granules themselves are structured in a way which prevents the digestive enzymes from breaking them down (e.g. raw potatoes, unripe bananas and high-amylose maize starch) (Nugent, 2005) [13].
3. Starch granules are disrupted by heating in an excess of water in a process commonly known as gelatinization, which renders the molecules fully accessible to digestive enzymes. Some sort of hydrated cooking operation is typical in the preparation of starchy foods for consumption, rendering the starch rapidly digestible (Haralampu, 2000) [9]. However, if these starch gels are then cooled, they form starch crystals that are resistant to enzymes digestion. This form of 'retrograded' starch is found in small quantities (approximately 5%) in foods such as ''corn-flakes" or cooked and cooled potatoes, as used in a potato salad.
4. Selected starches that have been chemically modified by etherisation, esterisation or cross-bonding, cannot be broken down by digestive enzymes (Lunn and Buttriss, 2007) [12].

Physiological effects of resistant starch

RS has received much attention for both its potential health benefits and functional properties (Sajilata *et al*., 2006) [17]. Resistant starch is one of the most abundant dietary sources of non-digestible carbohydrates and it has a smaller impact on lipid and glucose metabolism (Nugent, 2005) [13].

A number of physiological effects have been ascribed to RS, which have been proved to be beneficial for health (Sajilata *et al*., 2006) [17] and are listed in Table 2.2. The physiological properties of resistant starch (and hence the potential health benefit) can vary widely depending on the study design and differences in the source, type and dose of resistant starch consumed (Buttriss and Stokes, 2008; Nugent, 2005) [13].

It is possible that modern processing and food consumption practices have led to lower RS consumption, which could contribute to the rise in serious degenerative disease in affluent countries. This offers opportunities for the development of new cereal cultivars and starch-based ingredients for food products that can improve public health. These products can also be applied clinically (Topping *et al*., 2003) [21].

RS acts largely through its large bowel bacterial fermentation products which are, in adults, short-chain fatty acids (SCFA) (Topping *et al*., 2008) [22]. There is also increasing interest in using RS to lower the energy value and available carbohydrate content of foods. RS can also be used to enhance the fibre content of foods and is under investigation regarding its potential to accelerate the onset of satiation and to lower the glycemic response The potential of RS to enhance the sound health towards degenerative diseases, and to act as a vehicle to increase the total dietary fibre content of foodstuffs, particularly those which are low in energy and/or in total carbohydrate content (Nugent, 2005) [13]

Conclusion

Carbohydrates in the diet are starches. Starches are long chain of glucose found in grains, potatoes and various food. All starch we eat do not get digested, it passes through digestive tract unchanged. This type of starch functions like soluble fiber and has powerful health benefits.

References

1. Baghurst PA, Baghurst KT, Record SJ. Dietary fiber, non-starch polysaccharides and resistant starch - a review. Suppl To Food Austrailia, 1996, 48:3.
2. Croghan GA. Resistant starch makes better carbs. Issues of Functional Foods and Neutraceuticals.
3. Champ M, Matin L, Noah L, Gratas M. Analytical methods for resistant starch. Complex Carbohydrates in Foods, 1999, 169-187.
4. Dysseler P, Hoffem D. Estimation of resistant starch intake in Europe. Proceedings of the concluding plenary meeting of EURESTA. Den Haag: CIP-data Koninklijke Bibliotheek, 1995, 84-6.
5. Englyst HN, Kingman SM, Cummings JH. Classification and measurement of nutritionally important starch fractions. European Journal of Clinical Nutrition, 1992; 4:33-50.
6. Eerlingen RC, Deceuninck M, Delcour JA. Enzyme resistant starch II: Influence of amylose chain length on resistant starch formation. Cereal Chemistry, 1993; 70:345-350.
7. Eerlingen RC, Jacobs H, Delcour JA. Enzyme- resistant starch V. Effect of retrogradation of waxy maize starch on enzyme susceptibility. Cereal Chemistry, 1994; 71:351-355.
8. Eerlingen RC, Delcour JA. Formation analysis structure and properties of type III enzyme resistant starch. Journal of Cereal Science, 1995; 22:129-138.
9. Haralampu SG. Resistant starch: A review of the physical properties and biological impact of RS3. Carbohydrate Polymers, 2000; 41:285-292.
10. Knutson CA, Khoo U, Cluskey JE, Inglett GE. Variation in enzyme digestability and gelatinization behaviour of corn starch granule fractions. Cereal Chemistry, 1982; 59:512-15.
11. Lineback DR. The Chemistry of Complex Carbohydrates. Complex Carbohydrates in Foods, 1999, 125.
12. Lunn J, Buttriss JL. Carbohydrates and dietary fibre. Nutrition Bulletin, 2007; 32:21-64.
13. Nugent AP. Health properties of resistant starch. British Nutrition Foundation, Nutrition Bulletin, 2005; 30:27-54.
14. Rosin MP, Lajolo MF, Menezes WE. Measurement and characterization of dietary starches. J. Food Comp. Anal, 2002; 15:367-377.
15. Rabe E, Sievert D. Effects of baking, pasta production, and extrusion cooking on the formation of resistant starch. European Journal Clinical Nutrition, 1992; 46:105-107.
16. Ranhotra GS, Gelroth JA, Glaser BK. Effect of resistant starch on blood and liver lipids in hamsters. Cereal Chemistry. 1996; 73(2):176-178.
17. Sajilata MG, Singhal RS, Kulkarni PR. Resistant starch - A review. Comprehensive Reviews in Food Science and Food Safety, 2006; 5:1-17.
18. Sievert C, Pomeranz Y. Enzyme-resistant starch. I. Characterization and evaluation by enzymatic, thermoanalyical and microscropic methods. Cereal Chemistry, 1989; 66:342-347.
19. Seib PA, Woo K. Food grade starch resistant to alpha-amylase and method of preparing the same. Starch, 1999; 50:6-7.
20. Skrabanja V, Kreft I. Resistant starch formation following an autoclaving of buck wheat Fagopyrum esculentum Moench Groats. An in vitro study. Journal of Agrculture Food Chemistry, 1998, 46:2.
21. Topping DL, Anthony MF, Bird F. Resistant starch as prebiotic and synbiotic: State of the art. Proceedings of the Nutrition Society, 2003; 62:171-176.
22. Topping DL, Clifton PM. Short chain fatty acids and human colonic function: Roles of resistant starch and non starch polysaccharides. Physiological Reviews, 2008; 8:1031-64.
23. Tovar J. Bioavailability of starch in processed legumes. Importance of physical in accessibility and retrogradation. Thesis submitted to University of Lund, Sweden, 1992.