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Review Article

IMPORTANCE OF DIETARY FIBER AND STARCH IN THE PREVENTION OF SELECTED CIVILIZATION DISEASES: A REVIEW

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Abstract: ***Starch is a major component of our food; it metabolises easily and gets converted in to sugars which release energy instantly. Diabetic patients are debarred from consuming starchy and sugary foods. World over, potato and rice constitute the major component of human diet; both are starchy foods and forbidden for diabetics. In this review we describe starches from potato and rice can be made useful diet for diabetics.***

Key words: Dietary fibers, Starch

INTRODUCTION

With extensive research in the area of nutrition and diet some important conclusion have been drawn, such as, all starches are not the same in their effects on blood glucose and lipids and all starches are not completely digested. We have learned that the indigestible carbohydrates by humans are not just neutral bulking agents in “foods”, but have important physiologic effects, and even contribute energy to the diet [1]. However, knowledge in all these areas is far from complete [2]. In addition, there is unresolved controversy about how to define and how to measure indigestible carbohydrates and starch (dietary fibre, DF), DF was defined in 1953 by Hipsley as non-digestible constituents of plant cell walls however, later many modifications were brought out to satisfy their structure – function relationship [3] and finally, Codex Alimentarius Commission* (The Codex Alimentarius is a collection of internationally recognized standards, codes of practice, guidelines, and other recommendations relating to foods, food production, and food safety.) defined DF as Dietary fiber means carbohydrate polymers with $\geq$ 10 monomeric units, which are not hydrolyzed by the endogenous enzymes in the small intestine of humans [1]. Understanding the relationships between the compositions of raw food materials, the effects of processing on their structures and interactions, and their behaviour in the gastrointestinal (GI) tract are crucial for elucidating the relationships between diet and health. Present review deals with importance of starch and dietary fibers in the management of “Life style diseases”

Dietary fiber: Dietary fiber (DF) is chemically heterogeneous ingredients derived from plants consumed by man, as well as carbohydrates, which are not digested and absorbed in the small intestine, but undergo full or partial fermentation in the large intestine. Dietary fiber is subjected to bacterial fermentation in the gastrointestinal tract. The increase in fiber intake, in addition to physiological benefits, may reduce the risk of civilization diseases. Thus, fermentative end products are closely related to the intestinal microflora and can have a significant effect on the composition of the intestinal microflora [4-7]. An indigestible part of food is always obtained from plants, and the majority of plant products contain a mixture of two ingredients:

1. Soluble fiber, which dissolves in water, occurs in peas, beans, apples, citrus fruits, carrot roots, in oat and barley grains, etc., can easily ferment in the colon in gases and physiologically active by-products (gel) that can act as a prebiotic. These products slow down digestion, which in turn helps to lower cholesterol and blood glucose [2,4-7].

2. Insoluble fiber. This type of fiber remains unchanged up to the large intestine, making the waste heavier and softer, allowing it to shimmy through the intestines more easily promotes the flow of material through the digestive system and increases the stool volume, so it can be of benefit to those who fight constipation or irregular stools [2, 9-11].

Digestion and absorption of starch: The digestion of starch begins with salivary amylase; broken into polysaccharides and oligosaccharides end up with monosaccharides by hydrolysis before being absorbed. Pancreatic amylase in the small intestine hydrolyzes starch, with the primary end products being maltose, maltotriose, and α-dextrins, although some glucose is also produced. The products of α-amylase digestion are hydrolyzed into their component monosaccharides by enzymes expressed on the brash border of the small intestinal cells, the most important of which are maltase, sucrase, isomaltase and lactase [4[. This is reflected by the presence of finger-like villi in the mucosa of the upper small intestine, with wider and shorter villi in the lower half of the small intestine. However, carbohydrate digestion and absorption can occur along the entire length of the small intestine, and is shifted toward the ileum when the diet contains less readily digested carbohydrates [8,9].

Digestion in mouth: Carbohydrate digestion begins in the mouth. The salivary glands in the mouth secrete saliva, which helps to moisten the food. The food is then chewed while the salivary glands also release the enzyme salivary amylase, which begins the process of breaking down the polysaccharides in the carbohydrate food [7,9].

Digestion in stomach: After the carbohydrate food is chewed into smaller pieces and mixed with salivary amylase and other salivary juices, it is swallowed and passed through the esophagus. The mixture enters the stomach where it is known as chyme. There is no further digestion of chyme, as the stomach produces acid which destroys bacteria in the food and stops the action of the salivary amylase [2,7].

Digestion in small intestine: After being in the stomach, the chyme enters the beginning portion of the small intestine, or the duodenum. In response to chyme being in the duodenum, the pancreas releases the enzyme pancreatic amylase, which breaks the polysaccharide down into a disaccharide, a chain of of only two sugars linked together. The small intestine then produces enzymes called lactase, sucrase and maltase, which break down the disaccharides into monosaccharides. The monosaccharides are single sugars that are then absorbed in the small intestine [13,15,17].

Digestion in large intestine (Colon): Carbohydrates that were not digested and absorbed by the small intestine reach the colon where they are partly broken down by intestinal bacteria. Fiber, which cannot be digested like other carbohydrates, is excreted with feces or partly digested by the intestinal bacteria [19,20].

Potato and rice starches: Potato starch is starch extracted from potatoes. The cells of the tubers of the potato plant contain starch grains (leucoplasts). To extract the starch, the potatoes are crushed; the starch grains are released from the destroyed cells. The starch is then washed out and dried to powder. Potato starch contains typical large oval spherical granules ranging in size between 5 and 100 μm. Potato starch is a very pure starch, containing minimal protein or fat. This gives the powder a clear white colour, and the cooked starch typical characteristics of neutral taste, good clarity, high binding strength, long texture and a minimal tendency to foaming or yellowing of the solution [12,15].

Potato starch contains approximately 800 ppm phosphate bound to the starch; this increases the viscosity and high swelling power [16]. It gives the solution a slightly anionic character. Potato starch is gelatinized during hydrothermal treatment (140 °F); in this form it is easily digested. This triggers a rapid increase in blood glucose. The measure of blood glucose accumulation as a result of carbohydrate digestion is the Glycemic Index (IG). IG higher than 70 is considered high and <55 too low [17] but potato gives about 95, which means that after consuming 50 g of potato, the glucose level may increase by as much as 95%. However, there are ways to lower this indicator. Namely, after cooking potato tubers put them in the refrigerator for 24 hours, and then reheat, then their glycemic index should fall because the lower temperature transforms the starch contained therein into a more resistant one [17]. In addition, the glycemic index of a potato can be reduced by adding fat to it (e.g. olive oil). As a result, potatoes will be digested slowly in the intestine, which means no sudden increase in blood sugar level [18]. On the other hand, the positive effect is the fact that the consumption of potato with a high IG index in a short time provides the body with the necessary glucose and energy. The size of the Glycemic Cargo is also significant, calculated on the basis of the Glycemic Index and the amount of carbohydrates contained in the product consumed. It takes into account not only the amount of carbohydrates consumed, as well as the rate of their decomposition and absorption by the human body, and therefore its value also results in the potential level of glucose in the blood and the need for insulin [18].

'Resistant starch' from potato and rice: Starch resistant to digestive enzymes, but it is fermented in the large intestine by the strains of beneficial bacteria that colonize it. The health-promoting effect of resistant starch has a wide range. The effect of the fermentation process is the formation of short-chain fatty acids, mainly butyric acid, which nourishes symbiotic intestinal bacteria. Nourished microbiome is important for maintaining the health of the digestive system, prevents the development of diseases of the small and large intestines, among others colon cancer, ulcerative colitis or Crohn's disease. It also affects the regularity of bowel movements and normal intestinal motility, prevents bloating and constipation. Resistant starch lowers the energy intake of a meal with a large portion, so it can be used in the treatment of overweight and obesity. People with type 2 diabetes and / or insulin resistance should also pay attention to resistant starch (SO). SO increases the sensitivity of cells to insulin and lowers blood sugar. After a meal containing SO, there is no sudden increase in the level of glucose in the blood and the accompanying discharge of a large portion of insulin, thereby relieving the pancreas. In a rat study, it was found that eating meals with the addition of resistant starch by animals, increased the absorption of minerals such as calcium and phosphorus. metabolism.

How to speed up and slow down the metabolism, or regulation of the metabolic rate? Metabolism is the whole of chemical and energy transformations taking place in a living organism. The speed of these reactions depends largely on age and health, however, our lifestyle has a significant impact on the metabolic rate [19-21].

Resistant starch types: Starch is a polycarbohydrate, made up of glucose molecules connected together, which when released from bonds is a source of energy for the body. In English, starch is referred to as the resist starch. Four types of starch can be distinguished, each with different characteristics and different uses. RS1 - starch which is not physically available to the body is found in the cell walls of whole or partially crushed cereal and legume plants. RS2 - raw starch found in raw potatoes, lentils or immature bananas. RS3 - retrogradated starch that is, resistant on which we can influence the production. RS3 is found in boiled potatoes and cereal products that are cooked, then cooled and eaten. The process of cooking and then cooling causes the starch to pass from the digestible form to the body into a form resistant to the action of digestive enzymes. So cold, boiled potatoes, rice or buckwheat for lunch or oat flakes flooded in the evening with water or milk and eaten for breakfast contain probiotic resistant starch! RS4 - modified starch, artificially obtained and added to a variety of highly processed products.

Method for the determination of resistant starch: Of the many analytical procedures employed for resistant starch (RS), two have emerged as the leading candidates for approval. These are the methods described by Camp and his associates [22]. They both provide similar results. The first step is removal of digestible starch from the food sample using pancreatic α-amylase (in cases where there may be inhibition of the pancreatic enzyme by products of digestion, amylo-glucosidase is added). Sometimes the amylolysis is preceded by a proteolysis step with pepsin and trypsin to mimic the action of the stomach and intestine. The RS is quantitated either directly in the residue or by difference between total starch and digestible starch, which are determined separately (22).

A new procedure has been proposed which is derived from several RS analysis systems [22]. Its principle is that in-vitro RS is defined as that starch which is not hydrolyzed by incubation with α-amylase. Amyloglucosidase is added to avoid inhibition by by-products of amylase digestion. Hydrolysis products are extracted with 80% ethanol and discarded. The RS is then solubilized with 2N potassium hydroxide and hydrolyzed with amyloglucosidase. The procedure is relatively simple with no particular training required, and is summarized below. Source: Adapted from Noah, et al. [22]:

100 mg sample: Add 10 ml enzyme solution in buffer (pH 6.9); pancreatic α-amylase (500U) 0.1 M tris-maleate buffer solution (calcium chloride 4mM). Mix 16 hours at 37°C; then add 40 ml ethanol. Leave 1 hour, then centrifuge. Wash residue twice with 80% ethanol, dry at 60°C. Add 1.56 ml H_2O, then add 1.5 ml 4M KOH. Mix 0.5 hours at room temperature then add 12 ml H_2O_2To 1.5 ml dispersion, add approximately 0.65 ml 2M acetic acid (to obtain pH 4.5) and 0.1 ml amyloglucosidase (20/0.1 ml 0.1 M Na acetate buffer pH 4.5). Shake 90 min. at 65°C. Determine glucose using glucose oxidase assay. *The result is resistant starch.* * Ground in a mincer. The sample must be weighed to contain 50 mg starch

Resistant starch (RS) is classified as a fraction of water-insoluble fiber. It is also defined as a starchy fraction resistant to digestive enzymes, but it is fermented in the large intestine by strains of beneficial bacteria that colonize it [23]. Resistant starch acts as prebiotic [24] The health efficiency of resistant starch has a wide range. The effect of the fermentation process is the formation of short-chain fatty acids, mainly butyric acid, which nourishes symbiotic intestinal bacteria, which are important for maintaining the health of the digestive system, prevents the development of diseases of the small intestine and colon, including: colon cancer, ulcerative colitis or Crohn's disease [25]. It also affects the regularity and proper intestinal motility, prevents bloating and constipation [25]. Resistant starch lowers energy intake in a large portion of a meal, so it can be used to treat overweight and obesity. People with type 2 diabetes or insulin resistance should also use resistant starch. It increases the sensitivity of cells to insulin and lowers blood sugar. After a meal containing RS, there is no sudden increase in blood glucose levels and the accompanying outflow of a large amount of insulin, thereby releasing the pancreas. Eating meals with the addition of resistant starch increases the absorption of minerals, such as calcium and phosphorus, which affects the metabolism or regulation of the metabolic rate. Four types of starch can be distinguished, each of which has different characteristics and uses. And so: RS1 is a starch that is not physically available to the body, because it is found in the cell walls of whole or partially crushed cereal and legume plants; RS2 is raw starch in raw potatoes, lentils or immature bananas; RS3 - retrogradated starch, i.e. resistant, which is found in boiled potatoes and cereal products that are cooked and then chilled and eaten. The process of cooking and then cooling causes the starch to go from the digestible form to the form resistant to the action of digestive enzymes. Thus, cold, boiled potatoes, rice, or buckwheat for breakfast contain probiotic resistant starch [24], RS4 is a modified starch, artificially obtained and added to many highly processed products. It plays the role of a thickener in them [23].

After the cooling of the heat-treated products containing the gelatinized starch, its structure is changed (retrogradation), as a result of which the part undergoing is not digested. It consists of starch and its decomposition products not absorbed in the small intestine. Resistant starch in the large intestine is fermented by pre-biotic and /or probiotic bacteria from the genera *Bifidobacterium* and *Lactobacillus*. In tubers there are also so-called insoluble non-starch substances, primarily constituents of cell walls, such as: cellulose, hemicelluloses, lignins, etc. They form so-called dietary fiber. The content of dietary fiber in potato tubers is 2.0-2.3%. It is resistant to digestive enzymes and therefore has no energy value. However, it is necessary in food to "dilute" nutrients, thereby facilitating the access of digestive enzymes to them. Fiber improves intestinal peristalsis and also adsorbs bile acids and toxic heavy metals. Some of its components act as a prebiotic for probiotic microorganisms in the large intestine [20]. Eating too little fiber can make it difficult to control your blood sugar level because the fiber regulates the rate of digestion and contributes to the feeling of fullness. The fiber can move the food through the intestines too quickly, which means that fewer minerals are absorbed then with food. It can also cause flatulence and cramps, especially when fiber intake increases overnight. The recommended amount of dietary fiber (DF) depends on age and gender. For men under 50, the DF intake is about 38 g fiber a day for women - 25 g [USDA 2012]. People who have recently undergone digestive surgery or suffer from digestive disorders, such as Leœniowski-Crohn's disease, diverticulitis or ulcerative colitis, may use a low-fiber diet. It limits the daily intake of fiber to 10-15 g, so much less than the recommended norm for healthy adults. Foods with low fiber content, including boiled potato pie, slow down the digestion rate, reduce the amount of stool in the intestines and allow the intestines to rest [21]. Potatoes boiled or baked until tender and then mixed, because they have low fiber content and can be accepted in a low-fiber diet (without skin). According to USDA [2012], 1 serving of potatoes, without skin, contains 3.2 g of dietary fiber, slightly more than half of fiber, which is obtained from a large baked potato with intact skin [26].

CONCLUSION

Potato and rice are the major food items world over. The starch content of these foods upsets the blood sugar level because of the quick release of sugar in the blood. Resistant starch which gets digested in large intestine and releases sugars in the blood slowly is a boon for patients of life style diseases. The cooked potato and rice when cooled down their starch become resistant to digestion in small intestine and get digested in large intestine and metabolic products are released slowly in the blood stream; thus sugar levels do not surge quickly. The other advantage is that even on reheating this resistant starch is neither destroyed nor reconverted to starch. Thus after cooling one can reheat and use it.

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