CORRELATION OF LEGUMES' GLYCEMIC INDEX WITH ITS DIGESTIBILITY: A REVIEW

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Abstract: Legumes are a carbohydrate-containing food that has become a staple food for some individuals due to their ability to give people extended satiety. This is due to the slow digestion of foods for glucose utilization, implying a low glycemic index (GI). However, a sedentary lifestyle might prefer to consume high amounts of a carbohydrate-rich food such as white rice or white bread, commonly known as high GI foods. As a result, blood sugar levels rise rapidly, causing people to feel fuller for a short period, driving them to obesity or type II diabetes. This study includes a discussion of major findings related to the intrinsic and extrinsic factors that influence the starch digestibility in legumes. The intrinsic factors are the amylose-amylopectin ratio, starch structure, dietary fibre, and phytic acid. At the same time, the extrinsic factors are the rigid cell wall, the cooking methods, and the retrogradation process. These factors were evaluated by using the in-vitro or in-vivo method. According to a recent study, legumes with high amylose: amylopectin ratio had a higher tendency to retrograde during gelatinization, resulting in a crystal structure resistant to digesting enzymes. Legumes have robust cell walls that make it difficult for the enzyme to penetrate the starch. Thus, the digestion process took longer. Daily food intake of legumes could improve better health and guard against type-II diabetes, lower blood pressure, and even cholesterol. The food manufacturing industry should be considered in the extensive production of legume-based food products.

Keywords: Legumes, starch digestibility, low GI

1. Introduction

Legumes including lentils, beans, peas and pulses consist of high carbohydrates composition which are 65-72 % of starch and 10-20 % dietary fibre along with other significant components such as protein and polyunsaturated fatty acids. Starch can be classified as rapid digestible starch (RDS), slowly digestible starch (SDS), or resistant starch (RS) due to its susceptibility to amylases and subsequent digestibility. Legumes are also considered a low GI due to slow digestion starch, resulting in a low postprandial glucose and insulin response. However, people nowadays prefer processed food which have high GI over legumes, which is detrimental to their health (Grela et al., 2017). Therefore, legumes can be an ideal option for replacing grain, cereal or tuber starch for food and enhance human health. The main objective of study is to determine the factors influencing the legumes starch digestibility.

2. Discussion

2.1. Methods of Glycemic index estimation of legumes and starch digestion mechanism by α-amylase

The majority of researchers preferred *in vitro* (enzyme-based technique) over experiments using experimental animals or human volunteers (*in vivo*), which need blood sampling and appropriate ethical permission. Additionally, the *in vitro* method produces more precise results and requires less time than the *in vivo* method, as the rate and amount of starch digestion can be determined quickly and easily in the laboratory. However, no consensus exists regarding the technique or the findings. Each process requires a distinct strategy for sample preparation. Several of these procedures relied entirely on amylases, while others mixed amylases and proteolytic enzymes.

The human body's digestion of carbohydrate-containing foods happens in the mouth, stomach and small intestine. This enzyme is responsible for the breakdown of starches into maltose and polysaccharides. This digestion process is also similar for monogastric animals. The appropriate enzyme concentrations such as amylase, pepsin, trypsin, and AMG are implicated in hydrolysing the starch into simple units in the *in vitro* model (Lal et al., 2021). Besides, Guggenheim or log of slope (LOS) plots were used in those methods to properly analyse the starch digestibility curve.

2.2. Factors influencing the starch digestibility

2.2.1. Intrinsic factors

Legumes have a significant proportion of starch over cereals, generally containing between 30-37 % amylose and 72–75 % amylopectin. A study by Lu et al. (2018), cooked lentil flours possessed highest in RDS, lowest in SDS and intermediate in RS compared to raw lentil flours despite having a similar composition of amylose starch. This happens as amylose molecules' chains begin to disintegrate and separate into amorphous form during heating, reducing the size of the crystalline region and becoming diffuse. Thus, cooked lentil flours may facilitate hydrolysis by digestive enzymes, enhancing starch digestibility.

Legumes consist of high in resistant starch where it penetrates the small intestine resulting in a reduction in postprandial glucose and insulin responses and a reduction in starch digestion (low in RDS and high in SDS and RS). Therefore, it offers multiple health benefits, including diabetes management and reducing the risk of colon cancer.

2.2.2. Extrinsic factors

The integrity of the cell wall structure influences *in vitro* starch digestion in legumes. This is because the entire cell walls function as a barrier to the diffusion of amylase within the cells. Amylolytic enzymes cannot penetrate the intact bean cells, regardless of whether the legume has been cooked or not.

Furthermore, the gelatinization process also affects the starch digestibility of legumes because of inflated amylose and amylopectin due to water penetration inside those molecules during cooking, forming an easily hydrolysed paste by enzymes. Thus, cooking legumes could decrease their RS content and increase their RDS content. Pressure cooking are one of the cooking methods that boosted the starch digestibility of legumes further compared to conventional cooking, which could be ascribed to the increased degree of starch gelatinization and degradation of antinutrients

in the legume matrix (Jeong et al., 2019).

The retrogradation process occurs when the amylose and amylopectin molecules in gelatinized starch realign into more ordered structures during cooling and storage. The storage of legumes at 4 °C resulted in faster and more perfect crystallization of amylopectin than storage at 25 °C. Therefore, more resistant starch (decreasing RDS and increasing SDS and RS fractions) is formed when the samples held for a longer period of time (Yadav et al., 2010).

2.3. The benefits of legumes consumption on human health

According to the Ministry of Health (2017), each person should consume at least 30 g of legumes to achieve 50–70 % of total energy in daily carbohydrate intake. Legumes can help people lose weight, which the American Diabetes Association recommends for overweight, obese and at risk of developing type 2 diabetes mellitus. Legumes digest more slowly than cereal starch, resulting in less abrupt fluctuations in plasma glucose and insulin levels upon ingestion, which is tremendously favourable to human health.

3. Conclusion

As a conclusion, there is a positive relationship between low GI meals and factors such as amylose and amylopectin concentration and resistant starch, which contribute to starch slow digestion. Consumption of foods with a low glycemic index is associated with a decrease in modern lifestyle diseases such as diabetes and obesity. Legumes food products can also be obtained at affordable prices and not costly with better nutritional values than purchasing the cereal product. Further investigation of the starch digestibility and GI value between low glycemic index foods and other carbohydrates-rich foods is necessary since this study solely discussed the rate of starch digestion in low GI foods.

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