

L-Arabinose: A Novel Food Ingredient For A Healthier Living

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ABSTRACT

The development of food ingredients for a healthy diet to prevent further increase of obesity and diabetes numbers has top priority. L-Arabinose can play an important role in the management of blood glucose and insulin levels related to sucrose intake. The addition of L-Arabinose to a sugar containing diet has the following direct benefits: 1) up to 60% reduction of the glucose peak level related to sucrose consumption, 2) up to 60% suppression of the insulin peak level related to sucrose consumption, and 3) a sustained release of glucose to the body over a longer period of time. A low glycemic diet may have benefits like reduction of heart disease, lowering of blood cholesterol, management of body weight and composition, and prevention of type 2 diabetes. A low insulinic diet may lead to lower fat storage and prevention of pre-diabetes incidence. Sustained glucose release over a longer period of time has advantages for athletes and other people that value a responsible and healthy diet.

Keywords: L-Arabinose, biorefining, sugar beet, glycemic index reduction, sucrase inhibition

1 MODERN LIFESTYLES AND THE EFFECT ON PEOPLE'S HEALTH

Today's way of life is often fast track and characterized by frequent snacking. People tend to choose fast and convenient options just to keep on going. Often, this type of food is packed with readily digestible carbohydrates and fats, resulting in a disproportional daily calorie intake and high blood sugar loads. In the long term, these nutritional habits can not only bring the individual metabolism out of balance, but also have a remarkable impact on entire populations and health care cost. The global result is a tremendous rise in diseases, such as overweight and obesity, type 2 diabetes and cardiovascular diseases. More than 35% of the American adult population, equal to 78.6 million people, is reported to be obese [1], and the United States is amongst the top 3 countries in number of people suffering from diabetes (over 29 million adults). The annual cost associated with diabetes alone is \$245 billion [2].

The development of new health concepts to counteract the accelerating trends of obesity and diabetes is both a necessity and a requirement. Recently the consumption of

excessive amounts of free sugar and fructose has come under scrutiny of the World Health Organization [3]. The new WHO guideline recommends adults and children to reduce their daily intake of free sugars to less than 10% of their total energy intake. A further reduction to below 5% or roughly 25 grams (6 teaspoons) per day would provide additional health benefits. At the same time, lowering the glycemic response of the human diet is quickly gaining attraction amongst scientists and well-informed consumers.

2 BETAWELL® ARABINOSE

L-Arabinose (see Fig. 1) is a rare type of C5-sugar that naturally occurs in the hemicelluloses structure of most fruits and vegetables. Its name is derived from gum Arabic, another well-known food ingredient. Humans have always consumed L-Arabinose both pure as well as part of the hemicelluloses structure. The highest concentrations of L-Arabinose in food as monosaccharide can be found in instant coffee, wine and sake.

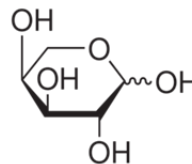


Figure 1: Structure of L-Arabinose.

Betawell® Arabinose is L-Arabinose extracted from sugar beets in a mild process that preserves the natural character of the product. Betawell® Arabinose is also called beet extract. The sugar beets used are grown in The Netherlands and are 100% GMO free. L-Arabinose has a nice, sweet taste that does not linger in the mouth and has no aftertaste. The sweetness strength is about 60% of the sweetness strength of sucrose.

2.1 Sucrase inhibition

When consumed, L-Arabinose selectively inhibits the sucrase enzyme in the small intestine. The sucrase enzyme normally splits the sucrose molecule into one D-glucose and one D-fructose molecule. During the period that the sucrase enzyme is inhibited by L-Arabinose, the splitting of sucrose is delayed or even prevented, and the release of D-glucose and D-fructose to the blood is delayed. This

activity of L-Arabinose is selective to the sucrase enzyme. The digestion of other carbohydrates is not affected.

When the sucrase enzyme binds to the sucrose molecule, they form a sucrase-sucrose-complex. L-Arabinose is a non-competitive inhibitor which means it binds to both the free enzyme and the sucrase-sucrose complex. These bonds prevent the release of D-glucose and D-fructose into the blood. By testing, it was determined that the bond lasts for several hours (on average 4 to 6 hours) [4]. The enzyme itself is unaffected by the activity of L-Arabinose. Depending on the amount of L-Arabinose in the small intestine, the digestion of sucrose is delayed or (partially) prevented.

3 AN ARABINOSE CONTAINING DIET IS THE SOLUTION FOR A HEALTHY LIFESTYLE

The development of food ingredients for a healthy diet to prevent further increase of obesity and diabetes numbers has top priority. L-Arabinose can play an important role in the management of blood glucose and insulin levels related to sucrose intake. A low glycemic diet may have benefits like reduction of heart disease, lowering of blood cholesterol, management of body weight and composition, and prevention of type 2 diabetes. The claimed effects of arabinose consumption are shown in Figure 2.

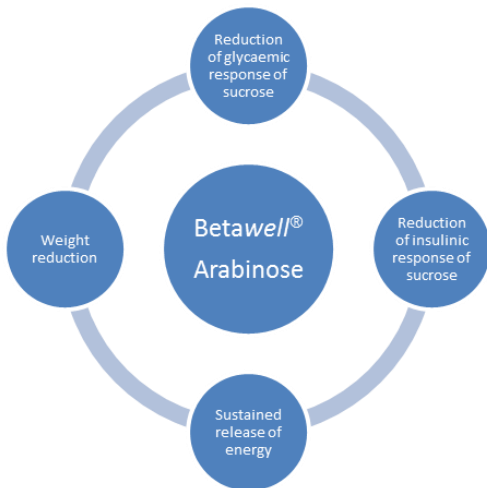


Figure 2: Claimed effects of L-Arabinose consumption.

3.1 Reduction of glycemic response of sucrose

Several research groups in Japan, Denmark and the United States have done clinical studies on humans with the consumption of mixtures of L-Arabinose and sucrose [5, 6, 7]. L-Arabinose dosages are normally between 1 and 8 wt% based on sucrose content. L-Arabinose has been tested on groups of 12 to 20 participants at dosage levels of 4 and 8

wt% based on sucrose content [5, 8]. Figure 3 shows the results of these studies.

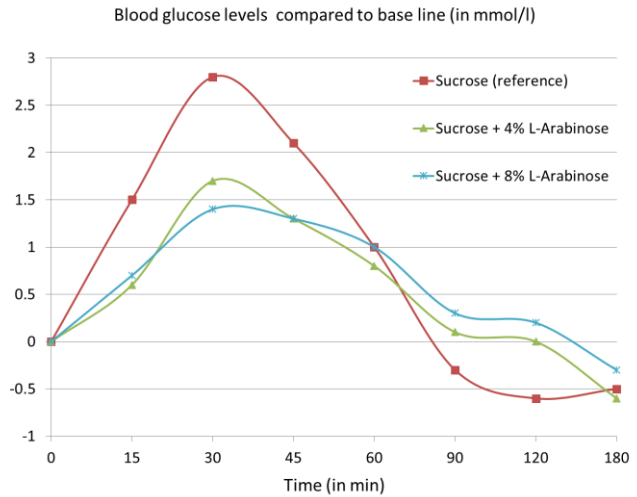


Figure 3: Glycemic response of sucrose/L-Arabinose mixtures.

It was found that the glycemic response of the sucrose consumption is significantly reduced. For the 4% L-Arabinose dosage level 3 grams of L-Arabinose is added to 75 grams of sucrose. The glycemic response measured is reduced by 35% and the Glycemic Index (GI) of this sucrose/arabinose mixture becomes 45. For the 8% L-Arabinose dosage level the performance is even better. More research is being conducted to generate data on the dose effect of L-Arabinose. In standard glycemic response testing L-Arabinose is added on top of the sucrose because L-Arabinose is not a readily fermentable carbohydrate. In commercial products however L-Arabinose would replace part of the sucrose, having a direct benefit of calorie reduction.

The other advantage of partial replacement of sucrose by L-Arabinose is the disappearance of the dip in the glucose profile which can be seen in Figure 3 between 90 and 120 minutes after sucrose consumption. This dip after a sucrose consumption is normally associated with the craving feeling potentially leading to another consumption.

3.2 Reduction of insulinic response

Insulin is the body's key hormone for the reduction of blood sugar concentration, thereby ensuring the glucose supply to the body and the brain. Insulin promotes both the uptake of glucose into cells and the formation of fat. Management of insulin levels leads to lower fat storage and prevention of pre-diabetes incidence.

The insulinic response of sucrose consumption mixed with L-Arabinose was investigated by Krog-Mikkelsen [5] and Kaats [6]. Krog-Mikkelsen tested the influence of the addition of 1, 2 and 3 grams of L-Arabinose to 75 grams of

sucrose dissolved in 300 ml of water. They both measured the glycemic and insulenic responses. For the L-Arabinose dosage level of 3 grams (equal to 4 wt% of sucrose content) they concluded that the effect of L-Arabinose addition on insulenic response was more pronounced than on the glycemic response. The peak in the insulin concentration was significantly smaller and also occurred later.

3.3 Sustained release of energy

Sustained release of energy is defined here as the release of the same amount of glucose to the body over a longer period of time. As L-Arabinose inhibits the sucrose enzyme, the glucose release from the sucrose is delayed and released to the body in a more gradual way. Sustained energy release is interesting for applications in sports nutrition. Other applications can be found in breakfast products and healthy snacks (bars, shakes).

The effect of L-Arabinose on the release of glucose from a sucrose containing drink was shown in Figure 3. Looking more closely to the graph of the drink with 8% L-Arabinose added to 75 grams of sucrose it can be seen that the L-Arabinose containing drink takes nearly twice as long to reach the original blood glucose level again compared to the sucrose only drink. The green arrow in Figure 4 shows the time difference of 80 versus 150 minutes. Taste differences between the two drinks were measured, but no significant difference was found which leads to the conclusion that L-Arabinose is easy to implement in existing formulations.

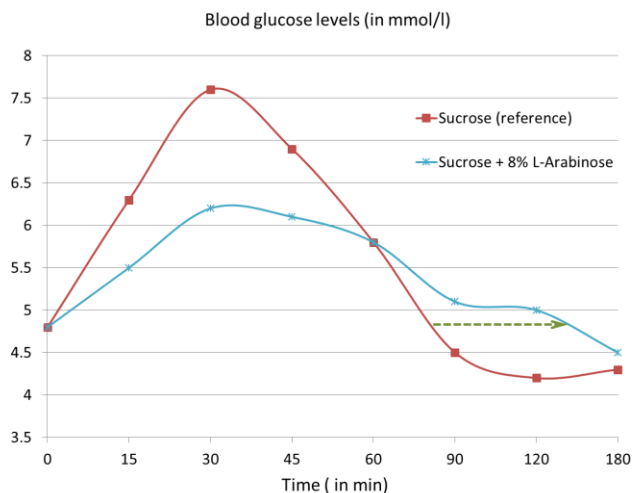


Figure 4: The effect of L-Arabinose on the release of glucose from a sucrose containing drink.

The results show that the glucose profile of the L-Arabinose containing drink shows a more gradual glucose release over a longer period of time. Athletes could benefit from a sustained energy supply, because it will keep them going for a longer period of time. The same is true for

people that enjoy a healthy breakfast that will keep them feeling satisfied until lunch time.

3.4 Additional health benefits of L-Arabinose

In addition to the beneficial effects on glucose, insulin and energy management L-Arabinose is also associated with weight reduction. Human and animal studies have claimed that the inclusion of L-Arabinose in a sugar containing diet may lead to a decrease in weight gain and even to weight reduction. Han [9], Fuji [10] and Liu [11] found positive effects on body weight and body fat during animal studies when giving the animals free access to food. Liu [12] and Zhang [13] measured a decrease in body weight of several kilograms in human studies after adding L-Arabinose to the regular diet of the participants over a period of 6 months. Multiple Japanese sources claim that the inclusion of L-Arabinose in a sucrose containing diet may lead to an increased growth of the right family of bifidogenic bacteria in the large intestine [14]. Bifidogenic bacteria may have a beneficial effect on the health resistance of their host.

4 CONCLUSION & DISCUSSION

L-Arabinose can play an important role in the management of blood glucose and insulin levels related to sucrose intake. The addition of L-Arabinose to a sugar containing diet has the following direct benefits:

- Reduction of the glucose peak level related to sucrose consumption by a maximum of 60%.
- Suppression of the insulin peak level related to sucrose consumption by a maximum of 60%.
- Sucrose becomes a low GI ingredient by adding a L-Arabinose dosage as low as 4 wt%.
- A sustained release of glucose to the body over a longer period of time.

A low glycemic diet may have benefits like reduction of heart disease, lowering of blood cholesterol, management of body weight and composition, prevention of type 2 diabetes and improvement of diabetes prevention. A low insulenic diet may lead to lower fat storage and prevention of pre-diabetes incidence. A sustained glucose release over a longer period of time has advantages for athletes and other groups of people that value a responsible and healthy diet.

5 BACKGROUND INFORMATION

ROYAL COSUN

Royal Cosun is a Dutch agro-industrial cooperative. Our ambition is to optimally use vegetable raw materials. We manufacture ingredients for food, non-food applications and the chemical industry. In addition, Royal Cosun is a proud partner in Pulp2Value governed by the Bio-Based Industries Joint Undertaking, which is a new €3.7 billion Public-Private Partnership between the European Union and the Bio-based Industries Consortium.

As member of the Pulp2Value project Cosun Biobased Products has an extensive R&D program in place to develop a production process for Betawell® Arabinose and obtain conclusive scientific data on the positive health effects of this ingredient.

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