Studies on the Nutritional and Physiological Implications of Sugar Alcohols in Cæcetomized Rats

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Indigestible but fermentable materials are widely used in the world mainly as sugar substitute for their many functional effects in nutrition and disease prevention. The appropriate evaluation of the functional effects of the above materials is very important before their application for consumption by human beings. It is sure that a wide range study of the effects of above materials directly in humans is really impossible because a vast level of studies on human beings is not possible for many ethical reasons. Therefore, an appropriate experimental animal model is definitely needs to study the actual functional effects of the above fermentable materials in humans.

Most of the indigestible but fermentable materials are poorly or not digested or are absorbed into the small intestine and finally entered into the distal part of the digestive tract for fermentation. In this regards, the physiological analogy of the large intestine of the experimental animal with human should be considered at first as it is act a major fermentation site in both cases. Rats are widely used as experimental animals in the world, but there is a major difference in the digestive physiology between these two species. Rats have a large voluminous cecum in the ileo-colonic junction when no such distinct feature was found in case of human. In rats, cecum is act as a major fermentation site including proximal colon for indigestible materials where colon is the only fermentation site in human. The anatomy of the digestive tract of cæcetomized rat is more analogous to human than an intact rat. Therefore cæcetomized rat can be a possible model animal to study the functional effects of indigestible but fermentable materials for humans.

Although fermentable materials has many functional effects for humans, over does or intake in large amounts may cause many gastrointestinal discomforts, e.g. bloating, flatulence, cramping, abdominal pain, and osmotic diarrhea. In spite of large scale gastrointestinal discomforts, no noble research has been investigated to identify the actual cause or to reduce the above fermentable material based discomforts or diarrhea. Identifying the actual cause and prevention of the possible risk of diarrhea caused by above materials is very important to increase their nutritional value and acceptability for humans.

A series of four experiments were carried out to investigate the possibility of cæcetomized rats as an experimental model animal for humans to study the functional effects of fermentable materials, as well as to identify the actual cause and possible ways and mechanisms of prevention of fermentable materials based osmotic diarrhea in cæcetomized rats. In the first two experiments, effects of two sugar alcohols (sorbitol and lactitol) were investigated based on feed intake, body weight gain, digesta movement, nutrient utilization, gut fermentation and serum lipid profile in both normal and cæcetomized rats in parallel to compare their effects. It was found that sugar alcohols caused diarrhea only in cæcetomized rats, not in normal rats during the experimental periods. Neither feed intake nor body weight gain was affected by the cæcetomy in rats in the both
experiments. Digesta transit time was significantly faster in the cecectomized groups and relatively slower in the normal groups fed sugar alcohols than their respective control diets. Body fat accumulation and gut ammonia nitrogen concentration was lowered in the both groups fed sugar alcohols containing diets whereas these effects were significantly higher in the cecectomized groups than the normal groups. Contradictory results for serum lipid profile in normal and cecectomized rats were observed when compared with human studies. The inverse results for large intestinal organic acid and blood urea nitrogen concentration were also found between the normal and cecectomized rats.

It was found that a tendency for diarrhea, faster transit time and body fat lowering effect of sugar alcohols in cecectomized rats support the results of human studies. For the first time these results indicate that cecectomized rat can be a good subject to study the physiological effects of sugar alcohols in humans. But further comparative study between human and cecectomized rat will be needed to confirm the actual possibility.

It has been reported that diarrhea is common phenomenon when consuming large amount or high doses of sorbitol either by adults or children. Sorbitol similarly caused diarrhea in cecectomized rats but not in normal rats in our first two experiments. Therefore, our third experiment was conducted to evaluate the effect of rice gruel or rice starch on sorbitol based diarrhea prevention in cecectomized rats. It was observed that both rice gruel and rice starch are very effective to reduce the degree of sorbitol induced diarrhea. Four different compositions of rice gruel were provided in four different phases to compare the effectiveness of rice gruels or rice starch in a certain composition level. It was found that 5% sorbitol caused diarrhea and 5% rice gruel is more effective to reduce the degree of diarrhea than other compositions (10% rice gruel or 30% rice starch). Although diarrhea was provoked in the following day after providing diets, most of the rats recovered within 3-5 days and continued to excrete hard feces.

The fourth and last experiment of this research was investigated to clarify the possible actual cause and mechanism of prevention of sorbitol based diarrhea by rice gruel in cecectomized rats. It was found that rice gruel delayed the gastric emptying as well as slowed down the intestinal transit in cecectomized rats. Therefore, the contact time sorbitol with small intestinal mucosa was increased and a large amount of sorbitol and fluid was absorbed in the third and last quarters of the small intestine. As a result a relatively smaller amount of sorbitol entered into the proximal colon for fermentation and organic acid concentration was relatively decreased. By this mechanism, an iso-osmotic environment was maintained in the distal part of the digesta and hard feces was formed in the mid to distal part of the colon.

The results of the present study indicate the possibility of the cecectomized rat as a possible tool to study the physiological effects of sugar alcohols in humans, and the effectiveness of rice gruel to prevent sorbitol based diarrhea in cecectomized rats. The possible actual cause and mechanism of prevention of sorbitol based diarrhea by rice gruel was also clarified in this study.