The effect of fiber diet on the jejunum of growing male albino rats A histological and histochemical study

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تأثير الغذاء المحتوي علي الألياف علي صائم ذكور الجرذان البيضاء في فترة النمو
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Introduction

Fiber is the portion of plant cells that is not digested in the human small intestine ***(Hamilton & Anderson, 1992).***

The concept of dietary fiber is a complex one that incorporates the physical and physiological functions of fiber and its effects both systemically and locally to the gastro-intestinal tract. Dietary fiber can be classified according to its solubility ***(James, Muir, Curtis, and Gibso, 2003).***

Pectins and gums are multi-branched hydrophilic substances forming viscous solutions that delay gastric emptying and nutrient absorption from the small bowel. They are used to delay gastric emptying and alleviate constipation ***(Spiller, 1994).***

Soluble fibers as, oat or bean products, lower cholesterol significantly for persons with hyper-cholesterolemia and for healthy young subjects ***(Anderson, 1985).***

Other fibers, including cellulose and lignins, are insoluble. They markedly accelerate colonic transit and are frequently used as laxatives ***(Spiller, 1994).***

High-fiber intake provides well-established benefits for persons with diabetes: it lowers insulin requirements, provides better control of blood glucose, and reduces serum lipids. High fiber foods also lower serum triglycerides and blood pressure. Several studies indicated that high fiber intake had a protective effect against coronary heart disease ***(Anderson, 1985).***

Benefits of fiber consumption have been documented in treatment of obesity and obesity-related risk factors. A high fiber weight reducing diet is most beneficial as part of a lifestyle modification program for weight management ***(Hamilton & Anderson, 1992).***

Therefore, encouraging the intake of a high-fiber diet is likely to have a range of health benefits ***(James et al., 2003).***

Aim of the work

The aim of the present study is to demonstrate the effect of fiber diet on histological, histochemical and scanning electron microscopical appearance of jejunum of growing male albino rats.

Review of Literature

The suckling weaning transition is characterized by high rates of growth and development. It may be a sensitive period during which inefficient dietary intake can program the body metabolism to increase risk of cardiovascular disease and diabetes in adulthood ***(Bell, Hoedl and Turchinsky, 2003).*** There are three major components of gut health: the diet, the mucosa and the commensal flora. The mucosa is composed of the digestive epithelium, the gut associated lymphoid tissue, and the mucus overlying the epithelium. All these factors are in a dynamic equilibrium to ensure the efficient function of the digestive system. Food should be chosen to favor conditions in the gut that stabilize this balance. Dietary fiber is the main substrate for bacterial fermentation, as it interacts both with the mucosa and the microflora. It has an important role in the control of gut health ***(Montagne, Pluske and Hampson, 2003)***. Thus if the flora is established early and maintained in the long term after gut barrier function have matured, then early diet may be of a major influence beyond infancy ***(Edwards and Parrett, 2003)***.

Dietary fiber

Dietary fiber is defined as the sum of lignin and polysaccharides that are not digested by endogenous secretions of the digestive tract of man. Dietary fiber includes any resistant starch, soluble and insoluble non starch polysaccharides ***(Trowell, Southgate, Wolever, Leeds, Gassullcand, Jenkins, 1976)***. Although dietary fibers are undigestible by mammalian enzymes, yet they are broken to a considerable extent through bacterial fermentation in the colon ***(Cummings, 1981)***. Moreover, ***Cummings, Englyst and Wiggins (1986)*** mentioned that within the colon, their breakdown was the result of action of many species of intestinal microflora predominantly anaerobe. Whereas, the ultimate end products were short-chain volatile fatty acids (SCFAs) and gases. ***Koruda (1993)*** found that SCFAs are primarily metabolized by the colonic mucosa. He added that the SCFAs which are not metabolized by the colonic epithelium are transported to the liver for metabolism. ***Agostoni, Riva, and Giovannini (1995)*** declared that dietary fibers are classified into two categories, soluble and insoluble depending on their solubility in water. They added that most foods contained a mixture of soluble and insoluble fibers. Soluble fibers included pectins, uronic acids, gums and some hemicelluloses as in fruits and seeds. They are widely used as food additives as well as in management of

constipation. On the other hand cellulose, lignin and other hemicelluloses made up the insoluble fraction of fiber. Whole cereals and vegetable peels are the main sources of cellulose and lignin. Cellulose is also associated with protection against cancer. They noticed that the diet of weaned infants was found to be too protein dense, especially with the use of cow milk or protein rich follow up formulas. Therefore, supplementing fiber containing foods would be advisable to avoid disturbing the infant's metabolic homeostasis. They recommended 5gm/day of soluble and insoluble fiber to be obtained in the weaning diet. This would be achieved by introducing fruits and vegetables on the basis of their relative allergenicity in gradually increasing amounts over time.

Williams, Bollella and Wynder (1995) stated that a safe range of dietary fiber intake for children older than 2 years was between (age + 5-10 gm/day). They found that this range would provide enough fiber for normal laxation and prevent future chronic diseases, adult onset diabetes and some types of cancer. They noted that applying this rule would increase fiber intake from 8gm/day at age 3 years to 25gm/day at age 20 years. After age 20 years, adult guidelines of 25-35gm/day dietary fiber are the goal. ***Topping and Clifton, (2001)*** explained that on weaning, adult bacterial profiles develop due to dietary change. They added that the number of beneficial bacteria was enhanced

with the selective stimulatory effect of dietary fiber on growth and/or activation of the gut microflora.

James et al., (2003) explained that soluble fibers especially oat fiber lowered serum cholesterol by reducing the absorption of both cholesterol and fat from the small intestine. They also decreased the absorption of bile acids. Soluble fibers could form gels, a mechanism which enabled this kind of fiber to slow gastric emptying, increase small intestinal transit time and slow the absorption of nutrients as glucose and therefore, fiber had a great effect on the glycemic index. They concluded that high fiber food with low glycemic index as legumes, barely, pasta and bread made with unrefined grains was useful in the clinical management of glucose intolerance and diabetes. On the other hand, insoluble fibers acted as a sponge, had water holding properties in the distal colon and bulked the stool in this way. They could also bind molecules as bile acids and carcinogens. Meanwhile, SCFAs especially butyrate had multiple health promoting effects as induction of differentiation of colonic epithelium, improvement of tight junction barrier function and suppression of tumorigenesis. The authors reported that hydrogen ions produced from products of fiber fermentation decreased the luminal pH and thereby prevented the growth of pathogenic pH sensitive bacteria. ***Montagne et al., (2003)*** stated that in the large intestine SCFAs stimulated the reabsorption of

water and sodium thus decreased the risk of diarrhea. ***Higgins (2004)*** in his study presented evidence that chronic feeding of rats with resistant starch significantly lowered plasma cholesterol and triglyceride concentrations versus digestible starch feeding. Moreover, resistant starch consumption presented a novel dietary agent for both the treatment of dyslipidemia and prevention of coronary heart disease and stroke. He added that dietary fiber had been shown to lower plasma glucose and insulin concentration following meals by increasing the viscosity of small intestinal contents, binding glucose so decreasing its availability for absorption, and inhibiting alpha-amylase action on starch.

Lim, Ferguso and Tannock (2005) stated that as colonic bacteria are risk factors for cancer colon, then altering the composition or metabolic activity of the bowel microflora might be important in reducing the prevalence of colorectal cancer. The effects induced by dietary fibers in protection against carcinogenesis included: reduced colonic transit time leading to decreased colonic exposure time to the carcinogen, induction of acidic luminal environment reducing the procarcinogenic enzyme activity, binding of the carcinogen to bacterial cell wall and finally detoxifying the carcinogen reactive compounds. They added that other effects included, cell-to-cell signaling between the microflora and host tissues which induced changes in

expression of genes coding for barrier function, gut motility, and angiogenesis. These genes have relevance with cancer.

Slavin (2005) stated that dietary fiber acted as a physiological modulator of energy intake by different mechanisms including: displacement of available energy and nutrients from the diet, increase in chewing which limited food intake by promoting saliva and gastric juice secretion resulting in increase satiety and decrease the absorption efficiency of intestine. He reported that the population that consumed higher fiber demonstrated lower obesity rates, as dietary fiber might have an effect on sensation of fullness during or between eating periods.