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Effect of guar gum on the serum lipid profile of Sprague Dawley rats

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Abstract

The aim of the study was to probe the hypocholesterolemic effect of legumes dietary fiber through "*chapaties*" a staple diet of the South Asia. Commercial wheat flour (*atta*) was blended with legumes i.e. lentil, chickpea and guar gum in various combinations to make composite flour for the preparation of chapaties. Maximum dietary fiber (8.85%) was observed in composite flour with 3g/100 g guar gum, which also gave whiter look and puffiness to the end product. Highest percent increase in dietary fiber (35.3%) was in flour with 3g/100 g guar gum followed by guar gum 2g/100 g (24.1%). The diets prepared from three best selected compositions along with control, were fed to male Sprague Dawley rats for 8 weeks. Lowest serum cholesterol (82.46 mg/dl) was observed in rats fed on guar gum 3g/100 g which showed a significant reduction (17.2%) as compared to control. Similarly, in case of LDL and triglycerides, guar gum 3 g/100 g showed highest decline i.e., 29.7% and 28.4% with reference to control, respectively. The present investigation suggests that five chapaties per day prepared from selected compositions provides an extra 5–8 g of dietary fiber that is helpful in lowering cholesterol in hypercholesterolemic individuals.

Keywords: Sprague Dawley rats; Composite flour; Dietary fiber; Chapati; Serum cholesterol; LDL; HDL; Triglycerides

1. Introduction

Composite flours containing wheat and legumes have proven practical uses in many parts of the world to improve the nutritional and functional properties of flour. Basically, composite flour technology refers to the process of mixing wheat flour with cereals or legumes to make use of local raw materials to produce high quality food products in an economical way (UNECA, 1985). For economic and social reasons, the people of Indian sub-continent heavily depend on pulses as sources of proteins, minerals and vitamins in the daily diets. Chickpea, pigeon pea, mung bean, urd bean, lentil and field pea are the pulse crops of significant dietary and economic importance in the region. In addition to nutritionally important, these are also being recognized as having therapeutic and medicinal properties (Singh, 1999).

Edible fibers have gained its importance in lowering the blood cholesterol. In order to improve the nutrition and health of the people especially heart patients, it is imperative to mix wheat flour with suitable edible materials containing dietary fiber which lower the serum cholesterol. In the region about 80% of the wheat flour produced is utilized in the form of unleavened flat bread locally known as "Chapati" and its culinary variations while the rest 20% is used for bakery products. (Butt, Anjum, Shaheen, Rehman, & Asif, 1997). When a staple diet consumed frequently by the masses is used as a vehicle, high population coverage can easily be achieved (Alberto & Jaime, 1998). Therefore, chapaties prepared by mixing wheat flour with legumes i.e. lentil, chickpea and guar gum can be beneficial for the normal individuals as well as hypercholesterolemic patients.

Dietary fiber adds no calories to the diet; it passes through the intestinal tract undigested. There are two main types of dietary fiber; soluble and insoluble. These two types of fiber vary in foods and exert quite different effects on human health. Insoluble fiber is effective in increasing feeling of fullness, stool size, bulk and helps to reduce constipation and hemorrhoids. It includes wheat bran, whole cereal grains and vegetables. Soluble dietary fiber acts like a sponge and absorbs water in the intestine, mixes

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the food into gel and there by slows down the rate of digestion and absorption. One gram of soluble fiber can lower total cholesterol by about 0.045 mmol/l in humans (Brown, Rosner, Willett, & Sacks, 1999). An inverse association between fiber and coronary disease has been reported. A 10 g greater daily intake of fiber appeared to lower the risk of coronary death by 29% (Morris, Marr, & Clayton, 1977; Khaw & Barrett, 1987; Rimm et al., 1996). Cholesterol lowering effects are most often associated with gelling mucilaginous viscous fibers such as guar gum and pectin. A study conducted on Wistar rats indicated that guar gum diets significantly lower the levels of cholesterol and triglycerides. Guar gum, a great source of dietary fiber contains 80% total dietary fiber, almost in the soluble form (Anonymous, 1998). Due to the various functions of guar gum, it has been observed that the US annually imports more than 96 million lb of guar gum from Pakistan and India (Pszczola, 2003).

Legumes are the important source of dietary fiber after cereals and their dietary fiber content ranged from 10.7% to 14.3% (Dalgetty & Baik, 2001). Chickpea and lentil have dietary fiber content 16.3% and 15.9%, respectively (Achremowicz, Korus, & Curylo, 2000). Some legumes provide a significant quantity of dietary fiber when consumed as whole grains and thus proved as hypocholesterolemic. It is evident that composite flour prepared by blending wheat and legumes in proper proportions can supply the balanced amino acids to the end users. Moreover, at the same time this combination may increase the fiber content of the diet resulting in easiest bowel movement, cholesterol reduction in serum and liver and beneficial effects to the diabetics (Mathur, Singhal, & Sharma, 1964; Murthy & Urs, 1985; Singh, George, & Soni, 1983;Toma & Curtis, 1986). Atherosclerosis is characterized by massive accumulation of cholesterol in the arteries that form the heart of an athermoatous plaque. Epidemiological studies have indicated a high level of plasma cholesterol as an important risk factor (Goldrick, Sinnet, & Whyte, 1970; Lewis et al., 1974).

Cholesterol is an animal sterol best known for its association with atherosclerosis and coronary heart disease. High level of LDL cholesterol deposits on the interior of blood vessels resulting hardened arteries, narrowing of the blood vessels and coronary heart disease. High levels of HDL cholesterol have been shown to reduce some of the harmful effects of LDL cholesterol. HDL picks up and transports cholesterol in the blood back to the liver, which leads to its elimination from the body. HDL can help to keep LDL cholesterol from building up in the walls of the arteries (Awan, 1993). Fiber can be helpful in reducing the cholesterol levels by reducing their absorption in the body (Shen, He, Price, & Fernandez, 1998). Low blood cholesterol levels (below 200 mg/dl) have been associated with a reduced risk of coronary heart disease. The body eliminates cholesterol through the excretion of bile acids. Soluble fiber such as guar gum in the diet at a level of 5 g/100 g elicited a significant lowering of plasma cholesterol during the absorptive period (Moriceau et al., 2000). Guar gum has shown 10–15% reductions in serum total cholesterol and 10–20% in serum concentration of LDL cholesterol. Intake of 15 g guar gum daily considerably reduces serum concentrations of total and LDL cholesterol over 2 years of treatment (Salenius, Harju, Jokela, Riekkinen, & Silvasti, 1995). About 44% reduction in LDL cholesterol and 22% decrease in triglycerides were observed in guinea pigs by feeding soluble fiber diet containing 2.5 g/100g of guar gum, 5 g/100g of psyllium and 5 g/100g of pectin diet (Roy, Vaga, & Fernandez, 2000). HDL cholesterol was found to be non significant by feeding 2–10 g/day soluble fiber (Brown et al., 1999). The effect of solid and liquid forms of guar gum on plasma cholesterol reduction is similar (Superko, Haskell, Sawrey, & Farquhar, 1988). It has been proved through clinical trials that, when used alone, guar gum may reduce serum total cholesterol by 10 to 15% (Todd, Benfield, & Goa, 1990; Uusitupa, Tuomilehto, Karttunen, & Wolf, 1984). Cholesterol levels especially low density lipoprotein (LDL) decreased by 11.5% and plasma cholesterol levels 9.6% by eating guar gum (Turner et al., 1990). A marked improvement (23%) has been found in HDL/LDL ratio during guar gum treatment (Tuomilehto, Silvasti, Manninen, Uusitupa, & Aro, 1989).

In Pakistan, to control cholesterol, little efforts are being carried out through diet management. It is mandatory to increase dietary fiber in the diet of vulnerable group by blending high dietary fiber commodities in the staple diet to reduce the threat of cholesterol. For this purpose, research trials were conducted on male Sprague Dawley rats to find out the impact of composite flour chapaties containing different levels of lentil, chickpea and guar gum on their serum profile with special emphasis on cholesterol, HDL, LDL and triglycerides.

2. Materials and methods

2.1. Materials

Commercial wheat flour (*atta*), guar gum, lentil and chickpea were purchased from the local market to make different composite flour compositions for chapati making.

2.2. Composite flours

The legumes were cleaned manually to remove extraneous materials. High viscosity guar gum (molecular weight 1.91×10^6) with particle size of 200 mesh was used. Wheat flour was blended with lentil, chickpea and guar gum flours in various combinations as mentioned in Table 1. Homogenous replicates for composite flours were made and stored at room temperature in polypropylene bags.

2.3. Chapaties preparation

Chapaties were prepared fresh at various storage intervals i.e. 0, 60 and 90 days from all the samples by