Article

# BLACK GRAM (*Vigna mungo*) - A hypolipidemic pulse

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## Abstract

Black gram is a pulse commonly used in Indian cuisine. Systematic studies on the effect of lipid lowering action by common pulses revealed that black gram possesses significant hypolipidemic action. Detailed experimental studies in animals have shown that a polysaccharide and a protein fraction contribute to the hypolipidemic action. Glycosaminoglycan metabolism is altered by inclusion of these fractions in the diet. Neutral detergent fiber isolated from black gram possesses, significant hypolipidemic, hypoglycemic, and anticolon-cancer activity.

Cardiovascular problems have been haunting human populations for a long time with no specific cure. It is believed that a shift in the eating, and physical habits might have paved the way for the alarming increase in cardiovascular diseases. Increase in the lipid level has been pinpointed as an important risk factor. Hence epidemiological and clinical studies were undertaken throughout the world to find an answer to this. We also attempted in a small way to find out whether the commonly consumed pulses have any correlation with the lipid profile (Devi & Kurup, 1970).

Black Gram [***Vigna mungo* (Linn.) Hepper** syn. *Phaseolus mungo* Linn., non Roxb. & auct; *Phaseolus radiatus* Roxb., Hindi-*Urd*] is a highly prized pulse. The main areas of production are Madhya Pradesh, Uttar Pradesh, Punjab, Maharashtra, West Bengal, Andhra Pradesh and Karnataka. It is mostly consumed as pulse and in the preparation of typical Indian dishes like *pappad, idli, dosa* and *vada*. It is a good source of phosphorus. Our investigations led to the conclusion that black gram has significant lipid lowering action. So, further studies were focussed to find out the active principles present in black gram responsible for that effect. A protein and a polysaccharide fraction were isolated from black gram. The globulin fraction at 5% level brought down the cholesterol and triglycerides in the serum, liver and aorta of rats fed high fat, high cholesterol diet to normal levels. Limited numbers of human studies were also carried out which indicated the hypocholesterolemic and hypotriglycerdemic effects of the protein. The polysaccharide fraction at 56% had a similar action, but to a lesser extent. The protein fraction contained carbohydrate residues and SDS PAGE electrophoresis showed that it was a heterogeneous mixture. Studies on the mechanism of hypolipidemic action revealed that even though the protein fraction increased cholesterol absorption, caused more hepatic degradation of cholesterol to bile acids and their fecal excretion (Devi & Kurup, 1972, 1973; Menon & Kurup, 1976). Regression of the experimentally induced atherosclerosis has also been studied with this fraction. Both biochemically and histochemically significant regression of atherosclerotic plaques were observed (Jayakumari *et al*, 1978). The proteolysis of this protein was also done and the action of this enzymatic hydrolysate was also studied. But these studies showed that the intact protein was more effective indicating the role of carbohydrates bound to the protein and its intact three dimensional structure (Kurup & Kurup, 1982). Impact of this protein fraction on glycoaminoglycans (GG) was also studied. Heparin sulphate and chondroitin sulphate decreased while other GG fractions were unaffected (Menon & Kurup, 1974, 1975). The implications of this observation have to be viewed in the light of the accumulation of GG reported in the coronary or cerebral arteries in heart attacked /stroke patients.

At this time role of dietary fiber in reducing atherosclerosis is gaining importance. Trowell (1975) suggested that natural carbohydrates, especially those rich in dietary fiber might protect against atherosclerosis and might reduce hypercholesterolemia. We estimated the fibre content of various purified starches and

black gram polysaccharide. It was shown that black gram polysaccharide had the highest fiber content and maximum hypocholesterolemic effect in rats fed both normal and high fat diet. Excretion of fecal bile acids and bile salts was maximum in animals fed polysaccharide. There was significant binding of bile acids when natural or pure bile acid solution was shaken with it (Vijayagopal *et al*, 1973).

A number of epidemiological studies also suggested a relationship between high fiber intake and incidence of coronary heart disease. The definition of the fiber itself underwent a sea of changes. Hence black gram fiber was isolated as neutral detergent fiber (NDF) by the process of Goring and Van Soest (1970). It was found to contain 43.5% hemicellulose, 35.76% cellulose, 15.07% lignin, 5.24% cutin, and 2.83% silica (Molly Thomas *et al*, 1990). When this NDF was administered at the level of 30% of that of diet, it significantly lowered cholesterol both in the serum and aorta. The action was much greater than that of pure cellulose. The stool bulk was increased in both the cases being greater in the case of cellulose. Enhanced excretion of the bile acids pointed out that the cholesterol lowering action is not only due to the presence of cellulose alone (Jaya Kumari & Kurup, 1979). Detailed studies showed that the hemicellulose is the most active component of NDF. Removal of hemicellulose reduced the hypolipidemic effect of NDF. Keeping this in view in-depth study on the effects of NDF in cholesterol and bile acid metabolism was undertaken (Indira & Kurup, 1989). Studies with labeled acetate drew a better picture of the mechanism. Cholesterol synthesis was enhanced as evidenced by the increased activity of HMG CoA and incorporation of labeled acetate to cholesterol (Molly Thomas *et al*, 1983). But the lipid lowering action was due to the greater hepatic degradation of cholesterol to bile acids. NDF could also reduce ethanol induced hyperlipidemia (Indira & Kurup, 1982).

Rat is a species resistant to atherosclerosis. But similar experiments with chicks, a species susceptible to atherosclerosis, also supported observed hypolipidemic action. *In vitro* studies showed that black gram NDF possess different binding affinities for different bile acids; maximum binding observed for chenodeoxy cholic acid and minimum binding with deoxycholic acid (Indira & Kurup, 1989). Sharma (1979) isolated isoflavanones from black gram and studied their action on experimentally induced hyperlipidemia. Among the isoflavanones, biochanin A and formononetin showed hypolipidemic action. These studies indicate that apart from proteins and fiber content the isoflavanones also contribute to the hypolipidemic action of black gram.

We also focused our studies to find out whether the consumption of dietary fiber at such a high level would interfere with the absorption of other nutrients. Enhanced fecal excretion of inorganic cations ($Mn^{++}$, $Cu^{++}$, $Fe^{+++}$, $Zn^{++}$, $Na^{+}$, and $K^{+}$) was seen in experimental animals. *In vitro* studies showed significant binding of inorganic cations. Absorption of glucose and cholesterol was lower in the presence of dietary fiber. NDF can also lower glucose level and so it may be used for the control of diabetes (Indira & Kurup, 1989). Since NDF interacted with the absorption of many nutrients studies were extended to find out whether it has any effect on the toxic effects of Malathion in rats. Results revealed that it raised the activity of acetyl cholinesterase which was decreased by Malathion, indicating that fiber rich diet can minimize the toxic effects of pesticides (Indira & Kurup, 1980).

Dietary factors can modify the metabolic activities of intestinal bacteria which play a role in the conversion of bile acids and neutral sterols to reactive metabolites, some of which may possibly act as co-carcinogens and/ or carcinogens. Considerable clinical interest had been expressed in the qualitative and quantitative aspects of dietary fiber in relation to the incidence of colon cancer. So the effects of black gram NDF on the metabolic activity of intestinal bacteria in chicks and in rats fed cholesterol containing diet was studied (Indira & Kurup, 1980; Manoj *et al*, 1993) by use of bacterial β-glucuronidase as an inducible enzyme. NDF at 30% level significantly lowered bacterial as well as tissue β-glucuronidase activity indicating the lower activity of intestinal microflora. This observation is relevant since the activity of microflora is positively correlated with the incidence of colon cancer. Effect of NDF on experimentally induced colon carcinogenesis with 1, 3 dimethyl hydrazine showed that black gram NDF may potentially play a role in preventing the formation of colon cancer (Manoj *et al*, 2001). Apart from modifying intestinal microflora dietary fiber may also bind such carcinogens/co-carcinogens formed from bile acids and preventing them from coming into contact with the intestinal mucosa.

Nearly three decades of research have shown that black gram fiber possesses significant hypolipidemic, hypoglycemic and anticolon-cancer activity. We had also attempted clinical trials in humans. Results were quite positive. So inclusion of black gram in daily diet will afford protection against many of these disorders.

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